Assessment of hand-arm vibration (HAV) exposure in an alumina refinery workshop.

A pilot study using new dosimetry technology

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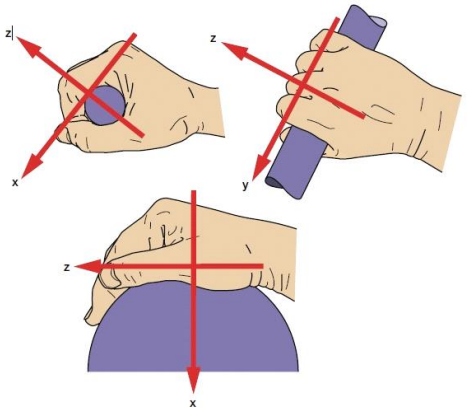
Introduction

- **HAV: A known occupational hazard in many industries**
- **Prolonged exposure leads to adverse health effects**
  - **Vascular**
  - **Neurological**
  - **Musculoskeletal**
- **400 workers compensation claims per year in Australia between 2000 and 2008 (Safe Work Australia, 2010)**
- **Critical to accurately assess the level of exposure**



HAV exposure dose

- **Dose is dependent on vibration magnitude and duration**
- **Vibration magnitude is affected by**
  - **Tool and task features**
  - **Individual operator characteristics**
- **Duration varies**
  - **For different tasks and from day to day**
- **Daily exposure dose-referred to as A(8)**
  - **quantity of HAV during a working day**
  - **duration normalised to 8h**



One tool $A_1(8) = a_{hv}\sqrt{\frac{T}{T0}}$ **Multiple tools** $A(8) = \sqrt{A_1(8)^2 + A_2(8)^2 + \cdots}$

Where a_{hv} is the vibration magnitude (m/s^2) of the tool; T_0 is exposure duration at a_{hv}; T is the reference duration of 8 hours

Workplace vibration dose assessments

- **It is difficult to conduct vibration dose assessments in the workplace because:**
  - **A range of tools with different vibration magnitudes is typically used**
  - **Constant observation is required to record exposure duration with each tool**

- **Traditional techniques**
  - **Measurement of the vibration magnitude of each tool**
  - **Using stop watch / video surveillance for duration**
  - **Measuring simulated job tasks in a laboratory**
  - **Measuring only selected work tasks**
  - **Making inferences from databases**
  - **Prone to errors**

New technology

Q2 Dosimetry (Curotec, Hungerford, UK)

- Receptacle “holsters”
- Glued onto each tool
- Each holster uniquely identifies its tool

- Accelerometer
- Clicked onto the holster of each tool used
- Activated by vibration

- Accelerometer data downloaded to a “beacon”
- Beacon uploads data via a wireless device

Objectives

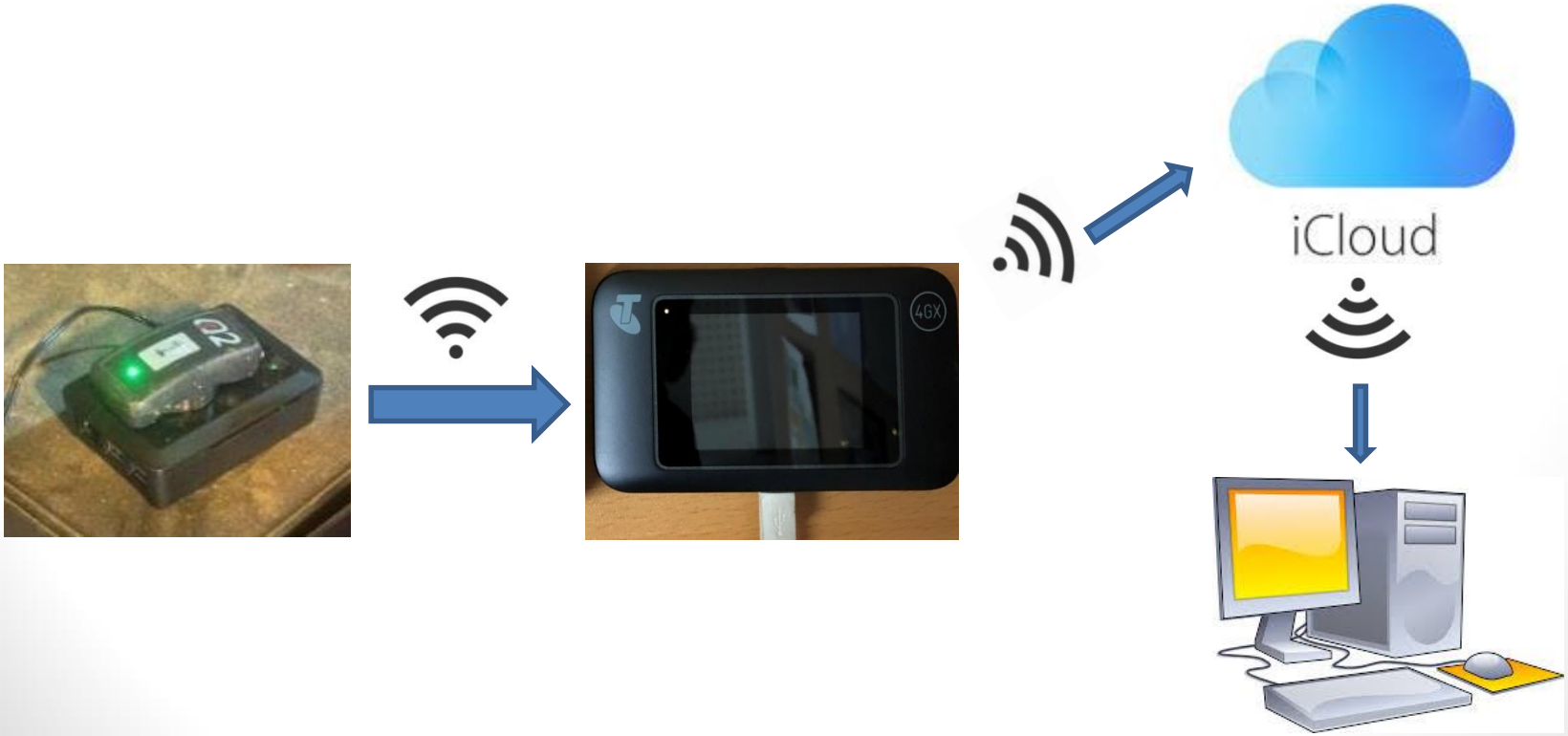
- **Pilot study to test the Q2 system**
- **Determine daily HAV exposure in a workshop**
- **Characterize risks by comparing results to EU standards**
- **Consider appropriate next step actions**

Methods

- **Cross-sectional study**
- **The work undertaken in the WAO workshop**
  - **Removal of deposits, cleaning and painting of valves and parts**
  - **4 working bays: physical descaling is undertaken in 2 bays**
  - **A tool survey identified and coded 18 vibration tools**
- **The workers**
  - **12 workers, 8 hours/day, 9 days/fortnight**
  - **Rotating from one bay to the next daily**
  - **7 of 12 workers available - all consented**
  - **Each issued with a Q2 accelerometer**

Methods

- **Data collection**
  - **Accelerometers were left in lockers at end of shift**
  - **Data was downloaded to beacon and uploaded to iCloud sever**
  - **Data was retrieved and analyzed from off-site computers**
- **Study period**
  - **21 consecutive days (Dec 2018 - Jan 2019)**



Outcome measurement

- **Daily vibration points**
  - **Calculated by the device**
  - **Data output shown in table**

Times Used	Total H/A HSE Points	Total W/B HSE Points	Total Time on tool	Asset No.
4	210		00:16:45	WA Workshop BB
5	63		06:24:44	Tool 3 Needle Scaler
1	21		00:04:49	Tool 19 Spare
1	0		00:00:52	Tool 4 Air Chisel
Totals	294	0	06:47:10	

- **Results compared to the EU Directive Standards**

- The Exposure Action Value (EAV) is 100 points = A(8) of 2.5m/s^2. If the EAV is reached further controls are required.

- The Exposure Limit Value (ELV) is 400 points = A(8) of 5m/s^2. If the ELV is reached there should be no more exposure during that shift.

Results

HAV daily exposure points

- 33 measurements (among 7 operators)
- Range: 9 to 650 points
- Arithmetic mean 181 points
- Geometric mean 100 points
- 19/33 (58%) > EAV (in yellow)
- 4/33 (12%) > ELV (in red)

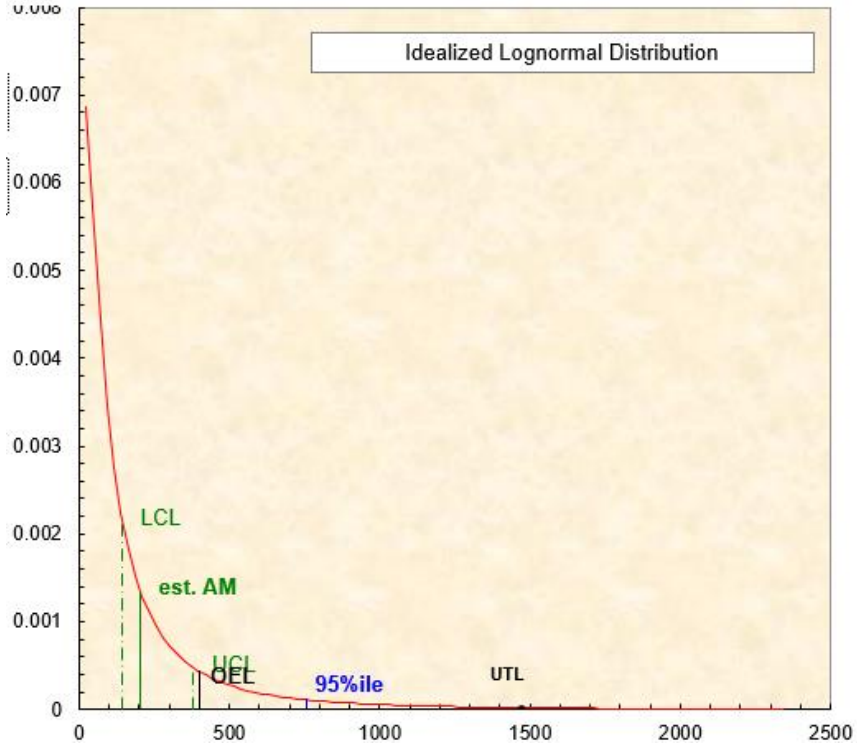
	OP1	OP2	OP3	OP4	OP5	OP6	OP7
Exposure point	17	105	130	101	194	135	650
	9	314	400	195	644	228	242
	50		43	35	466	635	267
	17			291			109
	69						9
	145						205
	41						
	73						
	61						
	86						
	42						
	11						

Similar Exposure Group

- **A logprobability plot of the data demonstrated a lognormal distribution, confirmed by the Shapiro-Wilk W-test ($p < 0.05$)**
- **This indicates it is appropriate to classify the data from the 7 operators as one Similar Exposure Group (SEG)**

Lognormal parametric statistics

- **Estimated arithmetic mean = 205 points**
- **Estimated percent above ELV (400 points) = 13%**
- **95% CI of estimated percent above ELV: 7-23%**



Tools with high vibration

Vibration tools	Maximum daily vibration exposure points generated
#14 needle scaler	589
#3 needle scaler	469

Another 7/18 tools recorded maximum daily vibration dose above the EAV

Discussion

- **Over half (58%) of the daily HAV doses were above the EAV**
- **12% of the daily HAV doses were above the ELV**
- **This indicates the level of HAV exposure in this SEG is unacceptable**
- **Continued exposure increases the risk of HAVS**
- **Further control measures are required**

Discussion

- **This is the first report of a field trial of the Q2 dosimeter**
- **We found the Q2 dosimeter**

  - Was able to measure vibration doses across a range of tools and job tasks

  - Removed the need for separate magnitude & duration assessments

  - Was able to measure HAV in real-time working conditions

  - Was practical with minimal interference to work activities

Discussion

Study limitation

- **Possible underestimation of daily vibration doses**

  - 2 holsters were knocked off tools on the last day, affecting 3 readings

  - If workers forgot to attach the accelerometer every time they switched tools (minimised by staff engagement)

Summary

- **The Q2 dosimeter is a practical tool for HAV dose measurements in a real working environment- particularly suitable for multiple tools and job tasks**

- **An unacceptable level of HAV exposure was identified in the selected workshop**

- **Further controls are regarded as necessary**

  - Targeting tools identified generating high HAV
  - Optimal job rotation
  - Improved training and education
  - Revised periodic medical evaluations to include HS for HAVS

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