Bringing Big Data to the Bedside in a Learning Healthcare System

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Conflict of Interest Statement

I have no real or apparent conflicts of interest relevant to this presentation.
Evidence-Based Medicine in the EMR Era

Jennifer Frankovich, M.D., Christopher A. Longhurst, M.D., and Scott M. Sutherland, M.D.

Many physicians take great pride in the practice of medicine. We use the data entered by our electronic medical records (EMRs) to conduct electronic searches to explore adverse events and outcomes. This approach can provide new insights into the population we serve.

### Results of Electronic Search of Patient Medical Records (for a Cohort of 98 Pediatric Patients with Lupus) Focused on Risk Factors for Thrombosis Relevant to Our 13-Year-Old Patient with Systemic Lupus Erythematosus.

<table>
<thead>
<tr>
<th>Outcome or Risk Factor</th>
<th>Keywords Used to Conduct Expedited Electronic Search</th>
<th>Prevalence of Thrombosis no./total no (%)</th>
<th>Relative Risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome — thrombosis</td>
<td>“Thrombus,” “Thrombosis,” “Blood clot”</td>
<td>10/98 (10)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Thrombosis risk factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy proteinuria (&gt;2.5 g per deciliter)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present at any time</td>
<td>“Nephrosis,” “Nephrotic,” “Proteinuria”</td>
<td>8/36 (22)</td>
<td>7.8 (1.7–50)</td>
</tr>
<tr>
<td>Present &gt;60 days</td>
<td>“Urine protein”</td>
<td>7/23 (30)</td>
<td>14.7 (3.3–96)</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>“Pancreatitis,” “Lipase”</td>
<td>5/8 (63)</td>
<td>11.8 (3.8–27)</td>
</tr>
<tr>
<td>Antiphospholipid antibodies</td>
<td>“Aspirin”</td>
<td>6/51 (12)</td>
<td>1.0 (0.3–3.7)</td>
</tr>
</tbody>
</table>

*In all cases, the sentences surrounding the keywords were manually reviewed to determine their relevance to our patient. Pancreatitis was defined as an elevated lipase level (twice the upper limit of normal) coexisting with abdominal pain. We used the word “aspirin” as a proxy for antiphospholipid antibodies, since it is standard practice at our institution to give all patients with these antibodies aspirin; if “aspirin” was found in the chart, then antiphospholipid-antibody status was confirmed by investigating the laboratory results.

We recently found ourselves in such a situation as we admitted to our service a 13-year-old girl of our collective Level V evidence, so to speak — was equally fruitless and failed to produce a consensus.

Of the 98 patients in our pediatric lupus cohort, 10 patients developed thrombosis, documented...
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Recommendations
• Digital Infrastructure
• Clinical Decision Support
• Performance Transparency
• Patient Centered Care
• Data Utility
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Recommendation 1: The Digital Infrastructure

Improve the capacity to capture clinical, care delivery process, and financial data for better care, system improvement, and the generation of new knowledge. Data generated in the course of care delivery should be digitally collected, compiled, and protected as a reliable and accessible resource for care management, process improvement, public health, and the generation of new knowledge.
“PhysiScore provided higher accuracy prediction of overall morbidity than other neonatal scoring systems, including the standard Apgar score. Physiological parameters, particularly short-term variability in respiratory and heart rates, contributed more to morbidity prediction than invasive laboratory studies.”
Joint Commission Sentinel Event Alert #50
April 8, 2013

- 2014 National Patient Safety Goal:
  - Phase 1 (2/2014): alarms to be established as an organization priority by all hospitals.
  - Phase 2 (2/2016): all hospitals expected to develop and implement specific policies and procedures and to educate organization members about alarm system management.
Mitigating Alarm Fatigue

Lucile Packard uses big data to tackle alarm fatigue

December 17, 2014 6:00 am by Dan Verel | 2 Comments

Hospitals across the country continually deal with alarm fatigue, an issue borne out of well-meaning but ultimately misguided attempts to monitor patient safety, and the results of simply having too many alerts can, in the worst-case, be deadly or near deadly.

At a minimum, the issue can significantly impact work flow at busy hospitals, prompting nurses to tune out one too many alerts.

At Lucile Packard Children’s Hospital, part of Stanford Healthcare, a pilot project is underway to curb the fatigue by re-defining guidelines on vital signs that trigger alarms. It’s an issue for all hospitals, but with children’s hospitals in particular given the level of complexity for their patients, according to Dr. Veena Goel, a fellow in clinical informatics and pediatric hospital medicine fellow at Lucile Packard.
3W Results for HR Alarms

~30% reduction in HR alarms
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Recommendation 3: Clinical Decision Support

Accelerate integration of the best clinical knowledge into care decisions. Decision support tools and knowledge management systems should be routine features of health care delivery to ensure that decisions made by clinicians and patients are informed by current best evidence.
Bringing Best Practices to the Bedside

Transfusion Strategies for Patients in Pediatric Intensive Care Units

“In stable, critically ill children a hemoglobin threshold of 7 g per deciliter for red-cell transfusion can decrease transfusion requirements without increasing adverse outcomes.”
Computerized Physician Order Entry With Decision Support Decreases Blood Transfusions in Children

WHAT’S KNOWN ON THIS SUBJECT: Studies reveal red blood cell transfusion practices to be variable among pediatricians. Recent data suggests significant risks to children receiving transfusions, and supports a conservative transfusion strategy. Computerized physician order entry with decision support has potential to improve transfusion utilization.

WHAT THIS STUDY ADDS: A significant lag exists between the dissemination of evidence-based recommendations and integration into clinical practice. This study reveals a strategy where computerized decision support improved the use of red blood cell transfusions, suggesting enhanced adoption of evidence-based recommendations.

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KEY WORDS: pediatric, red blood cell transfusion, computerized physician order entry, decision support

ABBREVIATIONS:
- RBCT—red blood cell transfusion
- CPOE—computerized physician order entry
- CDS—clinical decision support
- CMI—case-mix index
- CI—confidence interval

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www.pediatrics.org/cgi/doi/10.1542/peds.2010-3252
Variability in Stanford PICU Lab Utilization Rates

Over 50 fold difference in lab tests per patient day rate in the PICU
Embedding Time-Limited Laboratory Orders Within Computerized Provider Order Entry Reduces Laboratory Utilization

Natalie M. Pageler, MD\textsuperscript{1,2}; Deborah Franzon, MD\textsuperscript{1}; Christopher A. Longhurst, MD, MS\textsuperscript{3,2}; Matthew Wood, PhD\textsuperscript{2}; Andrew Y. Shin, MD\textsuperscript{4}; Eloa S. Adams, MD\textsuperscript{1}; Eric Widen, MHA\textsuperscript{2}; David N. Cornfield, MD\textsuperscript{1}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|}
\hline
\textbf{Outcomes} & \textbf{Preintervention} & \textbf{Postintervention} & \textbf{p} \\
\hline
Complete blood counts per patient day, mean ± 95% CI\textsuperscript{b} & 1.5±0.1 & 1.0±0.1 & <0.001 \\
Chemistry per patient day, mean ± 95% CI\textsuperscript{b} & 10.6±0.9 & 6.9±0.6 & <0.001 \\
Coagulation per patient day, mean ± 95% CI\textsuperscript{b} & 3.3±0.4 & 1.7±0.2 & <0.001 \\
PICU length of stay (d), mean ± 95% CI\textsuperscript{b} & 5.1±0.7 & 4.2±0.6 & 0.050 \\
Hospital length of stay (d), mean ± 95% CI\textsuperscript{b} & 16.2±2.1 & 11.6±1.6 & <0.001 \\
Mortality rate per 100 discharges\textsuperscript{c} & 3.9 & 3.0 & 0.320 \\
\hline
\end{tabular}
\caption{Summary of Outcome Measurements in Preintervention and Postintervention Populations\textsuperscript{a}}
\end{table}
Development of a Web-based Decision Support Tool to Increase Use of Neonatal Hyperbilirubinemia Guidelines

Christopher Longhurst, M.D., M.S.; Stuart Turner, D.V.M., M.S.; Anthony E. Burgos, M.D., M.P.H.

Clinical practice guidelines have many potential benefits, including minimization of practice variability, standardization in care, and dangerous sequelae of untreated conditions. Guidelines may result in significant cost savings by minimizing overtreatment. Historically, however, barriers deter implementation by health care providers including lack of familiarity with the recommendations, mismatch with the guideline theory, lack of belief that they result in an improved outcome, and the inconveniences and confusing nature of the guideline itself. Additional roadblocks may include mismatch between evidence and clinical situations, time pressures in clinical practice, and new skills.

Pediatrics (AAP) and the New York State Department of Health released clinical practice guidelines in 2005. The guidelines were developed on the basis of a combination of published data and linear extrapolation to automate the hour-specific risk stratification nomogram and phototherapy nomogram.
“Lessons learned at Stanford Children’s included the need for a continuous surveillance and improvement model, which resulted in several iterations of the HMPC; the importance of soliciting user input, which resulted in improvements in workflow; and consistent support from the quality management and information technology departments, which are crucial to eliminating barriers and facilitating improvement.”
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Recommendation 9: Performance Transparency

Increase transparency on health care system performance. Health care delivery organizations, clinicians, and payers should increase the availability of information on the quality, prices and cost, and outcomes of care to help inform care decisions and guide improvement efforts.
CLABSI checklist displays on dashboard
“Use of an electronic medical record–enhanced CLABSI prevention checklist coupled with a unit-wide real-time display of adherence was associated with increased compliance with evidence-based catheter care and sustained decrease in CLABSI rates.”
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Recommendation 4: Patient-Centered Care

Involve patients and families in decisions regarding health and health care, tailored to fit their preferences. Patients and families should be given the opportunity to be fully engaged participants at all levels, including individual care decisions, health system learning and improvement activities, and community-based interventions to promote health.
Dear Family Members,

We welcome you as an important member of the team involved in the care of your baby. Following is a list of information about your baby’s case and condition over the previous 24 hours. We hope you find this information useful as you think about how much information you would like to receive, and how involved you would like to be in the care and decision making about your baby. Handouts and brochures are available on many topics related to your baby’s condition and care while in the hospital. Please let my member of the care team know if you have any questions about the information below, or if there is additional information you would like to receive.

Date Printed: 10/05/12  For the 24 hour period of 10/04/12 12:00 to 10/05/12 12:00.

Your Baby’s Care Team
Your baby’s Doctor is: Cohen MD, Ronald
Your baby’s Nurse (Neonatal Nurse Practitioner) is: Miranda NP, Adrianna R.
Your baby’s Primary Care Provider is: Ornitz MD, Lloyd Jeffrey

Your Baby’s Respiratory Status
Your baby is receiving: 21% oxygen via CPAP as of 10/05/12 08:57.
Your baby had 3 A/I/Bs on a ventilator.

Your Baby’s Nutritional Status
Your baby’s current weight is: 2012, yes or 5 lb, 11 oz.
Your baby has gained: 37 grams since 10/01/12 06:58
Your baby has had: 476 mL of formula/meds/meds as of 10/05/12 08:55
Your baby’s last intake: 09.0 mL, received 376.0 mL by gavage tube and received 90 mL by IV from 10/04/12 08:01 to 10/04/12 10:59
Your baby’s last void: 5 times and last had: 3 stools in this time period.

Don’t forget to ask your baby’s nurse how much formula/meds is in the refrigeration for your baby.

Your Baby’s Most Recent Lab Results (complete blood count, etc.)
Your baby’s latest hemoglobin was: 14.3 g/dL 10/04/12 02:45
Your baby’s total heme levels were: 5.0 g/dL 09/27/12 05:15

Your Baby’s Current Scheduled Medications
- Levothyroxine (1.5 mg PO daily) 1 tablet
- Levothyroxine (1.5 mg PO daily)

Your Baby’s Plan for the Day

Gain weight, with fewer feedings needed on CLP than yesterday—doing well!

"Very Useful" Responses (%)

- Nurse: 90%
- Doctor: 80%
- Rounds: 70%
- Internet: 60%
- Written Materials: 50%
- Bulletin Boards: 40%
- Your Baby’s Daily Update: 30%

Information Source!
MyChart – a foundation for the future
MyChart for patient-reported outcomes

**PROs**
- Health-related quality of life (HRQOL)
- Symptoms
- Function
- Satisfaction with care or symptoms
- Adherence to prescribed medications or other therapy
- Perceived value of treatment
Apple HealthKit due for medical trials in Duke and Stanford

By Sumit Pasrich, Tech Times | September 16, 8:18 AM

HealthKit, Apple’s fitness and health service, is due for medical trials at Duke and Stanford universities.

Apple revealed HealthKit in June this year during the company’s Worldwide Developers Conference (WWDC). HealthKit is still under development and Apple hopes to launch the service with iOS 8 on Sept. 17.

HealthKit users will have the option to share information with others, and by giving consent, the service can use data from other apps on the iOS 8 device, professional at one place.
Recommendation 2: The Data Utility

Streamline and revise research regulations to improve care, promote the capture of clinical data, and generate knowledge. Regulatory agencies should clarify and improve regulations governing the collection and use of clinical data to ensure patient privacy but also the seamless use of clinical data for better care coordination and
Evidence-Based Medicine in the EMR Era

Jennifer Frankovich, M.D., Christopher A. Longhurst, M.D., and Scott M. Sutherland, M.D.

Many physicians take great pride in the practice of evidence-based medicine. Modern medical education emphasizes the value of the randomized, controlled trial, and we learn early on not to rely on anecdotal evidence. But the application of such superior evidence, however admirable the ambition, can be constrained by trials’ strict inclusion and exclusion criteria — or the complete absence of a relevant trial. For those of us practicing pediatric medicine, this reality is all too familiar. In such situations, we are used to relying on evidence at Levels III through V — expert opinion — or resorting to anecdotal evidence. What should we do, though, when there aren’t even meager data available and we don’t have a single anecdote on which to draw?

We recently found ourselves in such a situation as we admitted to our service a 13-year-old girl with febrile urinary tract infection. She had previously been treated for a short course of antibiotics, which had failed. On admission, she was noted to have a low-grade fever and some suprapubic pain but no hematuria. Physical examination was otherwise unremarkable. She was admitted for further evaluation. A urinalysis revealed 80 red blood cells per high-power field, which was followed by a negative urine culture. She was promptly discharged on a short course of antibiotics.

Much of the evaluation of her fever centered on her investigation for an acute illness, including lumbar puncture, chest radiographs, and blood cultures. As a result of this investigation, she was identified to have lower nephron proteinuria, antiphospholipid antibodies, and pancreatitis. Although anticoagulation is not standard practice for children with SLE even when they’re critically ill, these additional factors put our patient at potential risk for thrombosis, and we considered anticoagulation. However, we were unable to find studies pertaining to anticoagulation in our patient’s situation and were therefore reluctant to pursue that course, given the risk of bleeding.

A survey of our pediatric rheumatology colleagues — a review of our collective Level V evidence, so to speak — was equally fruitless and failed to produce a consensus.

approach, using the data captured in our institution’s electronic medical record (EMR) and an innovative research data warehouse. The platform, called the Stanford Translational Research Integrated Database Environment (STRIDE), acquires and stores all patient data contained in the EMR at our hospital and provides immediate advanced text searching capability. Through STRIDE, we could rapidly review data on an SLE cohort that included pediatric patients with SLE cared for by clinicians in our division between October 2004 and July 2009. This “electronic cohort” was originally created for use in studying complications associated with pediatric SLE and exists under a protocol approved by our institutional review board.

Of the 98 patients in our pediatric lupus cohort, 10 patients developed thrombosis, documented
“A new policy and ethical framework will be needed to support this evolving paradigm. Systematic implementation of real-time cohorts may require health care systems to allow any treating physician to access [deidentified but not anonymized] data about patients who are not under his or her direct care.”
**Problem:** A lot of medical care is educated guesses

**Opportunity:** Decisions influenced by what happened to people like you.

My Patient
A 55 year old female of Vietnamese heritage with known asthma presents to her physician with new onset moderate hypertension

**Intervention**
antihypertensives

**Outcome**
Diastolic pressure < 90 mm Hg

Variables associated with Outcome
- Drug A
- Asthma
- Ethnicity
- HDL
- HbA1c > 10%

Health Affairs, July 2014
Figure 1 – The Green Button in Action

- Point of care randomization / large simple trial
- Queue / Consider for randomization at point of care
- Guideline available?
  - Yes: Use level A guideline
  - No:
    - Useful byproduct
    - Use "Green Button"
      - Priority list of clinical situations
        - High priority
        - Increment priority
      - Large cohort of similar patients present?
        - Yes: Use practice-based evidence
        - No: Use professional judgment
Bringing cohort studies to the bedside: framework for a ‘green button’ to support clinical decision-making

When providing care, clinicians are expected to take note of clinical practice guidelines, which offer recommendations based on the available evidence. However, guidelines may not apply to individual patients with comorbidities, as they are typically excluded from clinical trials. Guidelines also tend not to provide relevant evidence on risks, secondary effects and long-term outcomes. Querying the electronic health records of similar patients may for many provide an alternate source of evidence to inform decision-making. It is important to develop methods to support these personalized observational studies at the point-of-care, to understand when these methods may provide valid results, and to validate and integrate these findings with those from clinical trials.

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EHR phenotyping

1. Characterize the index patient

2. Use phenotypes to measure similarity between the index patient and past patients

3. Choose cohort that best represents index patient with sufficient sample size

4. Visualize composition of optimal and neighboring cohorts

5. Use propensity score methods to adjust for confounders

6. Integrate with findings from clinical trials according to inclusion criteria

http://greenbutton.stanford.edu
An Ethics Framework for a Learning Health Care System: A Departure from Traditional Research Ethics and Clinical Ethics

Just as health professionals and organizations have an obligation to learn, patients have an obligation to contribute to, participate in, and otherwise facilitate learning.
Achieving a Nationwide Learning Health System

Charles P. Friedman, Adam K. Wong, David Blumenthal

Published 10 November 2010; Volume 2 Issue 57 57cm29

We outline the fundamental properties of a highly participatory rapid learning system that can be developed in part from meaningful use of electronic health records (EHRs). Future widespread adoption of EHRs will make increasing amounts of medical information available in computable form. Secured and trusted use of these data, beyond their original purpose of supporting the health care of individual patients, can speed the progression of knowledge from the laboratory bench to the patient's bedside and provide a cornerstone for health care reform.

According to conventional wisdom, 17 years elapse before a new element of validated clinical knowledge finds its way into routine clinical practice in the United States (1). Although there is undoubtedly considerable variance around this estimate, the latency between biomedical discovery and care implementation information will be stored in electronic form (4). At the same time, achievement of meaningful use of these EHRs will enable this clinical information to flow securely from the site where it was collected to a different location where the information has an authorized use. In practice settings that achieve meaningful
How do we ensure our healthcare system learns from every patient, at every visit, every time?
Thank you!

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