Flame retardants from source to disease

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Main types used in foam furniture in USA:

- Penta form of PBDE (PentaBDE): manufactured in US before 2005
- TDCPP (“chlorinated tris”, TDCIPP)
- Firemaster 550 (mixture)

PentaBDE:

- manufacture now banned by Stockholm Convention, but much is still in use causing exposure (probable environmental justice issue with used furniture)
- declining body burdens in Sweden; probably USA?
- most studied of the three
- partial model for examining exposure to the others
PentaBDE problem discovered through breast milk biomonitoring in Sweden

Now decreasing in Sweden

Human half lives ~ years

Norén and Meironyté 2000
A decade of research has told us a lot about how we are exposed to PentaBDE: indoor pathway

- Escape from products to dust, indoor surfaces & air
- Levels in dust, on hands & in blood/breast milk are all correlated
- Exposure through dust ingestion probably most important. Hand to mouth behavior probably plays a large part (hard to measure)
- Higher exposure of children
- Washing hands is associated with lower body burdens
- Home exposure may be more important than work, cars
PentaBDE residues on hands are associated with serum levels in adults and children

(Watkins et al 2011; Stapleton et al. 2012)
Diet is another route of exposure

- Bioaccumulation from environment?
- Animal feed?
- Food processing?
products → dust → hands → body burden

How are people exposed?

What are the health effects?

sub-clinical effects → disease
PentaBDE Toxicology (selected, mostly rats & mice)

endocrine disruption
thyroid
anti-androgen

reproductive effects
ovarian changes
decreased sperm, epididymis weight
delayed puberty

developmental neurotoxicology (similar to PCBs?)
Growing amount of PBDE epidemiological research:

- adult thyroid (Hagmar et al 2001)
- birth weight, thyroid (Mazdai et al 2003)
- testicular cancer (Hardell et al 2005)
- decreased birthweight (Chao et al 2007)
- cryptorchidism (Main et al 2007)
- sperm, adult males (Akutsu et al 2008)
- infant thyroid (Herbstmann et al 2008)
- thyroid, adult males (Turyk et al 2008)
- hormones, adult males (Meeker et al 2009)
- developmental neurotox, etc. (Roze et al 2009)
- birth outcomes (Wu et al 2009)
- developmental neurotox (Herbstman et al 2010)
- fecundity, menstrual cycles (Harley et al 2010)
- developmental neurotox (Gascon et al 2011)
- neonatal thyroid (Chevrier et al 2011)
- developmental neurotox (Hoffman et al 2012)
- developmental neurotox (Eskenazi et al 2013)
- thyroid (Abdelouahab et al 2013)
- developmental neurotox (Chen et al 2014)

... Many studies in general populations
Much less is known about exposure and health effects of TDCPP & Firemaster 550

TDCPP & TPHP (a component of FM 550) are thought to have short half lives in humans (hours?). Their metabolites are found in urine; high detection rates in studies conducted so far. While dust is probably important, dermal exposure and inhalation may play a role.

**TDCPP toxicology**
- Probable carcinogen (California)
- Endocrine disruptor?
- Possibly neurotoxic?

**Now to Jennifer!**