

# **What does this mean for policymaking? Building on the CUSP Research Roadmap with learnings from AURORA**

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# 1

## Analytical Methods & Representative Materials

Reliable, comparable MNP measurement is the prerequisite for everything that follows.

### CUSP RESEARCH NEEDS

#### IMMEDIATE

0–2 years

- Quality assurance and quality control (QA/QC)
- Reporting standards for analytical methods
- Relevant test & reference materials

#### MID-TERM

2–5 years

- Improve sensitivity, reduce detection limits
- Harmonise analytical methods across labs

#### LONG-TERM

>5 years

- Speed up assessments — indicator polymers, tracers, bulk measurements

### AURORA ADDS

## What we learned

### Reference materials

Synthesis workflows for a full suite of nano-particles (PE, PET, PVC, PMMA, PS, PP, PA) — labelled, fluorescent and aged.

### Tissue-ready protocols

Validated preprocessing for fluorescent MNP analysis in human placental tissue (Zoutendijk et al., 2025).

### Reporting and QA standards Epidemiological studies

Reporting standards depend on the application



# 2

## Hazard Assessment

From in vitro to in vivo: characterising how MNPs harm human cells, organs and development.

### CUSP RESEARCH NEEDS

#### IMMEDIATE 0–2 years

- Quantitative in vitro test systems
- Novel approaches for sensitive in-situ MNP detection
- In silico kinetic models and in-vitro-to-in-vivo extrapolation
- Reporting standards for hazard data

#### MID-TERM 2–5 years

- Tiered, fit-for-purpose high-throughput testing

#### LONG-TERM >5 years

- Characterise hazards of real-life MNPs
- Identify biological mechanisms of action

### AURORA ADDS

## What we learned

### Placental models

- Better Tiered test systems
- More realistic testing scenarios (complexity, chronicity)
- More sensitive/specific markers

### Cell-free vs. cellular

Intrinsic oxidative potential did not translate to intracellular oxidative stress — shows why real cell models matter.



# 3

## Exposure Assessment

Real-world MNP exposure data — at population scale — is what risk assessment is missing.

### CUSP RESEARCH NEEDS

#### IMMEDIATE 0–2 years

- Reporting standards for MNP exposure studies
- Robust SOPs and ILCs for real-world samples
- Interoperable data infrastructure and sharing platforms

#### MID-TERM 2–5 years

- MNP polymer types and concentrations in tissues
- Control real-world sample contamination
- Human MNP biomonitoring at scale

#### LONG-TERM >5 years

- Scale-up biomonitoring and develop exposure prediction

### AURORA ADDS

## What we learned

### Largest early-life cohort

- Reliable detection of all polymers remains a challenge
- There are inherent trade-offs that one needs to do when conducting human studies.
- Need to understand the impact of those choices

### Household exposure

- Identification of sources remains a priority. Is hampering current actionability.



# 4

## Risk Assessment Frameworks

Five complementary CUSP frameworks — converging on a unified approach to MNP risk.

### CUSP RESEARCH NEEDS

<b>IMMEDIATE</b> 0–2 years	<b>MID-TERM</b> 2–5 years	<b>LONG-TERM</b> >5 years
<ul style="list-style-type: none"><li>• Aggregated exposure assessment</li><li>• Qualitative risk assessments of MNPs and mixtures</li></ul>	<ul style="list-style-type: none"><li>• Exposure and effects in human populations</li><li>• Hazard data for key plastic types and mixtures</li><li>• Epidemiological research on human health risks</li></ul>	<ul style="list-style-type: none"><li>• Quantitative risk assessments (DNELs/DMELs)</li><li>• Address social determinants and health inequities</li><li>• Assess and amend existing test guidelines</li></ul>

### AURORA ADDS

## What we learned

### Early-life RAF, published

AURORA risk-assessment framework for MNPs in early life — adapted from WHO/IAAC, weight-of-evidence approach with a tiered scoring system (Christopher et al., 2024).

### Vulnerable populations

Explicit maternal, placental and fetal exposure pathways — putting unborn children at the centre of the framework.



## 5

# Mitigation Measures

The precautionary principle in practice — act on plastics now, refine as science evolves.

## CUSP RESEARCH NEEDS

### IMMEDIATE

0–2 years

- Map policy activities that can mitigate MNP exposure
- Identify essential vs. non-essential plastic uses
- Public awareness and behaviour change

### MID-TERM

2–5 years

- Criteria for low-migrating, safe-and-sustainable materials
- Alternative-materials substitution framework
- Assess mitigation strategies and risks of substitutes
- Life-cycle approaches to identify upstream MNP sources

### LONG-TERM

>5 years

- Economic impact and cost-effectiveness of policy measures

## AURORA ADDS

### What we learned

#### Sources of exposure

- Sources remain unclear
- Population exposure is documented
- Transfer to organs is documented
- No time to waste to start thinking of mitigation

#### Vulnerable-population lens

AURORA evidence makes the case to prioritise pregnancy and early life in any mitigation strategy.



# Keep pushing on the three R's

Science is converging. Policy doesn't need to wait for perfect evidence to act on plastic.

## REDUCE

Use fewer resources and generate less waste and pollution.

### Phase out non-essential plastic uses

Apply the essential-use concept; cut single-use applications where alternatives exist.

### Limit migration at source

Set criteria for low-migrating, safe-and-sustainable-by-design materials.

### Protect the most vulnerable

Prioritise exposure reduction for pregnancy and early life — AURORA evidence supports urgency.

## REUSE

Use products and materials again instead of discarding them.

### Reusable over disposable

Incentivise systems that replace single-use plastic in food, healthcare and packaging.

### Safe-by-design reuse

Reuse only where particle shedding and chemical migration are characterised and acceptable.

### Indoor environments

Address household sources — dust and fibres — that drive day-to-day MNP exposure.

## RECYCLE

Process materials so they can be used again.

### Avoid regrettable substitutes

Bio-based and biodegradable plastics may still shed MNPs — assess before scaling.

### Close the loop responsibly

Track additives and contaminants through the recycling stream.

### Whole-life-cycle policy

Apply LCA thinking to identify upstream MNP sources and prevent rebound effects.

Precaution is a policy choice.