A descriptive investigation and analysis of the 2012 outbreak of *B. pertussis* in Douglas County, KS

Michael Banfield, MPH Candidate, Kansas State University
Masters of Public Health, Infectious Disease Emphasis
Lawrence-Douglas County Health Department

- Serves Douglas County
- A population of 112,000 people
- Employs approx. 45 staff members
- Provides a number of services to the community
Health department reports increase in whooping cough cases in Douglas County

By Karrey Britt on July 20, 2012

Health department investigating case of whooping cough at Quail Run

By Karrey Britt on August 21, 2012

Posted: Fri 5:43 AM, Oct 28, 2011  A A ▲▼
Updated: Fri 9:15 AM, Oct 28, 2011

Whooping Cough Outbreak In Northeast Kansas

LAWRENCE, Kan. (WIBW)-- Health officials in Northeast Kansas are dealing with an outbreak of whooping cough.

Whooping cough cases persist in Douglas County

Whooping cough outbreak continues in Douglas County

By Adam Strunk on December 6, 2012
Task: Prepare an After-Action Report on Pertussis outbreak

- Assigned: January 9\textsuperscript{th}, 2013
- Assigned by: Kim Ens, Director of Clinic Services, LDCHD
- Primary contacts:
  - Kathy Colson, Clinic Coordinator, LDCHD
  - Charlie Bryan, Community Health Planner, LDCHD
  - Daniel Neises, Senior Epidemiologist, KDHE
What is Pertussis?

Commonly known as ‘whooping cough’
- In China, known as the ‘hundred day cough’
 百日咳

- Vaccine Preventable!
- Still endemic in the United States
- Etiologic agent: *Bordetella pertussis*
Disease Progression

- **Stage 1 - Catarrhal Stage**: May last 1 to 2 weeks. Symptoms: runny nose, low-grade fever, mild, occasional cough - Highly contagious.

- **Stage 2 - Paroxysmal Stage**: Lasts from 1-6 weeks; may extend to 10 weeks. Symptoms: fits of numerous, rapid coughs followed by "whoop" sound; vomiting and exhaustion after coughing fits (called paroxysms).

- **Stage 3 - Convalescent Stage**: Lasts about 2-3 weeks; susceptible to other respiratory infections for many. Recovery is gradual. Coughing lessens but fits of coughing may return.

Retrieved from: cdc.gov
Case Definitions

• 'Clinical Description for Public Health Surveillance: A cough illness lasting $\geq 2$ weeks with one [other symptom]...as reported by a health professional’

• Laboratory Criteria for Case Classification: Isolation of *Bordetella pertussis* from clinical specimen; OR, PCR for *B. pertussis*.'

From KDHE’s *Pertussis Investigation Guidelines*, pg. 4
Case Status - Confirmed

- **Confirmed:**
  - Meets clinical case definition and is laboratory confirmed
  - By culture or PCR
- OR, is epi-linked to a confirmed case
- Reported to CDC
Case Status - Probable

- **Probable**: Meets the clinical case definition, is NOT laboratory confirmed, and is not epidemiologically linked to a laboratory-confirmed case.
- During an outbreak: Cough of greater than 2 weeks
Pertussis Testing

Optimal Timing for Diagnostic Testing (weeks)

From KDHE’s Pertussis Investigation Guidelines, pg. 3
Disease Reporting

- Centers for Disease Control
  - Weekly

- Kansas Department of Health and Environment
  - Daily

- Lawrence-Douglas County Health Department
  - 24/7 Line

- Douglas County Physicians
Vaccination

DTaP
- Diptheria, Tetanus, acellular Pertussis
- Received at 2, 4, 6, and 15-18 months. Again between 4-6 years.¹
- FDA approval in 1991
- Replaced DTP

TDaP
- Tetanus, Diptheria, acellular Pertussis
- Between grades 7-10²
  - NIH recommends age 11-12
- FDA approval in 2005
- No CDC recommendations for vaccination intervals
- Separate from Td vaccine

¹
²
Scale of 2012 Outbreak – National and State

- Global outbreak
- Forty-nine states report increased incidence
- National incidence rate: 13.4/100,000 persons
- Kansas incidence rate: 25.5/100,000 persons
  - 1,912 investigated cases
  - 864 confirmed or probable
Scale of 2012 Outbreak – Douglas County

- 305 investigated cases in Douglas County
- Over 900 contacts
- Over 1% of Douglas County population involved
- Highest county incidence in the state at a rate of 130.4/100,000 persons
  - Baldwin City incidence rate: 43 cases per pop. of 4,569 = 941/100,000 people!
Goals

• Summarize events
• Present a cost estimation of preventative measures
• Determine vaccination status of reported population
• Review reporting methods/management of outbreak
• Provide recommendations for future outbreaks
Methods to Acquire Data

- Data source: EpiTrax
- Final data pull: February 6\textsuperscript{th}, 2013
- Hotwash: January 29\textsuperscript{th}, 2013
- Interviews:
  - Kathy Colson
  - Daniel Neises
  - Charlie Bryan
Pertussis Supplemental Reporting Form

INTERVIEW

EpiTrx # ___________________ Interviewer Name: _____________________________

Number of Call Attempts: ______ Follow-up Status: □ Interviewed □ Refused Interview □ Lost to Follow-Up*

Date of Interview (must enter MM/DD/YYYY): ___________________________

*At least three attempts at different times of the day should be made before considered lost to follow-up.

Respondent was: □ Self □ Parent □ Spouse □ Other, Specify: __________________________

DEMOGRAPHICS

County: _______________ Birth Gender: □ Male □ Female Date of Birth: _____________ Age: _______

Hispanic/Latino Origin: □ Yes □ No □ Unknown

Race: □ White □ Black/African American □ American Indian/Alaska Native □ Asian □ Native Hawaiian/Other Pacific Islander

□ Other_________________________ □ Unknown

CLINICAL

What date did you start to have symptoms of illness? Onset Date: _____________ Onset Time: ___________

Did you recover? □ Yes □ No □ Unknown If Yes, Recovery Date: _____________ Time Recovered: _____ AM/PM

Were you hospitalized? □ Yes □ No □ Unknown If Yes, Hospital Name: _____________________________

Days Hospitalized _____________ Admit Date: _____________ Discharge Date: _____________

Died? □ Yes □ No □ Unknown If Yes, Date of Death: _____________________________

Are you pregnant? □ Yes □ No □ Unknown If Yes, Expected Delivery Date: ___________________________

Did you receive antibiotics for this illness? □ Yes □ No □ Unknown

<table>
<thead>
<tr>
<th>1st Medication Name</th>
<th>Date started first antibiotic:</th>
<th>Number of days first antibiotic actually taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Erythromycin (incl. Pedialyte)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Cotrimoxazole (bactrim/septran)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Clarithromycin/Azithromycin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Tetracycline/Doxycline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Amoxicillin/Penicillin/Ampicillin/Augmentin/Cefaclor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Other specify: _______________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>☐ Unknown</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Medication Name</th>
<th>Date started second antibiotic:</th>
<th>Number of days second antibiotic actually taken:</th>
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<tr>
<td>☐ Cotrimoxazole (bactrim/septran)</td>
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</tr>
<tr>
<td>☐ Clarithromycin/Azithromycin</td>
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</tr>
<tr>
<td>☐ Tetracycline/Doxycline</td>
<td></td>
<td></td>
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<tr>
<td>☐ Amoxicillin/Penicillin/Ampicillin/Augmentin/Cefaclor</td>
<td></td>
<td></td>
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<tr>
<td>☐ Other specify: _______________</td>
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<td></td>
</tr>
<tr>
<td>☐ Unknown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Inclusion Criteria

- All cases ‘Reported to Public Health’ between January 1\textsuperscript{st}, 2012 and December 31\textsuperscript{st}, 2012
- Jurisdiction: Douglas County
- Disease: Pertussis
- ‘Probable’ and ‘Confirmed’ cases assigned equal weight, reported to CDC
Outbreak Summary

- 305 reported cases
- 146 confirmed or probable
- Sporadic cases in the first six months of 2012
- Twelve events meet KDHE ‘outbreak’ criteria
  - Two School outbreaks
  - Ten (10) household outbreaks
  - One officially identified by KDHE
Age and Gender Statistics

• Mean reported age: 16.4 (median: 10 range: 0 – 80+)
• Mean confirmed or probable age: 18
  – (median: 11 range: 0 - 80+)
• Reported Females: 176
  – Confirmed or Probable Females: 85
• Reported Males: 126
  – Confirmed or Probable Males: 61
Pertussis cases investigated by LDCHD in 2012*

*By week reported to public health
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Confirmed and Probable Cases</th>
<th>All Reported Cases</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 years</td>
<td>27</td>
<td>70</td>
<td>.386</td>
</tr>
<tr>
<td>5-9 years</td>
<td>34</td>
<td>81</td>
<td>.420</td>
</tr>
<tr>
<td>10-14 years</td>
<td>36</td>
<td>62</td>
<td>.581</td>
</tr>
<tr>
<td>15-19 years</td>
<td>10</td>
<td>22</td>
<td>.455</td>
</tr>
<tr>
<td>20-24 years</td>
<td>N/A</td>
<td>11</td>
<td>N/A</td>
</tr>
<tr>
<td>25-29 years</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>30-34 years</td>
<td>6</td>
<td>8</td>
<td>.750</td>
</tr>
<tr>
<td>35-39 years</td>
<td>8</td>
<td>9</td>
<td>.889</td>
</tr>
</tbody>
</table>

Values less than 6 are masked to protect patient privacy. All age ranges over 40 contained values less than 6.
Vaccination Status

• Of the 305 investigated cases:
  – 71.8% were reported as vaccinated
  – 15.7% were not vaccinated or had an unknown vaccination history
  – remaining 14.3% were left with a blank vaccination field

• Unknown and blank vaccinations fields cannot be interpreted and are removed from the sampling.

• 74% (108 of 146) of confirmed or probable cases vaccinated
Vaccine Efficacy

• Using methods outlined by Fielding et. al in *Effectiveness of Seasonal Influenza Vaccine against Pandemic (H1N1) 2009 Virus, Australia, 2010* (2011)

• Vaccinated but confirmed or probable cases:
  – 108 of 146 cases (.7397)

• Vaccinated and not a case (controls):
  – 111 of 126 (.8809)

• Vaccine efficacy = (1 – Odds Ratio) x 100

  \[= \left(1 - \frac{.7397}{.8809}\right) \times 100 = 16\%! \text{ But…}\]
## Vaccination Rates

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Vaccinated</th>
<th>All Reported Cases</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 years</td>
<td>55</td>
<td>70</td>
<td>.786</td>
</tr>
<tr>
<td>5-9 years</td>
<td>70</td>
<td>81</td>
<td>.864</td>
</tr>
<tr>
<td>10-14 years</td>
<td>55</td>
<td>62</td>
<td>.887</td>
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<tr>
<td>15-19 years</td>
<td>16</td>
<td>22</td>
<td>.727</td>
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<tr>
<td>20-39 years</td>
<td>9</td>
<td>32</td>
<td>.237</td>
</tr>
<tr>
<td>40-59 years</td>
<td>9</td>
<td>24</td>
<td>.375</td>
</tr>
<tr>
<td>60+</td>
<td>4</td>
<td>15</td>
<td>.267</td>
</tr>
</tbody>
</table>
Cost Analysis

• Estimated cost of case and preventative treatment associated with the outbreak is $12,189.
• Vaccination cost is not included
  – No additional or emergency vaccine shipments required for the county
• The cost of PCR laboratory testing is estimated at $16,555
• The cost of surveillance and man-hours from LDCHD dedicated to pertussis is estimated at $13,365
• Total estimated cost for additional public health surveillance, testing and prevention for the outbreak in Douglas County: $42,110
Lawrence Private School

• Officially recognized by KDHE
• Suspected Index case: Teacher, not vaccinated
  – Cough onset: Mid-October
  – Reported: Mid-November
• Five confirmed and probable cases resulted
  – Eight additional contacts were associated
Baldwin City School District Outbreak

- Dates: October 12 – November 5
- Index case: unidentified
- Not officially recognized by KDHE
- Same age groups, all cases in same area and within 42 days of each other
- 8 confirmed or probable cases
  - 34 associated contacts
Household Outbreaks

- Characterized as outbreaks where spread was limited to a single household
- Ten (10) identified
- Twenty-three (23) confirmed and probable cases, 2 suspect cases
  - 8 under vaccinated (65% vaccination rate)
  - 162 contacts associated
Conclusions/Discussion

• Outbreak began in July
• Ongoing in December
• Inconsistencies in data entry severely limited the validity of the data
• Origins of the outbreak are unknown
• Potential reasons for high incidence
Limitations of the Review

- Primary purpose of EpiTrax is surveillance, not research
- Many inconsistencies in data
- Passive Surveillance system
  - Likely many cases in the county went unreported
Management of Outbreak by LDCHD

Led by the LDCHD Communicable Disease Team

- Director of Clinic Services
- Communicable Disease Team Leader (PH Nurse)
  - Communicable Disease Investigator (PH Nurse) (Clinic Coordinator)
  - Communicable Disease Investigator (PH Nurse)
  - Interns or other PH Nurses
Management of Outbreak by LDCHD

- Participant Feedback form distributed to LDCHD participants
- Hotwash on January 29th with Communicable Disease Team
- Trigger point of outbreak not identified
- Incident Command System not activated
## Summary of Participant Feedback Form

| Strengths                                      | 1) Quick initiation of cases  
|                                               | 2) Thorough initial investigation  
|                                               | 3) Flexibility of staff  
|                                               | 4) Strong working relationship with KDHE and school nurses |
| Weaknesses                                    | 1) Follow-up in a timely manner  
|                                               | 2) Consistent follow-up on uncertain cases  
|                                               | 3) Lack of regular meetings (no formal declaration of ICS) |
| Notes to the evaluator (Observations possibly not recorded) | 1) Consistency/bias of interviewers regarding importance of investigations and follow-up  
|                                               | 2) Inadequate staff  
|                                               | 3) Improper training  
|                                               | 4) Physician response early in the outbreak |
| Suggested Improvements                         | 1) Increase staff cross training  
|                                               | 2) Improve consistency in charting  
|                                               | 3) Use DIGs more accurately  
|                                               | 4) Have back-up CD nurses  
|                                               | 5) Routine training |
| Resources needing reviewed, revised, or developed | 1) Add more individuals who can access EpiTrax  
|                                               | 2) Train additional nurses for CD team  
|                                               | 3) Consider training reviews |
| Additional Comments                            | 1) Training during an incident is not as effective as training prior to an incident  
|                                               | 2) The headsets were a nice addition. |
Summary of Hotwash

• Caseload exceeded expectations
• Goal: ‘to reduce the spread of disease’
  – Achieved?: uncertain
• CD team did not meet regularly
• Two nurses spent the majority of October through December conducting communicable disease investigations
• Current case management method: Binder
LDCHD Management of Outbreak

- Contacting cases within 24 hours of being reported to LDCHD: 93.8% success
- Measuring follow-up: not possible quantitatively
  - 35 investigations (11.5%) took 20 days or longer to complete
  - mean case investigation length: 8 days (median: 7 range: 0 – 42)
LDCHD Management of Outbreak

- CDC PHEP Capability 13: Public Health Surveillance and Epidemiological Investigation Evaluated
- Evidence-based, released in 2011 for strategic planning purposes
- All 15 capabilities must be demonstrated every 5 years – KDHE agreement
‘Without feedback from precise measurement...invention is doomed to be rare and erratic. With it, invention becomes commonplace.’

– Bill Gates, Bill and Melinda Gates Foundation Annual Letter 2013 (Paraphrase of Rosen)
<table>
<thead>
<tr>
<th>Capability</th>
<th>Function/Task #</th>
<th>Recommendation</th>
<th>Resource Element</th>
<th>Primary Responsible Agency</th>
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<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>1</td>
<td>Media Reporting Guidelines</td>
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<td>LDCHD</td>
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<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>1</td>
<td>Review data reporting requirements Standardized Data Entry (Measure 1)</td>
<td>Planning</td>
<td>LDCHD/KDHE</td>
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<tr>
<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>1</td>
<td>Written plans for analyzing data (Planning Resource Element 3).</td>
<td>Planning</td>
<td>LDCHD</td>
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<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>1</td>
<td>Improved Organizational Structure to Track Follow-Up Cases</td>
<td>Equipment and Technology</td>
<td>LDCHD</td>
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<tr>
<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>3</td>
<td>EpiTrax Training/Review</td>
<td>Staff and Training</td>
<td>KDHE/LDCHD</td>
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<tr>
<td>Public Health Surveillance and Epidemiological Investigation (#13)</td>
<td>4.1</td>
<td>Regular Communicable Disease Meeting</td>
<td>Staff and Training</td>
<td>LDCHD</td>
</tr>
</tbody>
</table>
Standardized Data Entry (Priority)

- Encouraged through participant surveys, the hotwash, and through the evaluator's analysis of data
- Not specific for pertussis but for all communicable disease and clinic work conducted at LDCHD
- Routine staff training should address how data is entered
- Consider performance reviews
Improved Organizational Structure to Track Cases

- Current system of binder is unreliable, not reminders
- EpiTrax provides system for regular reminders
- Regular staff review of cases could also address this
EpiTrax Training

• Some fields are open to interpretation
• KDHE staffing issues have delayed training
• Only one case used the ‘where acquired’ field appropriately
• Proper training from KDHE may alleviate this concern and satisfy this recommendation.
Regular CD Team Meeting/ ICS

- Some way to address issues during the incident
- Quicker identification of clusters or outbreaks
- Be creative about meeting times
  - KDHE meets briefly each day
  - Review cases electronically each day
- "An important lesson learned was that [the ICS] team was very valuable and need to be established earlier in the outbreak." – 2006 Mumps AAR
Update on Outbreak

- Jan. 1st: Change in cases investigated
- As of March 26, 2013: 7 Confirmed or Probable in Douglas County
- Still increased incidence compared to 2011
- Data validity from LDCHD has improved (‘where acquired’ field primarily)
Potential for Future Research

- Spatial-temporal associations among cases currently being investigated for the 2012 outbreak in the state of Kansas
- State data provided by KDHE
Acknowledgements

• The communicable disease staff of LDCHD, notably Kathy Colson
• Charlie Bryan, Preparedness Coordinator, LDCHD
• Daniel Neises, Senior Epidemiologist, KDHE,
• Kevin Kovach, Epidemiologist, Johnson County Health Department
• Supervisory Committee:
  – Notably: Dr. Stephan Chapes, Major Professor
  – Dr. Robert Larson
  – Dr. Mary McElroy
Sources

Sources

• Hart, B. (2013, February 13). Communication regarding KDHE PCR. (M. Banfield, Interviewer)
Sources

Source

- Schnirring, L. (2013). Researchers find first US evidence of vaccine-resistant pertussis. CIDRAP.
- Setting the record straight: developing a guideline for the reporting of studies conducted using observational routinely collected data. (2013). Clinical Epidemiology, 29-31.
Questions?
<table>
<thead>
<tr>
<th>Action</th>
<th>Courses Addressed</th>
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<tbody>
<tr>
<td>Employment for the National Agricultural Biosecurity Center:</td>
<td>-Biol 670</td>
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<tr>
<td>Prepared documents on various zoonotic disease and have addressed the</td>
<td>-Biol 730</td>
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<td>capabilities of various countries to address zoonotic disease</td>
<td>-Kin 818</td>
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<td>outbreaks and biosecurity.</td>
<td>-DMP 770</td>
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<td>-Geog 508</td>
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<td>-DMP 754</td>
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<td></td>
<td>-FDSCI 730</td>
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<td>-DMP 815</td>
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<tr>
<td>Internship with the Lawrence Douglas County Health Department:</td>
<td>-Biol 670</td>
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<tr>
<td>Through one summer internship and one semester internship, I've</td>
<td>-Kin 818</td>
</tr>
<tr>
<td>completed over 500 hours of unpaid work for the LDCHD. Work</td>
<td>-DMP 770</td>
</tr>
<tr>
<td>includes the following:</td>
<td>-Geog 508</td>
</tr>
<tr>
<td>-Completed various mapping requests for information, grant</td>
<td>-FDSCI 730</td>
</tr>
<tr>
<td>applications, etc.</td>
<td>-HMD 720</td>
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<tr>
<td>-Evaluated current GIS capabilities and limitations</td>
<td>-STAT 701</td>
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<tr>
<td>-Prepared and organized GIS files for future staff use. Identified</td>
<td>-STAT 705</td>
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<tr>
<td>sources.</td>
<td>-DMP 815</td>
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<tr>
<td>-Identified vulnerable populations and population estimates of those</td>
<td>-DMP 840</td>
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<tr>
<td>groups in the county</td>
<td>-DMP 806</td>
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<td>-Produced access to healthy foods maps; evaluated a model using</td>
<td>-DMP 754</td>
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<tr>
<td>convenience stores as distributors of fresh produce</td>
<td></td>
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<tr>
<td>-Analysis of clinic schedule: identified time slots and days of</td>
<td></td>
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<tr>
<td>week most likely to be missed, reported to Sue</td>
<td></td>
</tr>
<tr>
<td>-Internal audit on clinic pregnancy procedures (were the right</td>
<td></td>
</tr>
<tr>
<td>people being referred to the appropriate programs)</td>
<td></td>
</tr>
<tr>
<td>-Analysis of clinic pregnancy data: patient demographics, etc.</td>
<td></td>
</tr>
<tr>
<td>-Worked on a series of Health Indicator Briefs with Vince.</td>
<td></td>
</tr>
<tr>
<td>-Prepared some educational materials on GIS for Vince and Charlie</td>
<td></td>
</tr>
<tr>
<td>-Pertussis outbreak review</td>
<td></td>
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<td>Volunteer work with the Flint Hills Community Clinic:</td>
<td>-KIN 818</td>
</tr>
<tr>
<td>Work as a CNA and Greeter</td>
<td></td>
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<tr>
<td>Volunteer for the Riley County Health Department Flu Vaccination</td>
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<td>Clinic:</td>
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<td>Worked several dates checking people in for vaccinations.</td>
<td>-BIOL 670</td>
</tr>
<tr>
<td>KSU Graduate Student Council Health Insurance Representative:</td>
<td>-HMD 720</td>
</tr>
<tr>
<td>Work includes attending GSC meetings and relaying changes to the</td>
<td>-KIN 818</td>
</tr>
<tr>
<td>graduate health insurance to the council. Also responsible for</td>
<td></td>
</tr>
<tr>
<td>setting up webinars and meetings. Addressing student concerns</td>
<td></td>
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</table>