Clinical Practice: The Only Constant Is Change

Brent C. James, M.D., M.Stat.
Executive Director, Institute for Health Care Delivery Research
Intermountain Health Care
Salt Lake City, Utah, USA
★ **Geography is destiny** ("Who you see is what you get" *)
★ **There is no health care "system"**
★ **Supplier-induced demand:**
  - *Field of Dreams approach: Build it and they will come*
  - *James T. Kirk: Do something, Bones! She's dying!*
  - *Eddy: More is better -- if it might work, do it*
  - *Chassin: Enthusiasm for unproven methods*
  - *Boston City / Boston University Hospital, 1998:*
    - Same housestaff on both services
    - More beds / easier access to resources on Boston University service
    - Boston University readmit rate ~50% higher

American health care "gets it right" 54.9% of the time.

Medical injuries

Account for

44,000 - 98,000 deaths per year in the United States

More people die from medical injuries than from breast cancer or AIDS or motor vehicle accidents

Thomas et al. 1999
Current health care

**is the best the world has ever seen**

A few simple examples:

- **From 1900 to 2000, average life expectancy at birth increased from only 49 years to almost 80 years.**
- **Since 1960, age-adjusted mortality from heart disease (#1) has decreased by 56%; and** (from 307.4 to 134.6 deaths / 100,000)
- **Since 1950, age-adjusted mortality from stroke (#3) has decreased by 70%.** (from 88.8 to 26.5 deaths / 100,000)

*Initial life expectancy gains almost all resulted from public health initiatives -- clean water, safe food, and (especially) widespread control of epidemic infectious disease. But since about 1960, direct disease treatment has made increasingly large contributions.*


Medicine used to be simple, ineffective, and relatively safe.

Now it is complex, effective, and potentially dangerous.

Sir Cyril Chantler


Are most failures unavoidable?

The price we pay
(for)
diseases of medical progress

Barr, David. Hazards of modern diagnosis and therapy - the price we pay. JAMA 1955; 159(115):1452-6 (Dec 10)
Reasons for practice variation

Clinical uncertainty:

- **Complexity**
  - How many factors can the human mind simultaneously balance to optimize an outcome? -- Alan Morris, MD
  - "The complexity of modern American medicine exceeds the capacity of the unaided human mind" -- David Eddy, MD

- **Lack of valid clinical knowledge** (poor evidence)

- **Reliance on subjective judgment**
  - Subjective evaluation is notoriously poor across groups or over time

  - *Enthusiasm for unproven methods ...*  Mark Chassin, MD
  - *If it might work, do it ...*  David Eddy, MD, PhD
  - *Quality = spare no expense ...*  Brent James, MD, MStat
"Our minds are interpreters of evidence. We can accurately convert all forms of evidence (formal evidence, observations, experiences, colleague's experiences) into conclusions, which in turn determine our actions."

"Therefore, no one has to tell us what to do. Just give us the evidence and we will figure it out. Besides, there are lots of other factors that need to be considered. This can only be done with clinical judgment."

Dr. David Eddy
The core assumption is untenable

- Poor evidence
- The inherent complexity of modern medicine, versus the limitations of the human mind
- Variations in beliefs
- Variations in practices
- High rates of inappropriate care

Dr. David Eddy
Other factors affect our decisions

If our minds can't do the work very well, there are all sorts of other things to fill the void:

Evidence → Our minds → Conclusions → Actions

- Limited, complex
- Huge ranges of uncertainty
- Massive variation, inappropriate care

- Professional interests
- Financial interests
- Personal tastes
- Desire to have something to offer
- Love for the work
- Wishful thinking
- Selective memory
- Pressure from patients and family
- Legal considerations

Dr. David Eddy
A multidisciplinary team of health professionals -

1. Select a high priority care process

2. Generate an evidence-based "best practice" guideline

3. Blend the guideline into the flow of clinical work
   - staffing
   - training
   - supplies
   - physical layout
   - measurement / information flow
   - educational materials

4. Use the guideline as a shared baseline, with clinicians free to vary based on individual patient needs

5. Measure, learn from, and (over time) eliminate variation arising from professionals; retain variation arising from patients ("mass customization")
The healing professions - and health care delivery - are changing ...

From craft-based practice

- *individual physicians, working alone* (housestaff ::= apprentices)
- *handcraft a customized solution for each patient*
- *based on a core ethical commitment to the patient and*
- *vast personal knowledge gained from training and experience*

To profession-based practice

- *groups of peers, treating similar patients in a shared setting*
- *plan coordinated care delivery processes* (e.g., standing order sets)
- *which individual clinicians adapt to specific patient needs*
- *early experience shows*
  - *less expensive* (facility can staff, train, supply an organize to a single core process)
  - *less complex* (which means fewer mistakes and dropped handoffs, less conflict)
  - *better patient outcomes*
The solo practice of medicine is dead
(at an intellectual, not necessarily an economic, level)

• protocols as a common baseline
• mass customization
• higher productivity (a way to defend income)
• better patient outcomes (closing the quality gap)
• strong ties to electronic medical records
Issues for data automation

Principle: **Automation must improve productivity; you can't destroy clinical work flow!**

**Issue 1:** *Paper vs. electronic storage*

**Issue 2:** *Free-text vs. encoded data*
Four types of information

1. **Sound data** (e.g., recorded voice)
   - Computerized voice recognition

2. **Image data** (pictures, stored as rasterized pixel bitmaps; e.g.,
   - A picture of a feature on a patient's skin;
   - A digitized AP chest x-ray; or a
   - A picture of a handwritten or typed medical note.)

3. **Free-text data**
   - Standard word processor output;
   - Characters stored as codes, one per byte;
   - Even numbers are stored as characters;
   - Using ASCII codes (American Standard Code for Information Interchange)

4. **Encoded data** (multi-field "concepts" that computers can compare, interpret, etc.; required to do clinical decision support)
Clinical Data Repository (CDR)

EMPI - electronic master patient index

PCMS (inpatient EMR)

VocSer - vocabulary server

Results Review

Clinical Workstation (outpatient EMR)

Pathology - laboratory - microbiology - surgical pathology

Pharmacy (operations)

Imaging - reports - images

Financial transactions

Inventory relief

EDW link - patient registries - outcomes reporting - etc.
Levels of data automation

1. Automation of **billing scheduling** ⟷ encoded patient demographics

2. Automation of **lab** - (encoded) clin path - microbiology - surgical path
   - pharmacy - 3 national services, standard (encoded) formats
   - imaging - HL-7 formatted text (active research --> encoding)
   - digital image storage
   - consultation reports - HL-7 formatted text

3. **The 'electronic file cabinet'** - all electronic record (don't care about encoding)
   - efficient data entry - dictation/transcription --> 'hot text,' voice recognition
   - efficient storage and retrieval across many care sites
   - practice operations support - telephone call support, lab results management

4. **Level 1 encoding** (assumes encoded patient demographics, pharmacy, and lab)
   - encoded problem list - automatic 'registries' for common chronic diseases
   - encoded medication list - first easy step in computerized order entry
   - encoded allergy list

5. **Level 2 encoding** - focused condition-specific encoding

6. **Level 3 encoding** - fully encoded EMR, with text comments to customize
Implementing CW hot text

Dr. Mark Shepherd, Bryner Clinic

Average WRVUs per Day

Average Patient Wait Time

Q1, Q2 2000
Q3 2000
Q4 2000
Q1 2001
Q2 2001
Q3 2001
Q4 2001
Q1 2002
Q2 2002
Q3 2002
Q4 2002
Apr 2002
May 2002

Average Patient Wait Time (minutes)

Average WRVUs per Day
EMRs are essential tools for the future
(1) productivity enhancement; (2) protocol implementation

- hard to implement (at present time)
- requires a relatively large organization
- we are in the era of the big systems
- national effort to (1) establish standards
  (HIPAA was just the beginning) and
(2) drive EMR adoption (Regional Health Information Infrastructure)
## Community acquired pneumonia

<table>
<thead>
<tr>
<th></th>
<th>without protocol</th>
<th>with protocol</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Outlier&quot; (complication) DRG at discharge</td>
<td>15.3%</td>
<td>11.6%</td>
<td>↓ 24.7% (p&lt;0.001)</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>7.2%</td>
<td>5.3%</td>
<td>↓ 26.3% (p=0.015)</td>
</tr>
<tr>
<td>Relative resource units (RRUs) per case</td>
<td>55.9</td>
<td>49.0</td>
<td>↓ 12.3% (p&lt;0.001)</td>
</tr>
<tr>
<td>Cost per case</td>
<td>$5211</td>
<td>$4729</td>
<td>↓ 9.3% (p=0.002)</td>
</tr>
</tbody>
</table>
## Impact on net income

<table>
<thead>
<tr>
<th>Improvement to cost structure</th>
<th>Payment mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discounted FFS</td>
</tr>
<tr>
<td>Decrease cost per unit</td>
<td>✅</td>
</tr>
<tr>
<td>Decrease # units per case</td>
<td></td>
</tr>
<tr>
<td>Decrease other units per case</td>
<td></td>
</tr>
<tr>
<td>Decrease LOS (# nursing hours)</td>
<td></td>
</tr>
<tr>
<td>Decrease # of cases</td>
<td></td>
</tr>
</tbody>
</table>

| (45%) | (40%) | (0%)  | (15%) |

Discounted FFS (45%)  
Per case (40%)  
Per diem (0%)  
Shared risk (15%)
## Impact on net income

### Improvement to cost structure

<table>
<thead>
<tr>
<th>Decrease</th>
<th>Payment mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discounted FFS (45%)</td>
</tr>
<tr>
<td></td>
<td>Per case (40%)</td>
</tr>
<tr>
<td></td>
<td>Per diem (0%)</td>
</tr>
<tr>
<td></td>
<td>Shared risk (15%)</td>
</tr>
</tbody>
</table>

### Decrease cost per unit
- Decrease cost per unit
- Decrease # units per case
  - Decrease other units per case
  - Decrease LOS (# nursing hours)
- Decrease # of cases

### Decrease # units per case
- Decrease # units per case

### Decrease # of cases
- Decrease # of cases

### Discounted FFS (45%)

### Per case (40%)

### Per diem (0%)

### Shared risk (15%)
Pay for performance (P4P):

- one form of outcomes accountability
- relies of performance measurement (technical problems)
- two main forms:
  - hit performance goal, get %-age payment increase
  - shared savings models
High frequency injuries sources

1. **Adverse drug events (ADEs, ADRs)**
2. **Iatrogenic infections**
   - post-operative deep wound infections
   - urinary tract infections (UTI)
   - lower respiratory infections (pneumonia or bronchitis)
   - bacteremias and septicemias
3. **Pressure injuries**
4. **Mechanical device failures**
5. **Complications of central and peripheral venous lines**
6. **Deep venous thrombosis (DVT) / pulmonary embolism (PE)**
7. **Strength, agility and cognition (injuries and restraints)**
8. **Blood product transfusion**
9. **Patient transitions**
## Detecting Adverse Drug Events

<table>
<thead>
<tr>
<th># of ADEs / % (per annum)</th>
<th>Nurse Incidence Reporting</th>
<th>&quot;Enhanced&quot; Reporting</th>
<th>HELP System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total ADEs</td>
<td>9 / 0.025% (6)</td>
<td>91 / 0.25% (60)</td>
<td>731 / 2.0% (487)</td>
</tr>
<tr>
<td>Moderate and severe ADEs</td>
<td></td>
<td></td>
<td>701 / 1.9% (467)</td>
</tr>
</tbody>
</table>
### Simple criteria for detecting ADEs

<table>
<thead>
<tr>
<th>Detection criterion</th>
<th>Location</th>
<th>True Positive Rate (%)</th>
<th>% of All ADEs Detected</th>
<th>Cumulative Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. use of naloxone</td>
<td>pharmacy</td>
<td>21.9</td>
<td>28.3</td>
<td>28.3</td>
</tr>
<tr>
<td>2. use of benadryl</td>
<td>pharmacy</td>
<td>21.0</td>
<td>20.8</td>
<td>49.1</td>
</tr>
<tr>
<td>3. use of inapsine</td>
<td>pharmacy</td>
<td>39.2</td>
<td>20.4</td>
<td>69.5</td>
</tr>
<tr>
<td>4. use of lomotil</td>
<td>pharmacy</td>
<td>26.8</td>
<td>8.5</td>
<td>77.0</td>
</tr>
<tr>
<td>5. nurse reports of rash/itching</td>
<td>nurse reporting</td>
<td>17.9</td>
<td>5.1</td>
<td>82.1</td>
</tr>
<tr>
<td>6. use of loperamide</td>
<td>pharmacy</td>
<td>22.3</td>
<td>3.4</td>
<td>85.5</td>
</tr>
<tr>
<td>7. test for c. deficile toxin</td>
<td>clinical lab</td>
<td>24.3</td>
<td>3.1</td>
<td>88.6</td>
</tr>
<tr>
<td>8. digoxin level &gt; 2</td>
<td>clinical lab</td>
<td>2.3</td>
<td>2.2</td>
<td>90.8</td>
</tr>
<tr>
<td>9. abrupt med stop or reduction</td>
<td>pharmacy</td>
<td>48.0</td>
<td>1.0</td>
<td>91.8</td>
</tr>
<tr>
<td>10. use of vitamin K</td>
<td>pharmacy</td>
<td>4.8</td>
<td>0.9</td>
<td>92.7</td>
</tr>
<tr>
<td>11. doubling of blood creatinine</td>
<td>clinical lab</td>
<td>0.4</td>
<td>0.8</td>
<td>93.5</td>
</tr>
<tr>
<td>12. use of kaopectate</td>
<td>pharmacy</td>
<td>21.8</td>
<td>0.7</td>
<td>94.2</td>
</tr>
<tr>
<td>13. use of paregoric</td>
<td>pharmacy</td>
<td>9.8</td>
<td>0.7</td>
<td>95.0</td>
</tr>
<tr>
<td>14. use of flumazenil</td>
<td>pharmacy</td>
<td>77.3</td>
<td>0.7</td>
<td>95.7</td>
</tr>
</tbody>
</table>

*(case finding through "concurrent clinical triggers")*
Utah-Missouri study (AHRQ)

- Identified and validated ICD-9 Patient Safety Code set (~1,000 codes)

- Mined hospital discharge abstracts to identify charts for review (verified acceptable positive predictive value)

- Found numbers of verified injuries similar to those discovered by concurrent trigger tools (including serious outpatient events that result in hospitalization)

- Very little overlap with concurrent trigger methods: ICD-9 codes appear to capture a different universe of events (case finding through "retrospective code triggers")
LDS Hospital, 2001

ICD9-CM total code hits = 1574 (973 unique)

concurrent trigger total hits = ~2460 (~1950 unique)
(major advantage: can intervene and abort harm)

random sample of 200 encounters (from 1484 cases)

pharmacist verified ADEs from concurrent triggers = 258 (168 unique)

200 charts in random sample
- 13 charts couldn't be found (6.5%)
187 charts reviewed

10 coding errors (5%)
24 not ADEs (false positives) (13%)
51 outpatient poisonings and suicides (27%)
59 outpatient ADEs (32%)
43 inpatient ADEs (true positives) (23%)
(1484 x 0.230 = 341 unique inpatient ADEs)

Final estimates:
341 ADEs detected by ICD-9 codes alone
90 ADEs detected by both systems
168 ADEs detected by concurrent triggers alone
599 total ADEs detected
(43.1% of final total detected by concurrent triggers alone)

Tracking injuries

- **Current** (voluntary reporting) systems miss the vast majority of injuries (finding only 1 in 100-150 injuries)

- Most often (e.g., >80% of the time for ADEs), clinical teams don’t associate patient symptoms with the treatments that are causing them

- A more accurate perception of sources of injury can hugely change intervention strategies
Injury and near miss detection
- case finding
- evaluation
- classification

Epidemiologic analyses
- new taxonomies

Possible system fixes that could improve safety results
- hypotheses for process change
- explicit process models very useful

Prioritization
(is this event an epidemic?)

Rapid Cycle Testing
often with heavy reliance on intermediate outcomes (process measures)

Deployment and Implementation

Holding the Gains
Monitor final outcomes (i.e., injury rates) and intermediate process outcomes

Successful change ideas from the medical literature, other health care organizations, and other industries

Process Analyses
- FMEA
- HACCP
- other related methods

Detecting patient safety events

1. Case finding (based on explicit criteria)
2. Evaluation (based on explicit criteria)
3. Classification (based on explicit criteria)
### Case finding

#### Common events

<table>
<thead>
<tr>
<th>Event</th>
<th>Concurrent (data-based) trigger systems</th>
<th>Abstract (ICD-9) (data-based) trigger systems</th>
<th>Criteria-based manual systems (e.g., QaNRS, JCAHO SE, NQF &quot;Never Events&quot;)</th>
<th>Voluntary reporting (in a Culture of Safety)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse drug events</td>
<td>LDSH / B&amp;W</td>
<td></td>
<td>Relatively poor event detection rates</td>
<td></td>
</tr>
<tr>
<td>Iatrogenic infections</td>
<td>CDC infection control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure injury</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical device failures</td>
<td>LDSH</td>
<td>LDSH</td>
<td>Relatively poor event detection rates</td>
<td></td>
</tr>
<tr>
<td>Venous lines</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VTE</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfusions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient falls</td>
<td>B&amp;W</td>
<td></td>
<td>Relatively poor event detection rates</td>
<td></td>
</tr>
<tr>
<td>Patient transitions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rare events

- "Wrong" surgery
- Kidnapping
- Suicide
- etc. -

**Retrospective Chart Review**

**Criteria-based manual systems**

- LDSH
- x
- B&W
- x

**Abstract (ICD-9) trigger systems**

- Utah-Missouri (AHRQ)
- x

**Concurrent (data-based) trigger systems**

- LDSH / B&W
- CDC infection control
- x
- x

**Voluntary reporting**

- Relatively poor event detection rates
- Current most effective method
- Current most effective method

**Relatively poor event detection rates**

**Current most effective method**
Preventable causes of ADEs

Drug Administration Errors
- Rate
- Dilution
- Route
- Time
- Nurse
- Wrong Drug
- Dose

Ordering Errors
- Spelling
- Dosage
- Route
- Scheduling
- Order
- Missed

Physiologic Factors
- Age
- Weight
- Gender
- Renal
- Electrolyte
- Past Allergic Reaction
- Race
- Absorption
- Hepatic

Pharmacologic Factors
- Drug/Drug
- Drug/Food
- Drug/Lab
- Brand Name vs. Generic Drugs
- Pharmacist
- Patient
- Physician
- Dietician

Patient
- Psychic
- Neural
- Compliance

Physician
- Pharmacist
- Patient
- Physician
- Nurse/Clerk

IHC
Causes of Adverse Drug Events
## Causes of Adverse Drug Events

<table>
<thead>
<tr>
<th>Class</th>
<th>%</th>
<th>Description</th>
<th>Avoidable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharm Expected</td>
<td>28.0</td>
<td>Known drug reactions</td>
<td>?</td>
</tr>
<tr>
<td>Physio Renal</td>
<td>23.0</td>
<td>Failure to adjust for decreased renal function</td>
<td>Yes</td>
</tr>
<tr>
<td>Physio Age</td>
<td>14.2</td>
<td>Failure to adjust for patient age</td>
<td>Yes</td>
</tr>
<tr>
<td>Physio Weight</td>
<td>5.7</td>
<td>Failure to adjust for patient body mass</td>
<td>Yes</td>
</tr>
<tr>
<td>Order Dosage</td>
<td>5.0</td>
<td>Error in dosage on order</td>
<td>Yes</td>
</tr>
<tr>
<td>Physio Hemal</td>
<td>4.6</td>
<td>Failure to adjust for known hematologic factors</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Total preventable</strong></td>
<td><strong>66.2</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prospective daily surveillance of 202,222 inpatients for the occurrence of medication errors and adverse drug events

Definition of medication errors: Assumes that the physician orders correctly, but that the pharmacist then prepares the medication incorrectly, or that the nurse delivers it incorrectly. Specifically, (1) wrong preparation, (2) wrong dose, (3) wrong route of delivery, (4) wrong rate of delivery, and/or (5) wrong patient.
Attack injuries, not errors

What is classified as an "error" derives from what is judged to be "preventable;"

but, at this stage, those (subjective) judgments may be perverted by the "name, shame, and blame game," and seriously misinformed.

It is more useful to think in terms of "medical injuries" rather than "errors."
ADEs at LDS Hospital

Year

Total # moderate + severe ADEs

1989 233
1990 581
1991 567
1992 569
1993 567
1994 437
1995 477
1996 355
1997 271
1998 271
1999(3) 280
Prophylactic antibiotics on time

Organ space & deep infections per 1000


n = 9767 9713 9799 10093 9951 10117 9407 9612 9377 9500 9737 9700

0 2 4 6 8 10 12


10.14  9.89  10.19  8.92  8.75  8.83  8.74  8.11  7.86  7.53  8.83  8.74  8.11  7.86  7.53

0 2 4 6 8 10 12
An expanded national focus on patient safety

- standardized data systems
- independent, external audit
- detected injury rates much higher than today
- drive for substantial systems-level change
RDS by weeks gestation

Deliveries w/o Complications, 2002 - 2003

<table>
<thead>
<tr>
<th>Weeks gestation</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>1.19</td>
</tr>
<tr>
<td>38</td>
<td>0.68</td>
</tr>
<tr>
<td>39</td>
<td>0.47</td>
</tr>
<tr>
<td>40</td>
<td>0.42</td>
</tr>
<tr>
<td>41</td>
<td>0.25</td>
</tr>
<tr>
<td>42</td>
<td>0.39</td>
</tr>
</tbody>
</table>

n = 8,001 18,988 33,185 19,601 4,505 258
Elective inductions <39 weeks
Unplanned c-section rates

Electively induced patients by Bishop score, Jan 2002 - Aug 2003

Bishop score

Percent c-sections

<table>
<thead>
<tr>
<th>Bishop score</th>
<th>Multips n</th>
<th>Primips n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>49</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>130</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>274</td>
<td>99</td>
</tr>
<tr>
<td>5</td>
<td>567</td>
<td>164</td>
</tr>
<tr>
<td>6</td>
<td>856</td>
<td>278</td>
</tr>
<tr>
<td>7</td>
<td>1114</td>
<td>375</td>
</tr>
<tr>
<td>8</td>
<td>1266</td>
<td>487</td>
</tr>
<tr>
<td>9</td>
<td>1062</td>
<td>453</td>
</tr>
<tr>
<td>10</td>
<td>737</td>
<td>346</td>
</tr>
<tr>
<td>11</td>
<td>415</td>
<td>179</td>
</tr>
<tr>
<td>12</td>
<td>86</td>
<td>47</td>
</tr>
<tr>
<td>13</td>
<td>19</td>
<td>7</td>
</tr>
</tbody>
</table>
Average hours in labor & delivery

Electively induced patients by Bishop score, Jan 2002 - Aug 2003

<table>
<thead>
<tr>
<th>Bishop score</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.4</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>10.8</td>
</tr>
<tr>
<td>4</td>
<td>10.1</td>
</tr>
<tr>
<td>5</td>
<td>9.2</td>
</tr>
<tr>
<td>6</td>
<td>8.1</td>
</tr>
<tr>
<td>7</td>
<td>7.6</td>
</tr>
<tr>
<td>8</td>
<td>7.1</td>
</tr>
<tr>
<td>9</td>
<td>6.4</td>
</tr>
<tr>
<td>10</td>
<td>5.9</td>
</tr>
<tr>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>12</td>
<td>5.1</td>
</tr>
<tr>
<td>13</td>
<td>4.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Male</th>
<th>10</th>
<th>49</th>
<th>130</th>
<th>274</th>
<th>567</th>
<th>856</th>
<th>1114</th>
<th>1266</th>
<th>1062</th>
<th>737</th>
<th>415</th>
<th>86</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primips</td>
<td>18</td>
<td>35</td>
<td>61</td>
<td>99</td>
<td>164</td>
<td>278</td>
<td>375</td>
<td>487</td>
<td>453</td>
<td>346</td>
<td>179</td>
<td>47</td>
<td>7</td>
</tr>
<tr>
<td>Multips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Primiparous elective inductions

Bishop's score < 10
Bishop's score < 8
Goal: Reduce "inappropriate" nullip inductions by 50%
Labor & delivery variable cost

Expected maternal and fetal combined variable cost
Goal: hold increase to no more than 6.85%
Actual combined variable cost
Well newborn bilirubin testing

Newborns >= 35 weeks gestation seen in Well Newborn Nursery (excluding hospitals using Bilicheck testing)
Hour-Specific Bilirubin Risk Chart for Term & Near-Term Infants


Risk Factors
- Jaundice in the first 24h
- Visible jaundice before discharge
- Previous jaundiced sibling
- Gestation < 38 weeks
- Exclusive breastfeeding
- East Asian race
- Bruising, cephalohematoma
- Maternal age > 25y
- Male sex

† A TcB may be substituted for NSB. Near exchange levels, a NSB is preferred.

NSB = Neonatal serum bilirubin; TcB = transcutaneous bilirubin
Newborns w/ hyperbilirubinemia

Bilirubin > 19.9 mg/dL
Bilirubin > 25 mg/dL
"I am sorry for you, young men (and women) of this generation. You will do great things. You will have great victories, and standing on our shoulders, you will see far, but you can never have our sensations. To have lived through a revolution, to have seen a new birth of science, a new dispensation of health, reorganized medical schools, remodeled hospitals, a new outlook for humanity, is not given to every generation."

-- Sir William Osler