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LIVER FUNCTION IN WASTE WORKERS EXPOSED TO LEAD AND MERCURY OVER A TWO-YEAR PERIOD

Study Aim

The study was conducted with the objective of assessing :

- The possible changes in blood Lead and Mercury levels over time
- To look for a correlation between heavy metals exposure and a change in LFT's/ haematology profile

The Gap

- Literature review → gap in studies comparing full blood counts and liver function tests in waste workers exposed to Lead and Mercury over a period of time.
- USA study → incr. blood Pb levels over a 5- year period; hematological profiles → low Hb, incr. ESR, TLC, EOS & MONOS. Clinical correlation with incr. respiratory symptoms, inflammation of the airways, decr. in lung function & a wide range of general health problems
- Thai study → mercury levels higher than controls which correlated with clinical complaints of headaches, nausea, chest tightness and fatigue. Significant associations between improper use of personal protective equipment, and urinary mercury levels

Clinical Effects

- Effects of Hg: Neurobehavioural effects → Significantly impaired short term verbal and spatial memory, impaired sustained attention, & impaired motor speed. Incr psychiatric symptomatology, including anxiety, depression, phobic avoidance. Neurological symptoms of tremor, weakness in limbs, and excessive sweating
- Lead → lowered red cell counts, shortened mean red cell survival. Teratogenic, fetotoxic, causes dysfunction of the kidneys, joints, cardiovascular system and the respiratory system; severe damage to neurons in the brain and spinal cord and lowers IQ among children.

Waste Workplace

- The four key areas of activity in the waste industry are waste collection; transfer; sorting and recycling
- Waste workers are exposed to a broad spectrum of hazards. Higher risk of sustaining physical injuries , psychosocial pressures, infectious diseases and acute illness from biological hazards. Toxicity from chemical hazards.
- The major hepatotoxic substances in waste management work include carbon dioxide, volatile organic compounds (VOC), polyaromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) dioxins, heavy metals such as lead (Pb) and mercury (Hg).

In this study

- Blood lead and mercury concentrations were used in this study as biomarkers to quantify exposure; and were correlated with liver function and haematological profiles over time.
- Work place exposures are captured in a questionnaire with personal health demographics and other likely exposure sources via a targeted history.

Data Collection

- The data used was from workers working at the same site in 2012 and 2014.
- Data included:
 - 2 Completed Lead health surveillance questionnaires- SafeWork Australia Proforma Lead health report
 - 2 Completed Mercury health surveillance questionnaires- SafeWork Australia Proforma Mercury health report
 - Bloods test results including FBC profile, LFT's, Pb levels, Hg Levels

Study Design – research tools

This is an observational study of blood levels in waste management workers participating through their employer in a health surveillance program

- 2 periods to study 2012 and 2014.
- 300 files reviewed, 48 workers had data available for both periods
- With blood results attached
- Continuing to work in same role
- All results were from workers from the same site
- Main difference – nil in role, nil in work exposures over 2-year period

Methodology

- A univariate analysis was used for the description of the study population.
- A paired sample t-test and Pearson's correlation coefficient were used to assess:
 - the change in blood levels of the 2 metals in 2012 and 2014
 - the change in LFT's/ FBC in 2012 and 2014
 - for assessing correlation between Hg and Pb in the blood LFT's & FBC in 2012 and 2014
- Data analysis was conducted using SPSS Statistics Software.

Study Demographics

	Number	Job type	Youngest	Oldest	Average Age
Males	35	Rubbish Sorter	29 years	72 years	50.94 years
Females	13	Rubbish Sorter	33 years	66 years	51.92 years

Results

TABLE 1: COMPARISON OF BLOOD HG & PB LEVELS BETWEEN 2012 & 2014

	N	2012 Mean (SD)	2014 Mean (SD)	P*
Mercury	48	20.6 (20) nmol/L	16.9 (19) nmol/L	0.4
Lead	48	0.11 (.03) µmol/L	0.16 (.07) µmol/L	0.05
* Paired sample t test				

TABLE 2: COMPARISON OF HEMATOLOGICAL PARAMETERS BETWEEN 2012 AND 2014

	2012 mean (SD)	2014 mean (SD)	P*
Hb	148.6 (11.2) g/L	146.7 (11.9) g/L	0.09
MCV	88.7 (6.0) fL	87.6 (6.8) fL	0.007
WCC	7.8 (2.6) 10 ⁹ /L	8.1 (2.1) 10 ⁹ /L	0.45
Platelet	275.4 (59.3) 10 ⁹ /L	274.7 (53.8) 10 ⁹ /L	0.89
* Paired sample t test			

TABLE 3: COMPARISON OF GGT & ALT TESTS BETWEEN 2012 AND 2014

	N	2012 mean (SD)	2014 mean (SD)	P*
GGT	48	36.8 (34.5) U/L	39.7 (40.3) U/L	0.40
ALT	48	28.6 (14.8)	35.1 (16.6)	0.01
* Paired sample t test				

TABLE 4: PROPORTION OF WORKERS WITH ABNORMAL Hg AND Pb LEVELS IN BLOOD IN 2012 AND 2014

Year	Hg N (%)	Pb N (%)
2012	5 (10.4)	2 (4.2)
2014	2 (4.2)	2 (4.2)
P*	>0.05	>0.05

TABLE 5: NUMBER OF WORKERS WITH ABNORMAL HAEMATOLGOICAL & LFT'S

Year	Low Hb N (%)	Abnormal MCV N (%)	Abnormal WCC N (%)	Abnormal PLT N (%)	Abnormal GGT N (%)	Abnormal ALT N (%)
2012	2 (4.2)	3 (6.2)	5 (10.4)	1(2.1)	6 (12.5)	8 (8.3)
2014	2 (4.2)	5 (10.4)	3 (6.2)	1 (2.1)	7 (16.2)	15 (15.6)
P*	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

TABLE 6: CORRELATION BETWEEN HG, HB, MCV, WCC, PLT, GGT and ALT (PEARSON CORRELATION)

Year	Hb	WCC	MCV	PLT	GGT	ALT
2012	0.26 *	0.02	0.05 *	0.01	0.05*	0.12
2014	0.23 *	- 0.09 *	0.09 *	0.02	0.01	0.22
* P value >0.05						

Table 7: Correlation between Pb and Hb, MCV, WCC, PLT, GGT and ALT (Pearson correlation)

Year	Hb	WCC	MCV	PLT	GGT	ALT
2012	-0.04*	0.19	0.02	-0.85 *	0.01	-0.18*
2014	-0.06*	0.09 *	-0.03*	-0.15 *	0.02	-0.24*
* P value >0.05						

Discussion

- This study found statistically significant increase in:
 - ALT levels
 - blood Pb level
 - no significant difference in blood Hg levels over the 2 periods
- Significant correlations between
 - Pb and GGT
 - Hg and PLT, and ALT
- Pb concentration in blood is known to increase in people who are occupationally exposed.
- A possible explanation for occupational exposure can be the improper use of personal protective equipment.

Discussion

- This worksite filled with other hepatotoxic exposures from pesticides, PCB's, PAH's → may accelerate liver damage or increase liver transaminitis pattern
- Liver amino transferases can increase due to alcohol consumption, viral hepatitis, medications hemochromatosis, obesity and metabolic syndrome.
- Liver disease, though not diagnosed through a blood test alone is part of a battery of tests and serial biochemical screens in which ALT is used along with AST, PT, GGT, Alb, ALP, and BIL to monitor liver damage.

Other discussion points

- SWA Questionnaire– widely used tool, variability in answers and clinical details. Requires detailed interrogation of responses regarding past employment, exposures, PPE use, hobbies and diet.
- LFT's and FBC – crude markers
- Background of company being bought out and job security issues in answering questions

Methodological Flaws – Bias

- Sampling bias – sampling was non random
- Collection bias – different information collectors at different times.
- Recall bias – pitfall with questionnaires
- Out of a total of 300 workers at the company, complete records were available for only 48 of those workers.

Methodological Flaws – Confounders

- There are so many confounders in this study such as age, ethnicity, gender, comorbidities, etoh use, meds, hobbies, socio-economic status, other workplace hepatotoxins and smoking
- Confounders: Hawthorne effect, better working procedures or awareness of company policies
- Lack of complete adjustment for such confounders are could be significant factors in this study

Study Limitations

- Baseline studies of liver function and full blood counts were not available for comparison of the 2012 and 2014 results.
- Concomitant work records of machine audits and hygiene reports were not compared directly and in a holistic fashion
- PPE compliance reports were filled in by workers to a variable standard and the information is not routinely verified.
- Some health surveillance questionnaires had incomplete sections for previous employment, history of exposures and use of PPE in those roles.
- Workers were not well versed with regards to type of PPE used.

Conclusions

- The Pb concentration among the study population had increased over time.
- Significant correlations observed with:
 - Hg exposure and increase in PLT and ALT
 - Pb and GGT is noted
- The increase in ALT, GGT & PLT levels cannot solely be explained by the increase in Pb concentration but is noted; and should be further explored as part of a complete occupational health surveillance assessment.
- A planned study should be undertaken to evaluate the causes for the changes in Pb concentration over time with a holistic workplace and worker involvement hygiene monitoring program. A simultaneous review of hierarchy of controls and PPE audit should be instituted.

Thank you (s)