Industrial Engineers in Health Care

Institute of Industrial Engineers
Society for Health Systems

2001 Annual Conference
Panelists

- **Robert Luttman, RLA**
  - Brigham & Women’s Hospital (Boston), Alcoa Inc.

- **John Elliot, HCA**
  - Productivity management at HCA

- **Courtney McEvoy & Ellen Braun**
  - IE at Banner Health System

- **James Benneyan, Northeastern University**
  - Harvard Community Health Plan, Institute for Healthcare Improvement
Organizations Using IEs

- Hospitals
- HMO’s
- Physician offices
- Long-term care facilities
- Outpatient clinics
- Insurance organizations
- Government or regional agencies
Departments Using IEs

- System Engineering
- Management Engineering
- CQI, TQM
- Information systems
- Facilities management
- others
<table>
<thead>
<tr>
<th>Year</th>
<th>Study Description</th>
<th>Authors</th>
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<tbody>
<tr>
<td>1918</td>
<td>Time studies of surgery &amp; delays</td>
<td>Gilberth</td>
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<tr>
<td>1920-40</td>
<td>Basic process &amp; capacity analysis</td>
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<tr>
<td>1945</td>
<td>‘Management engineering’ &amp; nursing</td>
<td>Gilberth</td>
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<td>1959</td>
<td>Queueing and scheduling</td>
<td>Smalley, others</td>
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<td>1965</td>
<td>Clinical information systems</td>
<td>Kennedy et al</td>
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<td>1965</td>
<td>Hospital inventory optimization</td>
<td>Reed, Stanley</td>
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<tr>
<td>1965-66</td>
<td>Simulation, queueing of patient waits</td>
<td>Nuffield Report; Fetter, Thompson</td>
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<td>1972</td>
<td>Nurse scheduling (b &amp; b) algorithms</td>
<td>Warner</td>
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<tr>
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<td>Authors</td>
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<tr>
<td>1970-72</td>
<td>Perishable inventory, blood banks</td>
<td>Pierskalla</td>
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<td>1973</td>
<td>Opportunity costs &amp; hospital inventory</td>
<td>Duncan</td>
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<td>1972-73</td>
<td>Simulation planning models</td>
<td>Rising</td>
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<td>1974</td>
<td>Regional planning OR models</td>
<td>Shuman, Wolfe</td>
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<tr>
<td>1967-82</td>
<td>Diagnosis-related groups</td>
<td>DRGs</td>
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<td>1979</td>
<td>Forecasting bed needs</td>
<td>Griffith</td>
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<tr>
<td>1980</td>
<td>Cancer screening analysis &amp; optimization</td>
<td>Eddy</td>
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<tr>
<td>1988</td>
<td>Total quality management</td>
<td>Berwick, Bataldan</td>
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Common Projects Today

- Data analysis, benchmarking
- Cost analysis, reduction
- Process & quality improvement
- Simulation & flow analysis
- Patient, staff, & appointment scheduling
- Space planning, layout, utilization
- Information systems
• Statistical quality control research
• Patient safety reliability models
• Cancer screening optimization (who, when?)
• Access & waits
• Scheduling algorithms
• Regional planning capacity models
• Transplant allocation models
# Why This Matters

**Hospital-acquired infections:**
- 2 million NSI per year, $3,000/episode
- 8.7 million additional hospital days, 20,000 deaths/year

**Adverse drug events:**
- 770,000 to 2 million per year
- $4.2 billion annually

**Medical errors and caregiver-induced injury:**
- 98,000 deaths/year, 770,000 - 2 million patient injuries/yr
- $17 - $29 billion dollars

More US deaths/year than for traffic accidents, breast cancer, & AIDS.
Cancer Screening

**Cervical Cancer**

- 55-60 million Pap smears annually (US)
- $275M spent annually (US) on Pap smear screens
- Billions annually on cervical cancer treatment
- Accuracy of screening process between 60-90%
- 1.5% pathologists involved in lawsuits for false-negatives
- Recent settlements: $3.5M, $6.3M, criminal charges

Situation is worse for breast cancer, colorectal cancer, and prostate cancer
“Many leading approaches to quality improvement in hospitals are based on the principles of W.E. Deming. These include use of statistical measures to determine whether improvement in quality has been achieved. These measures should include nosocomial infection rates.”

Center for Disease Control

“An understanding of statistical quality control, including SPC, and variation is essential... Control charts are especially helpful in comparing performance with historical patterns & assessing variation & stability.”

Joint Commission
Use of Simple CQI Tools

A process flow chart is shown with the steps:

- **Act**
- **Plan**
- **Check**
- **Do**

New Member Application, Termination, or Re-Enrollment

Data Entry Process

Print Out New Entries at End of Each Day

Highlight Error for Correction

Yes

100% Inspection of Previous Day’s Input

Data Entry Error Found?

Process Remaining p/w, Activate Member’s Record

A diagram shows the relationship between Environment, Workers, and Quality Characteristic:

- **Environment**
  - Pressure
  - Humidity
  - Temperature

- **Workers**
  - Height
  - (Equip. A)
  - (Equip. B)

- **Surface**
  - Paint Bubbles (in 100 sq. ft. of Surface)

- **Equipment**
  - Compressor A
  - Compressor B
  - Sprayer A
  - Sprayer B

A bar chart shows the number of errors per week.

A scatter plot with a trend line shows the relationship between Monthly Volume and Month, with a correlation coefficient of r = 0.23.
Use of SPC Charts

X-bar Chart for C5

Trial X-bar Control Chart

Subgroup (Month) Number

Observation Number
Methicillin-resistant staph Aureus SPC

Start of Glasgow project

Number MRSA

Increasing rate of MRSA

Month
Other SPC Examples

Number Days Between Needle Sticks

# Procedures Between Surgical Site Infections

Days Between C. dif. Infections

Number CABGs Between Post-Op Infections
For Further Info

• IIE Society for Health Systems (SHS)  
  http://shs.iienet.org/

• Coop jobs or internships

• HIMSS  (www.himss.org)

• ASQC HCD  (www.healthcare.org/)

• INFORMS  (www.trinity.edu/aholder/HealthApp/)

• www.coe.neu.edu/~benneyan/healthcare


