UNCONVENTIONAL OIL AND GAS DRILLING AND HEALTH CARE UTILIZATION

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DISCLOSURES

• Grants: NIH, J &J, Merck, AstraZeneca.

• Consultation: J &J, Merck, AstraZeneca, Teva
What is the Marcellus Shale?

- Half the land mass of Pennsylvania
- 22,835 sq miles
- 84 trillion cubic ft of natural gas
- $2 - $4 per thousand cubic ft
- Enough for the entire US population for 4 yrs
- Shale sedimentary rock
- Organic rich and porous
- Contains thermogenic methane
The Drill Rig

- Drill head and pad 5-10 acre plot
- Ideally one per sq mile
- Saturating drilling 8 per square mile
- High density drilling in Susquehanna Co, PA

- Pennsylvania would need 22,000 to 160,000 drill rigs
- In April 2012 > 12,000 permits
The “Fracking” Process

Hydraulic fracturing, or “fracing,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.
The Holding Ponds for Flow-Back Water

- Need 5M gallons water per well head
- Each truck carries 4,000 gallons water
- 1250 truck loads
- Propant: 1.5 M pounds (silica/sand)
- Requires 750 truck loads
- X1 to x10 “frack” episodes per well
- <30% in the flow back water held in pits
Hydrofracturing, Marcellus Shale and Pennsylvania
HYPOTHESES

Increases in health care utilization are associated with well density and well water quality in Pennsylvania counties and zip codes.
OBJECTIVES


2. Determine whether PA well density by zip code is associated with alterations in health care utilization over time.

3. Characterize any association among well water quality (Columbia University), UOGD well density and health care utilization in NY and PA counties/zip codes.
METHODS

• Examine retrospective health care databases from 2007-2011 for inpatient and outpatient utilization.

• Compare New York Counties with those in Pennsylvania.

• Normalize for population.

• Correlate health care utilization and well density by zip code.

• Correlate water quality, health care utilization and well density.
NEW YORK AND PENNSYLVANIA COUNTIES
NEW YORK vs PENNSYLVANIA COUNTIES
HEALTH CARE UTILIZATION FROM 2007-2011
<table>
<thead>
<tr>
<th>Medical Count</th>
<th>Final Model</th>
<th>State (reference group=NY)</th>
<th>Year (ordinal)</th>
<th>State*Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Product Lines</td>
<td>Main Effects</td>
<td>1.40 [1.36, 1.44]</td>
<td>0.98 [0.97, 0.99]</td>
<td></td>
</tr>
<tr>
<td>Cardiology</td>
<td>Main Effects</td>
<td>1.74 [1.70, 1.79]</td>
<td>0.99 [0.98, 0.99]</td>
<td>NA</td>
</tr>
<tr>
<td>General Med.</td>
<td>Null Model</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>General Surgery</td>
<td>Interaction</td>
<td>1.38 [1.29, 1.47]</td>
<td>0.97 [0.96, 0.98]</td>
<td>1.04 [1.02, 1.06]</td>
</tr>
<tr>
<td>Gynecology</td>
<td>Main Effects</td>
<td>1.11 [1.05, 1.18]</td>
<td>0.89 [0.87, 0.91]</td>
<td>NA</td>
</tr>
<tr>
<td>Neonatology</td>
<td>State</td>
<td>0.61 [0.57, 0.65]</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Neurology</td>
<td>Interaction</td>
<td>1.43 [1.29, 1.58]</td>
<td>0.997 [0.98, 1.02]</td>
<td>1.034 [1.004, 1.07]</td>
</tr>
<tr>
<td>Normal Newborn</td>
<td>Interaction</td>
<td>1.20 [1.09, 1.31]</td>
<td>0.99 [0.97, 1.004]</td>
<td>0.97 [0.94, 0.996]</td>
</tr>
<tr>
<td>Oncology</td>
<td>Interaction</td>
<td>1.26 [1.11, 1.42]</td>
<td>0.94 [0.92, 0.96]</td>
<td>1.06 [1.02, 1.10]</td>
</tr>
<tr>
<td>Orthopedics</td>
<td>Main Effects</td>
<td>1.34 [1.27, 1.42]</td>
<td>0.95 [0.93, 0.97]</td>
<td>NA</td>
</tr>
<tr>
<td>Urology</td>
<td>State</td>
<td>1.24 [1.16, 1.33]</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Vascular Surgery</td>
<td>Main Effects</td>
<td>1.29 [1.18, 1.42]</td>
<td>0.95 [0.92, 0.99]</td>
<td></td>
</tr>
</tbody>
</table>
Estimated General Surgery Rate by Year/State and Estimated Rate Difference

Population Normalized General Surgery Rates

- **Red** - Estimated PA Rates
- **Blue** - Estimated NY Rates
- **Green** - Estimated Difference

Year:
- 2007
- 2008
- 2009
- 2010
- 2011

Estimated Rate Difference:
- 100
- 80
- 60
- 40
- 20
Estimated Neurology Rate by Year/State and Estimated Rate Difference

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated PA Rates</th>
<th>Estimated NY Rates</th>
<th>Estimated Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td>60</td>
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<td>2009</td>
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<tr>
<td>2010</td>
<td></td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>
Estimated Normal Newborn Rate by Year/State and Estimated Rate Difference

Population Normalized Normal Newborn Rates

Year

2007
2008
2009
2010
2011

Estimated PA Rates
Estimated NY Rates
Estimated Difference

Estimated Normal Newborn Rate by Year/State and Estimated Rate Difference

Population Normalized Normal Newborn Rates

Year

2007
2008
2009
2010
2011

Estimated PA Rates
Estimated NY Rates
Estimated Difference
PENNSYLVANIA ZIP CODE HEALTH CARE UTILIZATION AND WELL DENSITY
INPATIENT UTILIZATION BY ZIP CODE: 2007 (HEAT MAPS)
INPATIENT UTILIZATION BY ZIP CODE: 2011
HEAT MAPS
INPATIENT UTILIZATION IN PENNSYLVANIA ZIP CODES FROM 2007-2011

Normalized to zip code Population

n=117,030 hospitalizations over 5 years
OUTPATIENT UTILIZATION BY ZIP CODE: 2010
HEAT MAPS
OUTPATIENT UTILIZATION BY ZIP CODE: 2011
HEAT MAPS
OUTPATIENT UTILIZATION BY PA ZIP CODE 2010-2011


n=105,227 outpatient visits over 2 years
CONCLUSIONS

• Hospitalization rates differ between counties in Pennsylvania and in New York.

• From 2007-2011, there are increases in some but not all causes of hospitalization in PA versus NY counties.

• There is an association between hospitalization rates and well density in PA.
SIGNIFICANCE

The economic value of unconventional oil and gas drilling should account for the consequences on health care delivery and wellness of Pennsylvanians.

Further research is needed to ascertain the health care risk and specific morbidities associated with unconventional oil and gas drilling.
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