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Long Term Metal PM$_{2.5}$ Exposures Decrease Cardiac Acceleration and Deceleration Capacities

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Slide 2

Boilermakers and PM$_{2.5}$ Exposures

- Boilermakers build, maintain and repair boilers often located in power plants
- Boilermakers are exposed to PM$_{2.5}$ during welding
  - Base metal of Fe, Mn, Si, Cr, Ni
- Welders have increased risk of ischemic heart disease mortality and non-fatal myocardial infarction

(Cavallari, Fang et al. 2010)

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Slide 3

Heart Rate Variability (HRV)

- One proposed biological mechanisms for PM$_{2.5}$ related cardiovascular events includes altered cardiac autonomic response, which is measured by HRV
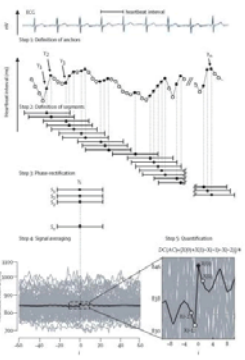

Electrical Activity of the Heart Over Time

- HRV is the analysis of the variation in heart periods

- Low HRV is a predictor of poor cardiovascular outcomes

Illustration www.polarusa.com/manuals/RS800/ch11.html
Task Force. 1996

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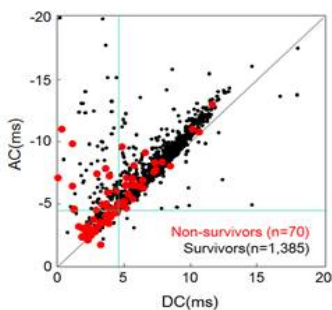## Slide 4

New indices in CV Research

- Acceleration Capacity: Variability in RR intervals before and after increase in a heart rate
- Deceleration Capacity: Variability in RR intervals before and after slowing in a heart rate

Bauer et al., Lancet **2006**;367:1674-81

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DC & AC ...

... are not symmetric (in 15% of post-MI patients)

Non-survivors (n=70)
Survivors(n=1,385)

HRV and PM$_{2.5}$

- Numerous studies report consistent associations between PM$_{2.5}$ air pollution exposures and HRV
- Fewer studies have investigated the association between occupational PM$_{2.5}$ exposures and HRV
  - No effect among vehicle maintenance workers
  - Positive association among patrol troopers
  - Negative association with 4-hr workday PM$_{2.5}$ and short duration HRV among welders

(Pope and Dockery. 2006) (Riediker et al. 2004)
(Cavallari, Fang et al. 2008)   6

Previous Research

- Short term and intermediate cardiac autonomic health effects of PM$_{2.5}$ using HRV(Cavallari, Eisen et al. 2007, Cavallari, Eisen et al. 2008, Vallejo, Ruiz et al. 2006, Cavallari, Fang et al. 2010)

- Short term effects of PM$_{2.5}$ using on DC (Baeur, Kantelhardt et al. 2006, Guzik, Piskorski et al. 2012)

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The Harvard Boilermaker's Cohort

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Data collection scheme

Obtained data on Jan. 2010, June 2010, Jan. 2011, June 2011, and June 2012

	Baseline AM (Pre-shift: 0 hr)	Afternoon (Post-shift: 6 hr)
Outcome measurements		
AC and DC	X	
Exposure measurement		
Real-time $PM_{2.5}$ (DustTrak)	X---X	

- Demographic, occupational, smoking, medical history from questionnaire

- Information on days since last welded

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Table 3-3: Linear regression coefficients (b1) of main effect of Cumulative Exposure Index (mg/m³-years) on acceleration capacity (msec) and deceleration capacity(msec).

Parameter	Acceleration Capacity(AC) Beta(95% C.I.)	Deceleration Capacity(DC) Beta(95% C. I.)
Models		
Model 1	0.65 (-0.05, 1.25)	-0.56 (-1.10, 0.02)
Model 2	**1.23 (0.23, 2.69)**	-1.07 (-2.06, 0.08)
Model 3	**1.26 (0.17, 2.69)**	-1.09 (-2.06, 0.12)
Model 4	**1.31 (0.14, 2.75)**	-1.15 (-2.09, 0.20)

Bold values indicate significant correlations (p<0.05)
Model 1: AC or DC = b0 + b1*CEI + e
Model 2: AC or DC = b0 + b1*CEI + b2*Age + e
Model 3: AC or DC = b0 + b1*CEI + b2*Age + b3*TOD + e
Model 4: AC or DC = b0 + b1*CEI + b2*Age + b3*TOD + b4*LWD + e

CEI=Cumulative Exposure Index (mg/m3-years)
Age=The residual of age on CEI was used to represent the heart age (variation in age not explained by the exposure)
TOD=Time of Day ECG was taken (AM vs PM)
LWD=Last Weld Day

Long Term Metal Particulate Exposures Decrease Cardiac Acceleration Capacity In Welders   10

Discussion

- The longer the work $PM_{2.5}$ exposure, the lower the AC and DC at follow up

- Increasing age is a strong predictor of declines in AC and DC at follow up
  - There is a potential for cardiac autonomic effects even among the young and healthy

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Strengths

✓ Tease out long term effects from short term effects
✓ Reduced misclassification of outcome variable
✓ Detailed work history data

Limitations

❖ Potential misclassification of Chronic exposure index
❖ We could not adjust for baseline AC and DC prior to recruitment

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Summary/Implications

- Long term $PM_{2.5}$ exposure decreases AC and may also decrease DC.

- Welding fume exposures adversely affects cardiovascular health

- Until the toxic component(s) of PM are identified and eliminated, exposure to occupational PM should be minimized

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Questions

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