Vaginal Microbial Ecology: an introduction

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The Importance of Understanding Normal Vaginal Communities

The bacterial communities normally found in the vagina represent the first line of defense against infectious diseases affecting the female reproductive tract.

These include:
- Yeast infections (candidiasis)
- Sexually transmitted diseases (syphilis, gonorrhea, chlamydia, trichomoniasis, HIV)
- Pelvic inflammatory disease (PID)
Development of Vaginal Microbial Communities

At birth: Sterile

Puberty:
Increased estrogen; colonization and succession

Reproductive age:
Glycogen metabolized to produce lactic acid

Menopause:
Decreased estrogen, less glycogen, less lactic acid

Normal Vaginal Microbial Communities

Common wisdom: Lactobacillus spp. are characteristic of vaginal flora in normal healthy women.

Growth of nonindigenous organisms, including pathogens, is restricted.

The mechanisms are unknown:
- Low pH (≤4.5)
- lactate
- other organic acids
- hydrogen peroxide
- bacteriocins
- others?

Albert Siegmund Gustav Döderlein, [German obstetrician and gynecologist, 1860–1941], first described the “Döderlein bacillus” in 1894.
Overall Objective
Can not discriminate between normal and abnormal conditions until normal conditions have been accurately defined.

4 Questions
- Are there different kinds of communities in different healthy women?
- If so, are the communities functionally equivalent?
- Are there differences among racial groups?
- Do these differences have important consequences for women's health?

Cultivation-independent methods of microbial community analysis

Molecular phylogeny: 16S rRNA genes

- Community ‘fingerprints’
  - Based on sequence polymorphisms of 16S rRNA genes

- Molecular phylogeny
  - Classification based on analysis of cloned 16S rRNA gene sequences
T-RFLP
[Terminal restriction fragment length polymorphism analysis of 16S rRNA genes]

Coolen et al. Microbiology 71: 8729-8737, 2005
High Resolution T–RFLP Profiles
2 primer pairs, 2 restriction enzymes

Analytical Procedure

Vaginal swabs

Extract bacterial DNA

PCR *

Community 16S rRNA genes

Community fingerprints
T-RFLP of 16S rRNA genes

A miracle happens

Composition of communities

Still another miracle happens

Sequence cloned genes

Libraries of 16 S rRNA genes

Another miracle happens

Number of different kinds of communities

Implications for Women’s Health

Bacterial Vaginosis (BV) adversely affects women's health in multiple ways.

- During pregnancy, BV is associated with adverse outcomes including amniotic fluid infections, spontaneous abortion, preterm delivery, low birth weight infants, postpartum endometritis.

- BV increases risk to sexually transmitted diseases.

What is bacterial vaginosis?

“BV is a polymicrobial clinical syndrome resulting from replacement of the normal H₂O₂-producing Lactobacillus sp. in the vagina with high concentrations of anaerobic bacteria (e.g., Prevotella sp. and Mobiluncus sp.), G. vaginalis, and Mycoplasma hominis. BV is the most prevalent cause of vaginal discharge or malodor; however, more than 50% of women with BV are asymptomatic. The cause of the microbial alteration is not fully understood. BV is associated with having multiple sex partners, a new sex partner, douching, and lack of vaginal lactobacilli; whether BV results from acquisition of a sexually transmitted pathogen is unclear.”

Ecological resilience

Resilience is the amount of disturbance that an ecosystem can withstand without changing its self-organizing processes.

- Not all disturbances have equal intensity, occur at the same frequency, or endure for the same length of time. Therefore, not all disturbances have the same consequences.
- Communities with fundamental differences in species composition and structure will differ in resilience.

Is BV a disturbed ecosystem?

Effect of Disturbances on Vaginal Communities

Disturbances to the vaginal environment are often imposed by human actions:
- douching
- intercourse
- birth control methods
But also include:
- menstruation
- menopause
- parturition
Hypotheses

(1) The symptoms of bacterial vaginosis (BV) reflect ecological disturbances of vaginal microbial communities.
   i) BV is not an infectious disease.

(2) Not all women are equally at risk to acquiring BV because of differences in the composition and structure of their vaginal communities.