Treatment of Vaginal Dysbiosis

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15 September 2015

Traditional clinical views on bacterial pathogenicity

IPI*	Which bacteria?	Colonized	Causes disease :
<0.1	Commensals (=microbiota)	100%	Rarely: Immuno-compromized, severe dysbiosis
0.1-0.3	Potential pathogenic microorganisms (PPMs) E.g. Streptococci, Staphylococci	20-80%	Sometimes: Specific circumstances / strains only
0.8-1.0	Pathogens E.g. STI pathogens	~0%	(Almost) always

* Intrinisic pathogenicity index = # diseased/# colonized = 0-1

Current VMB knowledge

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The Vaginal Microbiota: What Have We Learned after a Decade of Molecular Characterization?

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August 2014 | Volume 9 | Issue 8 | e105998

VMB clusters in 17 molecular studies

From optimal to severe dysbiosis

- No dysbiosis:
  - Dominated by *L. crispatus* (11), *L. jensenii* (2), *L. vaginalis*
  - Dominated by *L. iners* (15), *L. gasseri* (5)
  - Multiple Lacto spp with/without *G. vaginalis* (8)
- Moderate dysbiosis:
  - Dominated by *G. vaginalis* but with lactobacilli (4)
  - Mixture lactobacilli, *G. vaginalis*, other anaerobes (N=8)
- Severe dysbiosis:
  - No dominant taxa but highly diverse mixture of anaerobes with no/few lactobacilli (13); often multiple clusters due to differences in relative proportions of taxa
  - Dominated by PPMs (3)

Why is the VMB important?

VMB dysbiosis associated with:

- Pregnancy complications → pre-term birth
- Pelvic inflammatory disease
- HIV/STI acquisition in women and transmission to infants/male partners
- Infertility? Lower success rate of IVF
- Stigmatizing symptoms

PPMs (particularly GBS) associated with:

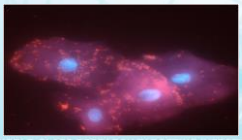
- Severe maternal and neonatal infections

Why is the VMB important?

- Chronic (sub)clinical inflammation now proven
  (Kyongo 2015, Borgdorff 2015, Anahtar 2015)
  - Dose-response relationship with severity of dysbiosis
- Adverse outcomes even if asymptomatic

VMB biofilm

- Vaginal biofilm research just starting
- Initial data with FISH probes:
  - Vaginal biopsies, vaginal smears, and urine sediments (Swidsinski 2005, 2010; Machado 2014; Hardy 2015)
  - Endometrial/fallopian tube samples (Swidsinski 2013)
  - In-vitro models (Patterson 2010, Cerca lab 2013)



VMB biofilm

- Current thinking:
  - *G. vaginalis* adheres to vaginal epithelial cells first and provides scaffold to which other taxa bind (Patterson, 2010)
  - Multiple *G. vaginalis* oligotypes (Eren, 2011); some are better biofilm producers than others (Harwich, 2010)
  - Other taxa: focus on *A. vaginae* and BVAB1-3 (Family Lachnospiraceae); many not yet investigated
  - *G. vaginalis* biofilm can also be present under foreskin in men; pieces can be sexually transmitted
- Not yet certain that *G. vaginalis* is dominant in all vaginal biofilms and which other taxa are important
- Unclear what proportion of first and recurrent BV episodes are associated with presence of biofilm

Traditional BV treatment

- First line tx (oral/vaginal metronidazole or clindamycin):
  - Cure rate 80% but recurrence rate 50+% within 6 months
  - Biofilm damaged and suppressed during tx but reactivated
- Cure rate:
  - Improved by longer first-line tx duration
  - Not improved by first line combinations or adding azithromycin, moxifloxacin, or partner treatment
- Recurrence rate:
  - Reduced by prophylactic use of first line drugs, hormonal contraception, male circumcision

Clinical studies by Sobel J, Swebke J, Bradshaw C, McClelland RS, Marrazzo J, Verstraelen H, Swidsinski A and others.

Novel approaches to optimize the VMB

- Probiotics:
  - Activity against biofilm (McMillan, 2011) and to restore VMB
  - Many tested with modest effects in short-term and disappointing effects in long-term →not recommended
- Vaginal pre/probiotics, ongoing RCTs:
  - Lactin-V (Osel, USA): Cohen *et al* in USA
  - Gynophilus (Probionov, France) and Ecologic Femi (Winclove, Netherlands): van de Wijgert *et al* in Rwanda
  - Efficacy may depend on endogenous microbiota

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WINCLOVE PROBIOTICS

Biofilm disruption

- General strategies: Physical removal, long-term antibiotics, chemical biofilm disruption (targeting structural biofilm components, quorum sensing, attachment and dispersal mechanisms)
- In vaginal dysbiosis:
  - In clinical use: boric acid (Reichman, 2009), add EDTA
  - Tested in women: antiseptic octenidine (Swidsinski, 2014) → not effective
  - Experimental BV: DNAse (Hymes, 2013), retrocyclin (Eade 2013)
  - Experimental PPMs: lysins, quorum sensing inhibitors
  - BUT: might cause epithelial damage → increase HIV acquisition, cell clump embolism, re-activation of infection
- Lactic acid and disinfectants do not disrupt biofilm

Conceptual VMB dysbiosis framework

1. BV with high loads of planktonic bacteria but no biofilm
   - *G. vaginalis* common but not required
   - Easy to treat, lower recurrence
2. BV with biofilm
   - *G. vaginalis* required?
   - Difficult to treat, high recurrence
3. High loads of PPMs
   - Highly inflammatory, severe sequelae
   - PPM biofilm present or not
   - With or without BV
   - PPM-specific treatment required

Diagnostic implications

- Differentiate dysbiosis types
- Differentiate from candidiasis, trichomoniasis, cervical STIs
- If recurrent or severe: need diagnostics to determine if BV and/or PPM biofilm is present

Treatment implications

- If planktonic BV: use BV antibiotic tx
- If planktonic PPMs: use targeted PPM antibiotic tx
- If BV and/or PPM biofilm: disrupt biofilm and use antibiotic tx
- If candidiasis: use antifungal tx
- If trichomoniasis/cervical STI: use pathogen-specific antibiotic tx
- If multiple: use combinations
- In all cases: restore optimal VMB after tx using pre/probiotics, topical/systemic hormones, and/or lactic acid, consider partner treatment

Research priorities

- Increase understanding of:
  - *G. vaginalis*: genotypes, role in BV biofilm
  - *L. iners*: how much can be tolerated, role in BV biofilm
  - Role of other taxa in BV biofilm
  - Interactions PPMs and VMB, role in BV and/or PPM biofilm
  - Associations VMB dysbiosis types and clinical outcomes
  - Much VMB dysbiosis is asymptomatic but is still associated with adverse outcomes: When to screen and intervene?
- Develop better/more relevant diagnostics
- Develop better biofilm disruption
- Develop better pre/probiotics to restore optimal VMB
- Continue to test (combinations of) interventions to optimize the VMB and prevent adverse outcomes