Lecture 514.094 The Pathophysiology of Allergy

Chapter 12: Allergies in pregnancy, lactation and early childhood

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The Pathophysiology of Allergy

Topics

1. Immunology of pregnancy
2. Influence factors on allergy development during pregnancy
3. Influence factors on allergy development around birth
4. Influence factors on allergy development during lactation
5. Influence factors on allergy development during babyhood
6. Management of allergy of mother during pregnancy
1 Immunology of pregnancy

1 Immunology of pregnancy

Why is this a topic at all???

⇒ The baby/fetus bears molecules which are foreign to the mother!
Immunology of pregnancy

Only in the 1950s, Sir Peter Brian Medawar (Nobel laureate 1960) pointed out that the fetus contains maternal as well as paternal antigens

should be rejected by mother’s immune system

1. Immunology of pregnancy

Hypotheses for survival of the “allogenic transplant” embryo

i. Anatomical barrier between mother and fetus ⇒ immunological, physical or physiological barrier blocks maternal immune competent or cytotoxic molecules and cells

ii. Fetus immunologically undeveloped ⇒ expresses no paternal antigens

iii. Maternal immune system inactive during pregnancy ⇒ no immune reactions

Immunology of pregnancy

Hypotheses for survival of the “allogenic transplant” embryo
ad iii. Immune system suppression mechanisms

3.a cytokines and Th1/Th2 environment
3.b LIF (leukaemia inhibitory factor)
3.c natural killer cells and macrophages
3.d HLA-G
3.e progesterone
3.f apoptosis
3.g complement
3.h blocking antibodies
3.i tolerance

http://homepages.uel.ac.uk/u9400777/
Immunology of pregnancy

Hypotheses for survival of the “allogenic transplant” embryo

ad iii. Immune system suppression mechanisms

3.a cytokines and Th1/Th2 environment

⇒ cytokines act locally

⇒ early stages of pregnancy: conceptus and placental tissue provide:

IFN, IL, TNF, GM-CSF ⇒ mechanism of action unclear

Immunology of pregnancy

Hypotheses for survival of the “allogenic transplant” embryo

ad iii. Immune system suppression mechanisms

3.a cytokines and Th1/Th2 environment

⇒ Th2-cytokine environment essential for successful pregnancy:
  IL-4, IL-5, IL-6, IL-10, IL-13
  

⇒ shift but no complete suppression of Th1, as mother and fetus need to be protected from pathogens


⇒ not only Th2-cytokines essential, as interleukins 11-18 have been found during different stages of pregnancy

Immunology of pregnancy

Hypotheses for survival of the “allogenic transplant” embryo

ad iii. Immune system suppression mechanisms

3.a cytokines and Th1/Th2 environment

⇒ decidual leukocytes and pre-implantation embryo secrete IL-10


⇒ during implantation blastocyst suppresses inflammatory response of maternal endometrium by IL-6


⇒ IL-4 for maintenance of pregnancy, suppresses Th1 by inhibiting IL-12 production by MΦ and DC; constitutively expressed in amniotic and decidual tissue; critical necessity discussed

Immunology of pregnancy

Mechanisms involved in maternal tolerance to the fetal semi-allograft

Influence factors on allergy development *in mother* during pregnancy

Influence factors on allergy development in mother during pregnancy

Smoking

- Exposure to tobacco smoke is risk factor for sensitization in all population and age groups (significant relationship between number of cigarettes smoked and IgE level in active smokers)

  Sherill DL et al. JACI 94:954-962 (1994)

- Smoking (previous, current light, current heavy) assoc. with sensitization to nickel


- Human patients: smoking independent risk factor for sensitization against respiratory allergens


- no explicit figures for smoking in pregnancy and allergy development in mother available

www.smokingstories.wordpress.com/page/2/
Influence factors on allergy development of mother during pregnancy

Alcohol

- Alcohol increased specific IgE against food antigens and aeroallergens in adults
  
  Gonzalez-Quintela A. *Front Biosci* **7**:234-244 (2002)

- Mouse model: liquid alcohol diet ⇒ high total IgE and Th2 cytokines, suppressed IgG2a
  

- Controversy: no enhanced SPT in students of high social class (18-35a)
  

- no explicit figures for alcohol consumption in pregnancy and allergy development available

www.topnews.in/health/effect-alcohol-foetus-development-not-clear-say-researchers-27782
Influence factors on allergy development of mother during pregnancy

Diet of the mother

- Japanese diet during pregnancy (vegetables, seaweed, fruit, antioxidants, fiber, minerals)
- seaweed (28g/day) decreased allergic rhinitis in women by 49%
- calcium, phosphorus and magnesium decreased allergic rhinitis (relax airways)
- β-carotene increased allergic rhinitis

Influence factors on allergy development of mother during pregnancy

Diet of the mother

- Vitamin D: two hypotheses:
  1) increase in VitD via supplementation \(\Rightarrow\) increase of allergic rhinitis


  2) deficiency of VitD due to reduced sunlight exposure \(\Rightarrow\) increase asthma and allergy (northern states of America needed 4x more epinephrine)


- asthma and eczema higher in children close to equator
  (melanoma protection recommendations?)

Influence factors on allergy development of mother during pregnancy

**Anti-acid medication**

- Gastric complaints during pregnancy in 70% of pregnant women
- 30-50% take acid-suppressing drugs ⇒ reduce pH in the stomach
- digestion incomplete


Influence factors on allergy development of mother during pregnancy

**Anti-acid medication**

- higher risk for sensitization against food allergens in human and murine studies (adult non-pregnant patients)

Human patients before and after acid-suppressing therapy (3 mo)


Influence factors on allergy development of mother during pregnancy

Anti-acid medication

- this sensitization status can also be induced in pregnant mother animals

- human study envisaged


**Antibody-response in mother mice**

**Skin tests in mother mice**
Influence factors on allergy development *of child* during pregnancy

Influence factors on allergy development of child during pregnancy

Anti-acid medication

- this sensitization status is conferred from mother to offspring in a murine model


Antibody-response in mother mice

Antibody-response in offspring
Influence factors on allergy development of *child* during pregnancy

**Anti-acid medication**

- this sensitization status is conferred from mother to offspring in a murine model


![Graph showing Th2-biased cytokine pattern in offspring](image)
Influence factors on allergy development of child during pregnancy

Genetics

- risk for atopy seems to be directly related to the family history of allergy
- especially to maternal atopy: only maternal total IgE levels correlated with CB and infant IgE levels and the development of infant eczema


- neither parent is allergic, the chance for allergies in child = 15%
- 1 parent is allergic ⇒ risk = 30%
- both are allergic ⇒ risk > 60%

Influence factors on allergy development of child during pregnancy

**Smoking**

- Mouse model: *in utero* exposure induced higher risk for sensitization against allergens in adulthood
  

- CBMC-proliferative responses to allergens (timothy grass, house dust mite) increased significantly in association with maternal smoking
  

- Th2 cytokines higher in serum samples of neonates with smoking mothers
  
Influence factors on allergy development of child during pregnancy

Smoking

In later life of children:
- enhanced total and specific IgE, eosinophil counts, airway disease,
- positive SPT, wheezing episodes/asthma

Kulig M et al. *Hum Exp Toxicol* **18**:241-244 (1999)
Ronchetti R et al. *JACI* **86**:400-4’07 (1990)
Influence factors on allergy development of child during pregnancy

**Smoking**

Alarmingly:

- 20% of children exposed in utero!
  

- 43% of children exposed to environmental tobacco smoke during first year of life
  

Contrasting: *pre- or postnatal* exposure more associated with sensitization risk


Influence factors on allergy development of child during pregnancy

Alcohol

- alcohol consumption of mother
- higher IgE levels in children and
- higher risk for atopic dermatitis in high-risk children

Influence factors on allergy development of child during pregnancy

Diet of the mother

Influence factors on allergy development of child during pregnancy

**Diet of the mother**

**Vitamin A:** possible association between reduced vitamin A and childhood *asthma*, not between maternal vitamin A intake during pregnancy and childhood *wheeze*

**Vitamin C:** methodologically weak and unsupportive of the possible effectiveness of vitamin C to prevent atopic outcomes

**Vitamin D:** high intake during pregnancy in northeastern US may decrease risk for recurrent wheeze at 3 yrs


**Vitamin E:** high maternal intake decreases CBMC proliferation to grass and dust mite allergens


All reviewed by Nurmatov U et al. *JACI, in press* (2011)
Influence factors on allergy development of child during pregnancy

Diet of the mother

Studied/discussed:

Selenium,
Zinc,
Sodium,
Calcium...

Fruits,
vegetables

Reviewed by Nurmatov U et al. JACI, in press (2011)
Influence factors on allergy development of child during pregnancy

Diet of the mother

Reviewed in:
Nurmatov U et al. JACI, in press (2011)

Key messages

- There are no published experimental studies investigating the role of nutrients and foods for the primary prevention of asthma and allergic disorders in children.
- The body of epidemiologic evidence in relation to nutrients and dietary factors for the prevention of asthma and allergic disorders is overall weak but nonetheless suggestive in relation to vitamins A, D, and E; zinc; fruits and vegetables; and Mediterranean diet, particularly in relation to asthma outcomes.
- The evidence was less encouraging in relation to vitamin C and selenium.
- There is a need for well designed randomized controlled trials of vitamins A, D, and E; zinc; fruits and vegetables; and Mediterranean diet. There is a need to prioritize vitamin D and E trials for the primary prevention of asthma in children.
- The existing level of evidence adds to the existing public health messages on a balanced healthy diet in relation to a Mediterranean diet and fruits and vegetables.
Influence factors on allergy development of child during pregnancy

**Diet of the mother**

- Antioxidant hypothesis:
  - Westernized diet deficient in antioxidants
    - increases susceptibility of population to allergy and asthma:
    - reduced AO-defense in lungs
    - increased oxidant damage
    - increased permeability of allergens & increased inflammation of airways
  - beneficial associations between maternal intake of some antioxidants during pregnancy and childhood asthma
  - but: limited data on maternal AO intake and childhood AD and AR

Devereux G. *Nat Rev Imm* **6**:869-874 (2006)
Influence factors on allergy development of child during pregnancy

Diet of the mother

Ratio n-3/n-6 FA: n-6 biased diet (vegetable oil, margarine)
   ⇒ more eczema in contrast to n-3 (fish)


Conjugated Linoleic Acid (CLA): -CH=CH-CH=CH-
   in milk, cream, butter, meat of ruminants (beef, lamb...)
   ⇒ *anti-inflammatory* properties

www.marsvenus-forum.de/viewtopic.php?t=3007&sid=12ed78855ac379749d8267e9128ebbf8
www.kiri.at/rindfleisch.pdf
www.nugowiki.org/index.php/Trans-10_Cis-12_Conjugated_Linoleic_Acid
Influence factors on allergy development of child during pregnancy

Diet of the mother

- **Lipid hypothesis:**
  - changes in dietary fats:
    - increased intake of n-6 PUFA
    - decreased n-3 PUFA and SFA
    - altered lipid composition of inflammatory cells (increased AA molecules)
    - PGE$_2$ produced $\Rightarrow$ suppressed diff. to Th1, reduces IFN-$\gamma$, promotes Th2
    - increased asthma and allergy

Devereux G. *Nat Rev Imm* **6**:869-874 (2006)
Influence factors on allergy development of child during pregnancy

**Diet of the mother**

**Probiotics**

- Germ-free animals ⇒ no tolerance in absence of gut microbiota
- Aberrant intestinal flora may cause or worsen allergic diseases
- Probiotics were recommended during pregnancy as well as for neonates
- role for certain probiotics (alone or with prebiotics) in the prevention of atopic eczema
  

- insufficient evidence to recommend probiotics for prevention or as part of therapy of allergic diseases
  

[Image 1](https://www.natural-weightloss-energy.com/2010/10/14/Probiotics_fight_colds_and_flues_according_to_new_study/)

[Image 2](https://www.drnatura.com/flora_protect.php)
Influence factors on allergy development of child during pregnancy

Diet of the mother

- Overall dietary pattern (e.g. Mediterranean, healthy, western or prudent pattern) during pregnancy is not associated with recurrent wheeze
- Maternal intake of individual nutrients may be more important

Dietary factors with immunomodulatory properties
- LC-PUFA, GI microbiota, dietary oligosaccharides, folate, antioxidants, and other vitamins, breast milk (postnatal period), and food antigens (as allergens or tolerogens)


www.ehow.com/how_4735599_maintain-proper-diet-during-pregnancy.html
Influence factors on allergy development of child during pregnancy

Season

- First trimester of pregnancy predicts sensitization to food allergens
- Positive in any food allergy test during first 4 years of life (IgE or SPT or OPT):
  - Children born in June-July: 5%
  - Children born in Oct-Nov: 10%

Influence factors on allergy development of child during pregnancy

**Antibodies via placenta**

- Allergen-specific IgG1 and IgG4 found in human cord blood, no IgE transferred (case study, n=1)  

- Oral tolerance-induction of mouse mother to OVA

- OVA-specific IgG transferred to offspring (not in FcRn-KO mice)  
  asthma-prevention even if sensitized after 8 mo (dependency on IFN-γ shown)  
Influence factors on allergy development of child during pregnancy

Antibodies via placenta

⇒ most murine studies show protective potential of maternal allergen-specific antibodies against allergen-specific IgE-induction in offspring


OVA-model

CODFISH-model


Influence factors on allergy development of child during pregnancy

**IgE in placenta**

- IgE in human placenta bound to Hofbauer cells (Mϕ) in villous tissue
- Irrespective of maternal allergy status

Rindsjö E et al. *Allergy* 65:554-560 (2010)

Immunohistochemical staining of IgE in a second trimester human placenta.
Influence factors on allergy development of child during pregnancy

IgE in placenta

- IgE in placenta is of maternal origin, has to be transported over TB
- neither bound to FcεRI nor to FcεRII, stains with FcγRI
- can be allergen-specific
- correlation of total and allergen-specific IgE in placenta with maternal plasma, no allergen-specific IgE in cord blood ⇒ IgE most probably of maternal origin
Influence factors on allergy development of child during pregnancy

**Antigens via placenta**

- Der p 1 found in fetal circulation or amniotic fluid
- The amniotic fluid at 16 weeks and fetal circulation at term
  - Two routes of allergen transfer to the conceptus: transamniotic and transplacental
- IgG is actively transported to fetus across the placenta from maternal vasculature
  - Der p 1 carried in complexes with IgG?

Influence factors on allergy development of child during pregnancy

**Antigens via placenta**

- OVA, β-Lactoglobulin, Bet v 1, Der p 1 found in fetal circulation or amniotic fluid
- Enhanced uptake when IgG (polyclonal) is added (ex vivo model)


- Part of normal development of immunity?

[Mouse model]

Influence factors on allergy development of child during pregnancy

Antigens via placenta

Allergenic Food

Early exposure to peanut allergens in utero or via breast milk increases risk of peanut allergy in predisposed children.


More peanut during pregnancy → elevated peanut IgE in children with egg and milk allergy.


Contrasting to:

“Advice on avoiding peanuts in pregnancy should be withdrawn.”

Influence factors on allergy development of child during pregnancy

**Antigens via placenta**

⇒ however, allergens mainly retained in placenta ⇒ therefore, no direct dose/immune response relation found in cord blood

Influence factors on allergy development of child during pregnancy

Maternal allergen exposure during pregnancy

- elevated dust mite levels prenatally → increased cord blood IgE to dust mite
- elevated cockroach allergen prenatally → not assoc. with cord blood IgE, but indirect relation via maternal total IgE

Influence factors on allergy development of child during pregnancy

Other factors transferred from mother to child

- maternal DNA in cord blood

- leukocyte trafficking from mother to fetus in utero
Influence factors on allergy development of child during pregnancy

Mother living on a farm

- early-life contact with livestock and fodder, and consumption of unprocessed cow’s milk = most protective exposure
- intense microbial exposure modulates innate & adaptive immunity

Influence factors on allergy development of child during pregnancy

Mother living on a farm

- intense microbial exposure \(\Rightarrow\) TNF, IL-10 \(\Rightarrow\) Treg \(\Rightarrow\) suppress Th2 \(\Rightarrow\)
- CD14 not inhibited \(\Rightarrow\) more PRR \(\Rightarrow\) amplification of innate response;
- IFN-\(\gamma\) in children via DC and NK with TLR via microbes \(\Rightarrow\) counteracts Th2, accelerates Th1 by activating DC IL-12 production

Influence factors on allergy development around birth

Pali-Schöll et al. JACI 123:1012-21 (2009)
Influence factors on allergy development around birth

Mode of birth

- Cesarean section \(\Rightarrow\) increased allergic rhinitis and atopy among children of atopic parents  

- Higher number of wheezing episodes and food-specific IgE during first 2 yrs 
Influence factors on allergy development around birth

Prematurity and low birth weight

⇒ not associated with food allergy  

⇒ even preventive for AD at 1 year  

⇒ however: born extremely preterm decreases lung function in adolescents  
3 Influence factors on allergy development around birth

**Birth order**

- higher is better: CBMC proliferation to grass and dust mite allergen (and to ConA and Mycobact. PPD) higher when first pregnancy


- means of IgE after the first, second, and third or higher delivery were 74.4, 66.6, and 43.0kU/L (significant direct effect of birth order on maternal IgE)

Influence factors on allergy development during lactation
Influence factors on allergy development during lactation

**Diet of the mother**

**Antigen via breast milk**

- Antigen via breast milk in early and recent studies thought to *induce sensitization* (eg. peanut, milk, egg)
  

- however:
  - mothers of sensitized children consumed no different amounts
  - mothers avoidance did not protect from sensitization


Influence factors on allergy development during lactation

Diet of the mother

Antigen via breast milk

- Antigen via breast milk induces *tolerance and protection* from allergic asthma:
  - lower IgE, IgG1, IgA, IL-4, IL-5, IL-10, IL-13, collagen in lung, lower eos and mucus, lower CD40L+CD4+T-cells

- worked also in B-cell-deficient disrupted transmembrane μ exon or RAG-2-KO (lymphocyte deficient) mice

- no antibodies necessary

Influence factors on allergy development during lactation

**Diet of the mother**

**Antigen via breast milk**

- Antigen via breast milk induces tolerance
- Dependent on additional immune-regulatory factors:
  - TGF-β2 is the predominant cytokine present in human milk

**TGF-β together with allergen */ TCD4⁺ Tregs */ allergen-specific protection**


4 Influence factors on allergy development during lactation

Diet of the mother

Antigen via breast milk

⇒ Form of antigens dependent on handling by mother’s organism, e.g. digestion


⇒ Does acid-suppression also influence antigens in breast milk???

⇒ acid-suppression drugs papers cited by Verhasselt

⇒ Does acid-suppression also influence microbiotic milieu???
Influence factors on allergy development during lactation

Diet of the mother

Antigen via breast milk

4 Influence factors on allergy development during lactation

Diet of the mother

⇒ In summary no strong evidence for an allergen-avoidance diet during lactation, even in high-risk breast-feeding mothers, for preventing atopy in child

Influence factors on allergy development during lactation

**Antibodies via breast milk**

- mainly sIgA & IgA2

- colostrum also contains IgG (mainly bovine colostrum)


  en.wikipedia.org/wiki/Colostrum#Human_colostrum

| Table 3. Total immunoglobulin levels and anti-Hib IgA and IgG antibody* concentrations in colostrum and milk from the two CVI mothers |
|---|---|---|---|---|
| | M1 | Milk | M2 | Milk |
| IgG (mg/dl) | 1.95 | 1.37 | 112.10 | 9.10 |
| IgM (mg/dl) | 50.00 | 0.11 | 0.51 | 0.43 |
| IgA (mg/dl) | 2.60 | 0.09 | 0.15 | 0.07 |
| IgA anti-Hib PRP (mg/l) | 0.05 | 0.03 | < 0.005 | < 0.005 |
| IgG anti-Hib PRP (mg/l) | 0.28 | < 0.015 | < 0.015 | < 0.015 |

*Range of immunoglobulin concentrations (mg/dl) in colostrum from healthy mothers of our population (42).

*Not available.

PRP, polyribosyl-ribitolphosphate polymers.

Influence factors on allergy development during lactation

**Antibodies via breast milk**

- OVA-specific IgG transferred via breast milk → asthma-prevention in mice (IgG via placenta or breast milk induces tolerance)

Influence factors on allergy development during lactation

Other factors transferred into breast milk

- e.g. Chemokines IL-8, RANTES, IP-10, MIG in breast milk


### Table 2 | Relationships between the immune system of the nursing infant and the immune function of breast milk

<table>
<thead>
<tr>
<th>Immune effects</th>
<th>Agents in milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensate directly for developmental delays in the infant immune system</td>
<td>Secretory IgA, lactoferrin, lysozyme, IFN-γ and PAF-acetylhydrolase</td>
</tr>
<tr>
<td>Compensate indirectly for developmental delays in the infant immune system</td>
<td>Oligosaccharides and nucleotides</td>
</tr>
<tr>
<td>Enhance reduced functions, such as specific-antibody production</td>
<td>Cytokines and anti-idiotypic antibodies</td>
</tr>
<tr>
<td>Adapt the gastrointestinal tract to extra-uterine life</td>
<td>Epithelial growth factors</td>
</tr>
<tr>
<td>Prevent inflammation</td>
<td>PAF-acetylhydrolase, antioxidants, IL-10 and TGF-β</td>
</tr>
<tr>
<td>Enhance survival of defence agents</td>
<td>Secretory IgA, lactoferrin and lysozyme</td>
</tr>
<tr>
<td>Establish commensal bacterial flora</td>
<td>Growth factors for commensal bacteria</td>
</tr>
</tbody>
</table>

Adapted from REFS 7-9. IFN, interferon; IL, interleukin; PAF, platelet-activating factor; TGF, transforming growth factor.
Influence factors on allergy development during lactation

Breastfeeding vs. formula diet


Influence factors on allergy development during lactation

**Breastfeeding vs. formula diet**

- Prevention up to 6 years of age ⇒ mainly delay of disease onset
  

- In summary: insufficient data for dietary intervention of child between 4-6 months

Influence factors on allergy development during lactation

Exposure route to antigens

⇒ “Dual-allergen-exposure hypothesis”: exposure route to antigen (esp. food) may determine IR with environmental contact, e.g.

Skin ⇒ sensitization

Oral ⇒ tolerance

⇒ Environmental contact in absence of food consumption ⇒ increased risk for food allergy

Influence factors on allergy development during babyhood

Influence factors on allergy development during babyhood

**Complementary feeding**

- no delay of complementary food after 4 months of age (not before 17 weeks, but not delayed beyond 26 weeks)
- prolonged exclusive breast-feeding/delayed introduction may even be risk factor for AD, asthma or atopy


- no special diet, even when high-risk infant
- *fish* during 1st year of life = preventive for atopic diseases
- *gluten* (max. 7g cereals with gluten/day) between 5 and 7 months in parallel to breast-feeding = preventive for celiac disease


www.baby.at/396/beikost-baby-einfuehren
Influence factors on allergy development during babyhood

**Early vitamin supplementation**

- Vitamin supplementation within first 6 months
- Increased risk for asthma in black children
- Increased food allergies in exclusively formula-fed children

Influence factors on allergy development during babyhood

**Antibiotic usage in early infancy**

- antibiotic use within the first 6 months of life
- exposure was associated with increased risk of asthma and allergy at 6 years of age

Influence factors on allergy development during babyhood

- Living on farm with livestock and fodder, i.e. exposure to environmental bacteria
- Epigenetics (diet of mother, diesel exhaust particles, wood smoke, road traffic, smoking of grandmother...)
- Pets/house dust
- Passive smoking
Summary of preventive measures

- avoid tobacco smoke in passive and active form
- avoid alcohol consumption
- no special diet for mother during pregnancy or lactation (except when allergy is diagnosed)
- no avoidance of other allergen sources (except when allergy is diagnosed)
- breastfeeding: min. 4 mo, max. 9 mo exclusively
- EHPF or AA-based formula only for high-risk children
- avoid non-prescription drugs and substances/supplements
Management of allergy of mother during pregnancy

Pali-Schöll et al. JACI 123:1012-21 (2009)
Management of allergy of mother during pregnancy

Diagnosis
- detailed medical history and symptom analysis
- diary of allergy symptoms and avoidance of specific allergens accompanied by monitoring of changes of allergic symptoms
- do not put the mother on a rigid elimination diet
- *In vitro* diagnostic tools such as serological testing (e.g. RAST) are preferred to *in vivo* testing
- although not contraindicated, skin prick testing should be postponed until after birth
- also *in vivo* tests (food challenge tests and patch tests)
Management of allergy of mother during pregnancy

**Treatment**

- Food allergy \(\Rightarrow\) avoid offending food
- Other allergens \(\Rightarrow\) avoid allergen contact
- Recommendations for treatment of asthma and allergies in pregnancy

**Drugs preferred for use during pregnancy**

<table>
<thead>
<tr>
<th>Category</th>
<th>Drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-inflammatory</td>
<td>cromolyn, beclomethasone, prednisone</td>
</tr>
<tr>
<td>Bronchodilator</td>
<td>inhaled (\beta)-adrenergic agonist, theophylline</td>
</tr>
<tr>
<td>Antihistamine</td>
<td>chlorpheniramine, tripelennamine</td>
</tr>
<tr>
<td>Decongestant</td>
<td>pseudoephedrine, oxymetazoline</td>
</tr>
<tr>
<td>Cough</td>
<td>guaifenesin, dextromethorphan</td>
</tr>
<tr>
<td>Antibiotic</td>
<td>amoxicillin</td>
</tr>
</tbody>
</table>

**Drugs that generally should be avoided during pregnancy**

- \(\alpha\)-Adrenergic compounds (other than pseudoephedrine)
- Epinephrine (other than for anaphylaxis)
- Iodides
- Sulfonamides (in late pregnancy)
- Tetracyclines
- Quinolones

Adapted from the NAEPP expert panel report. *JACI* 115:34–46 (2005)
Management of allergy of mother during pregnancy

Treatment

Hyposensitization (immunotherapy)

⇒ should not be initiated during pregnancy because of the risk of systemic reactions

⇒ patients who were already on immunotherapy before the pregnancy, maintenance treatment may be continued ⇒ allergen dose should not be increased during pregnancy but rather reduced if necessary

⇒ don’t stop, don’t start, don’t increase dose!


⇒ Active or passive allergen-specific vaccination of mothers may represent a feasible strategy for the prevention of allergic sensitization in childhood

Thank you for your attention!