Occupational exposure to bisphenol A. Urinary biomonitoring

Sophie NDAW, INRS (France)
What is Bisphenol A or BPA?

Polycarbonate production
- Optical media
- Electronical & Electronics
- Construction
- Medical & Healthcare
- Bottles & Packaging
- Automotives

Epoxy production
- Protective Coatings
- Can Coating
- Composites
- Sea containers
- Flooring
- Adhesives
- Electrical & Electronics

Other products
- Other resins
- Thermal paper
BPA effects – human health trends

- Altered brain development and behavior
  - Hyperactivity
  - Abnormal behavior
- Endocrine disruption
  - Obesity
  - Type 2 diabetes
- Reproductive effects
  - Early sexual maturation
  - Miscarriage
- Cancer
  - Prostate
  - Breast

Controversial discussions around the effects of BPA
Human exposure to BPA

- Diet
- Beverage
- Dust
  - Thermal paper
- Medical devices
- Workplace exposure

- Inhalation route
- Oral route
- Dermal route

Average exposure through diet
100 – 300 ng/kg/day (ANSES 2010)

Increasing focus
- Thermal paper
- Dermal route
- Workplace exposure
ANSES 2013 – BPA risk assessment for human health

• Address the risks for human health of pregnant workers and consumers exposed to BPA through thermal paper they may handle

• Identify adverse effects for the unborn children’s health on:
  ■ Vulnerability of the developing mammary gland
  ■ The brain and the behaviour
  ■ The metabolism and obesity
  ■ The female reproductive system

• Evaluation based on models and assumptions for the exposure to BPA
Occupational exposure to BPA through thermal paper

- Thermal paper manufacturers
- Printing companies workers
- Cashiers

186,000 French cashiers

Women: 89%
Men: 11%
INSEE 2011
Study design: 2013 - 2014

- BPA quantification in thermal paper
- Questionnaire
  - Job / work description
  - Food (canned food...)
  - Tobacco
  - DIY: paints...
- Urinary biomonitoring
Urinary excretion of BPA

- **Unconjugated BPA** (or BPA free form): biologically active form for ERs
- **Conjugated BPA**: inactive forms

Biomonitoring

- Free BPA in urine
- Total BPA (conjugated + unconjugated BPA) in urine
- Spot urine samples
  - Pre-shift
  - Post-shift
  - First morning void
Exposure of cashiers to BPA

- 134 participants in 10 companies (restaurants, shops, …)
- **90 cashiers** (69 women) aged 20-60 years (median 32 years)
- 10 to 1000 receipts/day (estimation)
- BPA in thermal paper: 1% - 1.8% (w/w)
- **44 controls**, aged 21-59 years (median 41 years)
  - Administrative staff
  - IT department
  - Supply staff
### Urinary BPA levels of cashiers and controls

**Distribution of BPA concentration**

#### Total BPA µg/l

<table>
<thead>
<tr>
<th></th>
<th>Nb samples</th>
<th>GM (GSD)</th>
<th>Median</th>
<th>95th percentile</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>N= 44</td>
<td>195</td>
<td>3,52 (2,35)</td>
<td>3,54</td>
<td>14,2</td>
</tr>
<tr>
<td>Exposed</td>
<td>N= 90</td>
<td>390</td>
<td>8,58 (2,83)</td>
<td>8,92</td>
<td>44,0</td>
</tr>
</tbody>
</table>

#### Free BPA µg/l

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<tr>
<td>Control</td>
<td>N= 44</td>
<td>195</td>
<td>0,21 (2,33)</td>
<td>0,20</td>
<td>0,73</td>
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<tr>
<td>Exposed</td>
<td>N= 90</td>
<td>390</td>
<td>0,28 (2,17)</td>
<td>0,28</td>
<td>0,88</td>
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</table>
Effect of exposure on BPA levels

Total BPA (median)

<table>
<thead>
<tr>
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<th>Total BPA µg/l</th>
<th>Total BPA µg/g creat.</th>
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<tr>
<td>Controls</td>
<td>3.54</td>
<td>2.89</td>
</tr>
<tr>
<td>Cashiers</td>
<td>8.92*</td>
<td>6.76*</td>
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Free BPA (median)

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<td>0.28</td>
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<tr>
<td>Cashiers</td>
<td>0.21</td>
<td>0.22</td>
</tr>
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* P < 0.05
Effect of other variables on BPA levels

- Sex: non significant difference between men and women

- Number of receipts handled
  - Estimation: 10 to 1000 receipts/day
  - No relationship between the number of receipts handled and total BPA concentration

- Age

- Length of service

- Tobacco

- Hand washes
Exposure of printing company workers

- 45 participants
- 30 occupationally exposed workers
- 15 non-occupationally exposed workers
- BPA in thermal paper: ≈0.6% (w/w)
Urinary BPA levels of printing company workers

**Distribution of BPA concentration**

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<tr>
<td>Control</td>
<td>N= 15</td>
<td>116</td>
<td>2.54   (2.40)</td>
<td>2.41</td>
<td>11.5</td>
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<tr>
<td>Exposed</td>
<td>N= 30</td>
<td>225</td>
<td>7.23   (3.87)</td>
<td>5.33</td>
<td>108</td>
</tr>
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</table>

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<tbody>
<tr>
<td>Control</td>
<td>N= 15</td>
<td>116</td>
<td>0.24   (1.96)</td>
<td>0.24</td>
<td>0.63</td>
</tr>
<tr>
<td>Exposed</td>
<td>N= 30</td>
<td>225</td>
<td>0.48   (2.09)</td>
<td>0.44</td>
<td>2.09</td>
</tr>
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Effect of exposure on BPA levels

Effect of the paper type on the operator exposure

* P < 0.05
Thermal paper is a source of exposure to BPA for workers

- **Previous data**
  - Thayer et al., 2015: total urinary BPA level
    - non-cashiers (n=21): 1.25 µg/g creatinine
    - cashiers (n=33): 2.76 µg/g creatinine

- **INRS data**
  - Controls (n=44): 2.89 µg/g creatinine
  - Cashiers (n=90): 6.76 µg/g creatinine
Restriction proposal submitted by ANSES (ECHA – 2014)

- Restriction regarding the use of BPA in thermal paper
  - Committee of Risk Assessment (RAC) opinion: june 2015
    restriction is the most appropriate measure to address the identified risks
  - Committee for socio-economic analysis (SEAC): opinion september 2015
    comparing the socio-economic benefits to the socio-economic costs, the proposed restriction is considered unlikely to be proportionate
  - Pending decision of the Commission
BPA alternatives in thermal paper

- Bisphenols: BPS, BPF and BPAP
- Phenolic substances: D8, D90, TGSA
- Urea-based substances: UU, Pergafast 201

Other occupations likely to be exposed to BPA:

Main use of BPA is in the production of polycarbonate plastics and epoxy resins (>90% of the total amount of BPA)

- Plastics industries: production of BPA based polycarbonate products
- Epoxy resin factories
- Liquid paint factories
- ...
Our job: making yours safer
Thanks for your attention