The Pittsburgh Cervical Cancer Screening Model (PCCSM)

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Objectives

Employ novel decision science tools of Bayesian network model analysis to create a quantitative multivariable model of cervical cancer risk which reflects data from a large health system using the latest advances in screening and prevention technologies and MWH institutional risk management strategies.

- HPV Vaccination
- Liquid-based Cytology
- Location-guided Computer-assisted screening
- Widespread adjunctive HPV reflex testing and Pap-HPV cotesting
- Continuous Quality Improvement laboratory focus on missed screening opportunities to detect histologically diagnosable CIN23/AIS/Cancer cases
- Conservative Workload Policies
Bayesian networks

- Bayesian networks (BN): also called causal networks.
- Acyclic directed graphs modeling probabilistic influences among variables.
- Graphical part of a Bayesian network reflects the structure of a modeled problem.
- Local interactions among neighboring variables are quantified by conditional probability distributions utilizing system data.
- BN are powerful tools for modeling complex problems involving uncertain knowledge.
- BN widely employed in a variety of fields, including engineering, science, and medicine with some models reaching the size of hundreds or thousands of variables.
Database

- Magee-Womens Hospital of UPMC, laboratory data from over three and half years, 2005-2008
- LBC: ThinPrep Pap tests (TPPT)
- ThinPrep Pap Imaging System (TIS): 96% of all Paps
- Pap test results classified by TBS 2001
- hrHPV DNA test results (Digene HC II method)
- Histopathological data: biopsy and surgical procedure results
- Clinical data: history of contraception, history of infections, history of cancer, menstrual history, history of Pap abnormality, HPV vaccine status
- Demographic data: age and race
The Pittsburgh Cervical Cancer Screening Model

Database

- 393,531 Pap test results
- 75,301 hrHPV DNA test results
- 42,814 cervical and endometrial biopsies and surgical procedures
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- **Expert knowledge**
- **Clinical data**
- **Cytology data**
- **Histology data**
- **HPV data**

CoPath, CDR

**Graphical structure**

**Numerical parameters**
The Pittsburgh Cervical Cancer Screening Model: Static version

19 variables; 278,178 numerical parameters
The Pittsburgh Cervical Cancer Screening Model: Dynamic version

Risk of Cervical Precancer (CIN23/AIS) and CxCa

- cervix:CIN2_CIN3_AIS
- cervix:carcinoma
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Patients’ Data (history data and current state)

Cervical Precancer and Cancer Risk Assessment over Time
PCCSM: Risk Assessments for Histopathologic Precancer (CIN2/3, AIS) and Invasive Cervical Cancer
PCCSM: Risk Assessments for Histopathologic Precancer (CIN2/3, AIS) and Invasive Cervical Cancer

347,601 patients’ data used to train model
45,930 patients’ data tested (Apr-Aug 2008)
PCCSM: Risk Assessments for Histopathologic Precancer (CIN2/3, AIS) and Invasive Cervical Cancer

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Any-HSIL
Any-CIN23/AIS
HPV(+) x3
ASC_H HPV(+)
ASCUS HPV(+)
All Negative Paps

Current state: ASCUS HPV+

Prior history

The Pittsburgh Cervical Cancer Screening Model 13/20
The Pittsburgh Cervical Cancer Screening Model (PCCSM) is used for risk assessments for histopathologic precancer (CIN2/3, AIS) and invasive cervical cancer. The current state being considered is ASCUS HPV(+) or ASCUS HPV(-). This model evaluates various HPV and cytology results to determine the risk of precancerous or cancerous conditions. Prior history is a crucial factor in these assessments.
“The past is never dead. It’s not even past.”

William Faulkner, 1951
Conclusions

• The Pittsburgh Cervical Screening Model (PCCSM) constitutes a large Bayesian Network modeled database which reflects prevalent current use in the U.S. of advanced screening technologies.

• The PCCSM identifies groups of patients that are at different risk levels for developing cervical precancer and cervical cancer, quantitatively reflecting current and future risk based on both combinations of current test results and varying prior history.

• Both the current and near term (1-3 yrs) future risk of precancer (histologic CIN23/AIS) and Invasive Cervical Cancer in the PCCSM are most strongly correlated with the degree of cytologic abnormality.
Conclusions

• PCCSM quantitative risk assessments can be used as a personalized aid in clinical management and follow-up decision-making.

• The PCCSM supports the complementary nature of cytology and HPV testing.

• The PCCSM identifies numerous promising paths for future research and investigation.
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