Automated Review of Laboratory Test Appropriateness

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Department of Laboratory Medicine, Yale-New Haven Hospital
<table>
<thead>
<tr>
<th>Test Name</th>
<th>+</th>
<th>Total</th>
<th>Billable Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenovirus PCR, CSF</td>
<td>0</td>
<td>442</td>
<td>$154,213.80</td>
</tr>
<tr>
<td>Adenovirus PCR, Nasopharynx</td>
<td>33*</td>
<td>8432</td>
<td>$2,941,925.00</td>
</tr>
<tr>
<td>Adenovirus DFA, Nasopharynx</td>
<td>7</td>
<td>12,378</td>
<td>$1,631,173.00</td>
</tr>
<tr>
<td>West Nile virus IgM, CSF</td>
<td>5</td>
<td>439</td>
<td>$75,336.79</td>
</tr>
</tbody>
</table>

* Intermediate results counted as positive

Over $4.7M
When to test?

Cost

Feedback
“There is no standard definition for what constitutes an inappropriate, incorrect, or duplicative test order.”
Prevalence Node

\[ P(\text{Disease}) = 1 \]
P(Disease) = 0.5
Test Node

- **Sick**
  - **Test+** (Sick) = Sensitivity

- **Healthy**
  - **Test-** (Healthy) = Specificity
P(Test+ | Sick) = Sensitivity

P(Test- | Healthy) = Specificity

1 - Sensitivity

1 - Specificity
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* Intermediate results counted as positive
Patient may be sick

*Prevalence = \( \frac{1}{2} \)
Test is perfect

Prevalence = \frac{1}{2}
Test is perfect

\[
\text{Prevalence} = \frac{P_{\text{pre-test}}}{5} = \frac{1}{5}
\]
West Nile Test

Sensitivity = 95%
Specificity = 99%

\[ P(Disease) = \frac{\text{Specificity} + P(\text{Positive Result}) - 1}{\text{Specificity} + \text{Sensitivity} - 1} \]
Decision Tree

- **Test**
  - **Sick**
    - **Test+** → **Treat**
      - $O_{Sick}^{Treat} + Cost_{Test}$
    - **Test-** → **No Treat**
      - $O_{Sick}^{NoTreat} + Cost_{Test}$
  - **Healthy**
    - **Test+** → **Treat**
      - $O_{Healthy}^{Treat} + Cost_{Test}$
    - **Test-** → **No Treat**
      - $O_{Healthy}^{NoTreat} + Cost_{Test}$

- **No Treatment**
  - **Sick**
    - $O_{Sick}^{NoTreat}$
  - **Healthy**
    - $O_{Healthy}^{NoTreat}$

- **Treat**
  - **Sick**
    - $O_{Sick}^{Treat}$
  - **Healthy**
    - $O_{Healthy}^{Treat}$
Summary

• Poor test use is costly to our patients!
• Test appropriateness is defined by a decision analysis weighing the costs and benefits
• Test utilization is a disagreement between the laboratory and the clinicians on the threshold for ordering a test
• Retrospective calculation of pre-test probability can harmonize test use between the clinic and lab
Understanding Test Results for Infectious Diseases
Consider the likelihood of disease before performing laboratory testing

The likelihood that a patient has a disease depends on many factors:

- Has the patient been in an area where the disease is found?
- Does the patient have signs and symptoms typical of the disease?
- Does the patient have risk factors for contracting or developing the disease?

**DISEASE IS COMMON***

100 people tested for the disease ‡

NEGATIVE TESTS
- True Negatives
- False Negatives

1% FALSE NEGATIVE
1 of 60 people who tests negative has the disease

POSITIVE TESTS
- False Positives
- True Positives

3% FALSE POSITIVE
1 of 40 people who tests positive does not have the disease

**DISEASE IS RARE†

100 people tested for the disease ‡

NEGATIVE TESTS
- False Negatives
- True Negatives

0% FALSE NEGATIVE
None of the 97 people who tests negative has the disease

POSITIVE TESTS
- False Positives
- True Positives

67% FALSE POSITIVE
2 of 3 people who test positive do not have the disease

* 40 out of 100 patients in this area have the disease
† 1 out of 100 patients in this area have the disease
‡ Test specificity = 98% (high) and test sensitivity = 98% (high)

Thank you David Peaper for this slide.
### Clinical Features Associated with West Nile Meningoencephalitis

<table>
<thead>
<tr>
<th>Seasonality / Date of Order</th>
<th>August or September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Age ≥ 50 years</td>
</tr>
<tr>
<td>Fever</td>
<td>Temperature ≥ 100.4 F prior to or during admission</td>
</tr>
<tr>
<td>CSF Cell Count</td>
<td>White blood cells ≥ 5 cells / mm³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Orders</td>
<td>439</td>
</tr>
<tr>
<td>Test Positive</td>
<td>5</td>
</tr>
<tr>
<td>Symptom Positive</td>
<td>12</td>
</tr>
<tr>
<td>Department A</td>
<td>132</td>
</tr>
</tbody>
</table>
Prevalence: Clinical Thinking

Tested population

Fever
CSF WBC
Season

Age