Giardiasis Diagnosis and Treatment in the United States: New Tools for an Old Disease

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Giardiasis in the United States

• *Giardia intestinalis* parasite

• 1.2 million cases/year

• Hospitalizations cost $34 million/year

• 8% of US cases are travel-associated

• Children 1–9 years: Highest annual incidence
Giardia transmission in the United States
Highlights from *Giardia’s* long history

- 1632: Van Leeuwenhoek’s Microscope
- 1965
- 1992
- 2002

CDC

NNDSS (National Notifiable Diseases Surveillance System)
Giardiasis symptoms, diagnosis and treatment: an expected sequence

- Prolonged, non-bloody diarrhea
- Abdominal cramps
- Bloating
- Flatulence
- Long-term sequelae

Adapted from Gardner, 2001. *Clin Microbiol Rev.* Figure 2
Prolonged GI symptoms

Giardia diagnostic test

Giardiasis diagnosis (Dx)

Antiparasitic prescription (Rx)

• Is this sequence actually happening in the US?
• If not, how do patients get diagnosed and treated?
• Do pediatric and adult giardiasis care differ?

Adapted from Gardner, 2001. Clin Microbiol Rev. Figure 2
Giardiasis is difficult to diagnose

- Nonspecific symptoms and low clinical suspicion
- Parasites are shed intermittently in feces
- Multiple specimens recommended
- Providers must order *Giardia*-specific tests

...which can lead to problems

- Delayed diagnoses
- Disrupted daily life
- Ineffective antibiotic prescriptions → antimicrobial resistance

• Actual vs. expected patient care is unknown

• Reason to suspect room for improvement

We can’t fix what we don’t measure
Study aims

1. Describe pediatric and adult giardiasis clinical care in the US
   • GI symptom visits
   • Diagnostic tests
   • Antiparasitic prescriptions
   • Antibiotic prescriptions

2. Quantify and characterize the use of the expected giardiasis care sequence
MarketScan insurance claims database

- Large (enormous) database of health insurance claims data
  - ~170 million unique persons
  - 1995–present
- Claims records for:
  - Hospital stays
  - Outpatient office visits
  - Diagnostic procedures
  - Prescriptions
  - Commercially insured, excluding Medicare/Medicaid
- Longitudinal data
  - Patient = event timeline
- Big data, more economical than a cohort study
## Example of one person’s insurance claims data in MarketScan

<table>
<thead>
<tr>
<th>Date of Service</th>
<th>Procedure Code</th>
<th>Diagnosis Code</th>
<th>Rx Name</th>
<th>Copay</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/7/15</td>
<td>Office visit</td>
<td>Diarrhea</td>
<td></td>
<td>$64.78</td>
</tr>
<tr>
<td>5/14/15</td>
<td>Office visit</td>
<td>Giardia</td>
<td></td>
<td>$50.39</td>
</tr>
<tr>
<td>5/14/15</td>
<td>Ova and Parasite - stool</td>
<td>Giardia</td>
<td></td>
<td>$30.29</td>
</tr>
<tr>
<td>5/14/15</td>
<td>METRONIDAZOLE</td>
<td>Giardia</td>
<td></td>
<td>$15.00</td>
</tr>
<tr>
<td>6/9/15</td>
<td>Giardia Rapid Test</td>
<td>Giardia</td>
<td></td>
<td>$36.48</td>
</tr>
</tbody>
</table>
MarketScan giardiasis cohort

N = 2,995

- ≥1 giardiasis outpatient visit: ICD-9-CM code 007.1
- Diagnosed from 2006–2010
- Evidence of Rx coverage
- Enrolled 90 days before and after diagnosis
## MarketScan giardiasis cohort characteristics (N=2,995)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female gender</strong></td>
<td>1,499</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–17</td>
<td>915</td>
<td>30.6</td>
</tr>
<tr>
<td>18–44</td>
<td>1,151</td>
<td>38.4</td>
</tr>
<tr>
<td>45–64</td>
<td>929</td>
<td>31.0</td>
</tr>
<tr>
<td><strong>US Census Region of residence</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>1,297</td>
<td>43.3</td>
</tr>
<tr>
<td>West</td>
<td>774</td>
<td>25.8</td>
</tr>
<tr>
<td>Midwest</td>
<td>544</td>
<td>18.2</td>
</tr>
<tr>
<td>Northeast</td>
<td>361</td>
<td>12.1</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Giardiasis outpatients as event timelines in MarketScan

-90 days

GI symptom

Giardia test

Giardiasis Dx

Antiparasitic Rx

Antibiotic Rx

+90 days
Event-specific descriptive results

- 48% were diagnosed on their first symptom visit
- 50% had no *Giardia* diagnostic tests
- 64% had $\geq 1$ antiparasitic prescription
- 27% had $\geq 1$ antibiotic prescription
- Children had more tests and fewer prescriptions than adults
The whole tub of ice cream

Giardiasis outpatients (N=2,995)
A new tool for finding patterns in longitudinal data

EventFlow: Visual Analysis of Temporal Event Sequences and Advanced Strategies for Healthcare Discovery

http://www.cs.umd.edu/hcil/eventflow/
EventFlow: simplifying complex longitudinal data

Scatterplot

Example EventFlow Output

http://www.cs.umd.edu/hcil/eventflow/
Persistent GI symptoms

*Giardia* diagnostic test

Giardiasis Dx

Antiparasitic Rx

Antibiotic Rx
Expected sequence query in EventFlow

- **Giardia diagnostic test**
- **Antiparasitic Rx**

**Sequential**
- **Antibiotic Rx** (crossed out)

**OR**
- **GI symptom**

**Concurrent**
- **Antibiotic Rx** (crossed out)
Expected giardiasis clinical event sequence

- 18% of outpatients followed the expected sequence
- No difference between children and adults
18% had the expected sequence (N=541)

http://www.cs.umd.edu/hcil/eventflow/
18% had the expected sequence (N=541)

96%: First event = *Giardia* test

http://www.cs.umd.edu/hcil/eventflow/
18% had the expected sequence (N=541)

96%: First event = *Giardia* test

4%: Drug → Test → Drug → …

Outpatients with expected sequence

0 days

Time from outpatient’s first event

90 days

http://www.cs.umd.edu/hcil/eventflow/
18% had the expected sequence (N=541)

86%: Test → Drug

Median time: 4 days

http://www.cs.umd.edu/hcil/eventflow/
82% had unexpected sequences

- Identify gaps between recommendation and reality

- How does care differ between children and adults?
Pediatric unexpected care sequences (n=807)

http://www.cs.umd.edu/hcil/eventflow/
Pediatric unexpected care sequences (n=807)

39%: First event = *Giardia* test

12%: First event = Antibiotic

http://www.cs.umd.edu/hcil/eventflow/
Pediatric unexpected care sequences (n=807)

Median time: 21 days

http://www.cs.umd.edu/hcil/eventflow/
Adult unexpected care sequences (n=1647)

27%: Antiparasitic only

45%: First event = Antiparasitic
Unexpected care sequences compared

Age <18 years (n=807)

Age 18–64 years (n=1647)
EventFlow analysis unlocked novel insights

- Most outpatients do not have the expected care sequence

- Giardiasis care differs fundamentally by age
  - Children: Comprehensive testing workup
  - Adults: “Treat first, test later (or not)”

- Findings will drive provider follow-up as we develop revised guidance
Interpret with care

- Must analyze and validate patterns identified with EventFlow

- MarketScan: administrative data not collected for our study purpose expressly
Public health research impact

- Largest analysis of US giardiasis diagnosis and treatment
- First use of EventFlow at CDC
Future directions

- Clinical guidance should incorporate insights from cohort studies of patient care patterns
- Recommend data visualization tools to complement conventional analyses
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### Epidemic Intelligence Service Program
Thank you

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