Background
- Incidence of congenital cardiovascular malformations (CCVMs): 8 per 1,000 live births
- In 2009, CCVMs were responsible for 3,189 deaths
- Leading cause of death among infants with congenital malformations
- Adults living with CCVMs: approximately 8 per 1,000
- Growth impairment
- Gross motor abnormalities
- Reduced exercise tolerance
- Anxiety
- Risk factors for CCVMs poorly understood
- Etiological studies yield conflicting risk estimates
- Reasons:
  - Imprecise exposure assessment
  - Selection bias
  - Recall bias
  - Classification of CCVMs differ among studies

Objective
- To compare CCVM diagnoses at birth and at a 1 year follow-up
- Low birthweight (<2.5 kg, ≥2.5 kg)
- Gender (male, female)
- Percent of diagnoses changed similar in both periods (10.76% before, 10.89% after)
- Initial diagnoses made with only echocardiography, on infants small for gestational age, and on BWIS dataset: large, population
- Categorical Variables:
  - Dichotomous: isolated CCVM vs. other
  - Echocardiography least invasive, may mislead diagnosis
- No other study has looked at CCVM diagnoses over time
- Results important to other etiological CCVM studies
- International Society of Cardiology coding used for CCVM diagnoses

Study Population
- Baltimore-Washington Infant Study (BWIS)
  - Large, population-based
  - Case control
  - Studied etiology of CCVMs
  - 1981-1989
  - 11,000 square miles including Northern Virginia, Washington, D.C., entirety of Maryland
- Near 100% ascertainment of cases in study area during study period
- All pediatric cardiology centers in study area participated
- Pathology logsbooks, medical examiner’s reports, death certificates
- Cases (<4,390)
- Infants born alive confirmed to have a structural CCVM before 1st birthday
- Including patient ductus arteriosus
- International Society of Cardiology coding used for CCVM diagnoses
- Case infants’ diagnoses confirmed (or changed) at 1-year check-up
- 1-year check-up diagnoses (updated diagnoses) used in BWIS studies
- Controls (n=3,572) chosen randomly, annually from non-CCVM population
- Stratified by hospital
- 95% controls were 1st or 2nd selection
- Trained interviewers obtained exposure data from mothers at home
- Environmental, occupational exposures
- Medical and medication history
- Family history and sociodemographic factors

Study Variables
- Continuous Variables
  - Gestational Age (weeks)
  - Birth weight (grams)
- Categorical Variables
  - Gender (male, female)
  - Size for gestational age (small, normal, large)
- Non-cardiac malformations (isolated CCVM, chromosome, syndromic, organ malformation)
- Diagnostic modality at birth (echocardiography, cardiac catheterization, surgery, autopsy)
- Diagnostic modality at update (same as at birth)
- Prematurity (gestational age <38 weeks, ≥38 weeks)
- Low birthweight (<2.5 kg, ≥2.5 kg)
- Time between birth and initial diagnosis (<week, <month, ≥month)
- Dichotomous: echocardiogram vs. other
- Dichotomous: isolated CCVM vs. other
- Outcome variable: change in diagnosis from initial to updated diagnosis
- Dichotomous variable (yes, no)
- CCVMs originating in earliest gestational age out rank those from later in gestational age

Results
- 16 of 119 with changed diagnoses maintained initial diagnoses, but were outranked by additional diagnoses
- Exploratory chi-squared and t-test testing between change and predictors resulted in significant results for:
  - Site for gestational age (p=0.01)
  - Echocardiogram only (p=0.001)
  - Birthweight (p=0.009) (2885 grms vs. 3059 grms, mean weight of changed and unchanged, respectively)
  - Chi-squared testing between discordant changes and predictors were significant for:
    - Race (p=0.03)
    - Autopsy status (p=0.02)
    - Time from birth to registration (p=0.02)
- Stratification by pre-1985 births and post-1985
- 1985: color flow-doppler echocardiography
- Percent of diagnoses changed similar in both periods (10.76% before, 10.89% after)
- Non-cardiac malformations significantly associated with change in early strata
- Echocardiogram only, size for gestational age, and birthweight significant in 1985 and after period

Major Findings
- Initial diagnoses made with only echocardiography, on infants small for gestational age, and on infants with isolated CCVMs more likely to be changed than alternatives
- Approximately 10% of diagnoses changed from initial to 1-year diagnosis
- 5 out of 45 ORs changed more than 30% using initial diagnoses
- 6 out of 45 risk factors determined significant with 1-year updated diagnoses no longer significantly associated with CCVM when using initial diagnoses

Discussion
- No other study has looked at CCVM diagnoses over time
- Reflect accuracy, variability, and permanence of infant CCVM diagnoses
- Results important to other etiological CCVM studies
- Others may not use multiple diagnostic teams over time
- Diagnostic accuracy studies show echocardiography alone to be as accurate as catheterization
- Our results do not support this conclusion
- Echocardiography least invasive, may misdiagnosis
- 1985 cut-off stratified analysis contradicts this
- Small size of infant major challenge in diagnosis
- Other malformations may be associated with certain CCVMs making diagnosis easy
- Strengths
  - BWIS dataset: large, population-based with wide variety of exposure assessment by trained interviewers
  - Weaknesses
    - Changing diagnostic technology and methods over time and across diagnosing physicians
    - Limited sample size of rare CCVMs

Conclusion
- Initial diagnoses made with only echocardiography, on infants small for gestational age, and on infants with isolated CCVMs more likely to be changed than alternatives
- Etiological studies may be inaccurate if only birth diagnoses used in analyses

References