2015 Annual Meeting
May 3, 2015
Los Angeles, California

Improving Telehealth Business Performance Using Human Factors and Process Management Tools

Half Day Course
Meeting Room 409AB
12:00 PM – 3:00 PM

Coordinated by the ATA Human Factors Special Interest Group
Improving Telehealth Business Performance Using Human Factors and Process Management Tools

Half Day Course
May 3, 2015 – 12:00pm – 3:00pm
Room 409AB

This course focuses on the impact of human factors and processes on business performance and the tools needed to improve telehealth service delivery. Participants will learn about the critical link between the human factors aspects of the business process and how these factors affect actual performance. Experts in the field will cover how to improve process performance, such as throughput and cost, using operational, as well as human factors parameters. This course will also show participants how to model a process statically, as well as dynamically, demonstrating the link between the process parameters and the resulting performance. The expected takeaway from this course is a better understanding of the operational aspects of the telehealth process and an ability to improve the process using relatively simple means.

LEARNING OBJECTIVES
- Understand telehealth as a scalable & sustainable business to provide patient care
- Help attendees learn the basic tenets of human factors
- Describe how to improve the delivery of telehealth using human factors and process management tools
- Teach effective telehealth operational aspects

Agenda

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<th>Time</th>
<th>Topic</th>
<th>Who</th>
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<td>12:00 – 12:05</td>
<td>Welcome and Introduction</td>
<td>David Ben-Arieh, PhD</td>
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<tr>
<td>12:05 – 12:20</td>
<td>Overview and Motivation</td>
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<td>Human Factors and Telemedicine</td>
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<td>Break</td>
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<td>Process Modeling and Analysis</td>
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<td>Basic Variability</td>
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<td>Break</td>
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<tr>
<td>2:10 – 2:25</td>
<td>Value Stream Mapping</td>
<td>David Ben-Arieh, PhD</td>
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<td>2:25 – 2:40</td>
<td>Capital and Cash</td>
<td>David Ben-Arieh, PhD</td>
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<td>2:40 – 2:50</td>
<td>Putting It All Together</td>
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<td>2:25 - 3:00</td>
<td>Summary and Q&amp;A</td>
<td>David Ben-Arieh, PhD</td>
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Improving Telehealth Business Performance Using Human Factors and Process Management Tools

Course Faculty

David Ben-Arieh, PhD, Director, Health Operations Resource Center, Kansas State University (Moderator & Presenter): Dr. David Ben-Arieh is a Professor of Industrial Engineering at Kansas State University. His industrial experience includes working for AT&T Bell Laboratories, and consulting for the aerospace industry and NASA. Dr. Ben-Arieh holds a PhD in Industrial Engineering from Purdue University. In recent years Dr. Ben-Arieh has focused on applications in Health Care Systems Management, including patients flow, information systems integration, and patient quality and safety improvements. Currently David Ben-Arieh is the director of the Health Care Operations Resource Center at Kansas State University.

Lesley Strawderman, PhD, Associate Professor of Industrial Engineering, Mississippi State University: Lesley Strawderman, PhD, PE, is an associate professor of industrial engineering at Mississippi State University. She received her PhD in industrial engineering from Pennsylvania State University in 2005. She has also received an MSIE from Pennsylvania State University and a BSIE from Kansas State University. Dr. Strawderman’s research interests center around human factors and ergonomics. She is particularly interested in the use of usability metrics in service quality improvement. Her research has also included topics such as health care process improvement, consumer product design, cognitive processing, safety, and engineering education.
Improving Telehealth Business Performance Using Human Factors and Process Management Tools

Sunday, May 3, 2015
12:00 PM-3:00 PM
Los Angeles, CA

David Ben-Arieh, Lesley Strawderman & Gilbert Leistner
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Dept. of ISE  
strawderman@ise.msstate.edu
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After Completing this workshop you will:

• Understand telehealth as a scalable & sustainable business to provide patient care

• Understand the basic tenets of Human Factors

• Understand telehealth operational aspects

• Modeling and understanding Telehealth

• Understand how to improve the delivery of telehealth using Human Factors and Process Management tools
Disclaimer

- Very broad sets of processes
- No universal set of accepted processes
- Some material requires interpretation
- Prepared from material believed accurate at the time the presentation was assembled, but some items, such as rules, regulations, & law are subject to frequent change
- Demonstration of methodologies – no intention to provide clinical, billing, or legal advice & nothing presented here should be taken as such
Overview
The Odds (to ~2012)

• 74% of (US) patients open to telehealth, but...
• Over 75% of telemedicine programs designed for healthcare professionals have failed
• No lack of need, or technology, or providers (for the moment), or money
• No lack of knowledge of the Business 9
The Business Nine (B9)

1. Customers/Patients
2. Value Proposition
3. Delivery
4. Relationships with Customers/Patients
5. Revenue & Costs
6. Law & Compliance
7. Resources
8. Services & Activities
9. Partners & Investors
10. Time
The Odds (now)

- Telehealth is growing
- 2014-2015—3 leading for-profit telehealth companies raised >$150 million in new money to grow—and that does not include investment in apps and mHealth
- Law, economics, demographics, reimbursement, technology are in alignment
- Risk of failure is falling slightly, but beware the rush
The Odds (now)

- Adapt, adopt, or get squeezed
- Telehealth being run as a business
- Needs more than the Business 9
- At the point of care much health IT fails, is rejected, or underutilized
- Implementation risk control requires good integration to workflow & cashflow.
Overview Technology
Case Report: Getting Paid by Savings

A posting in the ATA Business & Finance Special Interest Group reported telemedicine SAVINGS for 20 psychiatric providers in 2010:

- >3,185 hours of drive time by 20 providers
- $305,994 in salaries for drive time (av. $96.07/hr.)
- $178,413 in travel expenses (gas, food, lodging, etc.)
- >176,700 miles of driving (≈$29,155)
- Cut 71.4 tons of CO\textsubscript{2} emissions (30 years of Prius driving)

Total calculable amount >$513,000

- Increased efficiency (patient services vs. driving)
- Allowed 2,593 more patient services
- Revenue from 2,593 more patient services
Work Flows & Cash Flows

• Effective (tele)medicine = process + value stream
• Process & value stream = work flow + cash flow
• Work flow + cash flow = economics + human factors + ergonomics
Work Flows & Cash Flows

• Three main revenue models:
  – Get reimbursed or otherwise paid directly
  – Not get reimbursed but get paid indirectly
  – Don’t get paid or lose money

• Two main delivery systems:
  – Store & Forward & Synchronous—can provide same/similar info but are less equal economically

• Many ways to adopt & implement
Overview of Economics

Classical Economics

Supply-Demand Curve Assumptions:
1. Many buyers & sellers, no single agent influencing transactions
2. Standardized product (commodities, mostly)
3. No barriers into or out of the market
4. Perfect information available to all (transparency)
5. Full system of property rights—ownership of products & production clear

Production Curve Rule:
1. Produce as long as revenues greater than costs.
   Allow for non-monetary revenue
   Allow for idea of “Commons” idea in “costs”
Overview of Economics

Real(er) World Healthcare Economics

Supply-Demand Curve Assumptions:
1. Some sellers, few true buyers, manipulation possible
2. Most “buyers” don’t pay for their own consumption
3. Vaired products, variable outcomes
4. Complex barriers into or out of the market
5. Poor pricing information/transparency
6. Payments with unilateral changed/ denial

Production Curve Rules:
1. Demand rises until production saturated
2. Ability to increase production limited
3. Delay delivery to ration product
4. Deny/reduce payment ex post facto

![Supply-Demand Curve](image)

![Composite Score](image)
Tech Adoption & Production Efficiency Frontier

Risk & Reward
Which Choice Is Efficient?

Initial Projections
For New Technology

Production Possibilities Frontier

Production Possibility Frontier 2
Results From Application of New Technology

Today

Efficient Zones Under the Curves (or line)

Zone of Implausible Outcomes--1

Zone of Implausible Outcomes--2
Human Factors & Ergonomics: Applications in Telemedicine
What is “Human Factors”?

“How human factors discovers and applies information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, tasks, jobs, and environments for productive, safe, comfortable, and effective human use” (Sanders & McCormick)
What is Ergonomics?

Ergon = work
Nomoi = natural laws
Ergonomics = the science of work

Ergonomics is the science of fitting the work to the user
Human Factors

The goal of human factors and ergonomics (HFE) is to make the human interaction with systems one that

- Enhances performance
- Increases safety
- Increases user satisfaction

HFE involves the study of the factors and the development of tools to achieve these goals.
Human Factors Cycle

A. Identification of Problems

1. Analysis Techniques
2. Task Statistics Accident

B. Implement Solutions

- Design
  - Equipment
  - Task
  - Environment
  - Selection
  - Training

Performance
Principles of the HFE Profession

• Fit the task to the person
• Recognize the need to design to accommodate a large number of users
• Realization that not all problems are the result of human error
• Improvement requires a cyclical design process
Benefits of HFE

Research has shown a positive internal, external, and social ROI after ergonomics improvements

<table>
<thead>
<tr>
<th>Increased</th>
<th>Decreasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>Accidents, injuries</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Labor costs</td>
</tr>
<tr>
<td>Trust</td>
<td>Training time</td>
</tr>
<tr>
<td>Productivity</td>
<td>Errors</td>
</tr>
<tr>
<td>Quality</td>
<td>Rework</td>
</tr>
<tr>
<td>Satisfaction, commitment</td>
<td>Absenteeism and turnover</td>
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</tbody>
</table>
Human Factors in Healthcare

Incorporating HFE into Healthcare Improvement Projects

– Physical ergonomics
  • NIOSH lifting guidelines, fatigue, work/rest schedules

– Human error
  • Classification and prevention

– Cognitive abilities and limitations
  • Information processing

– Human computer interaction
  • Design of technology and interfaces

– Macroergonomics and organizational design
  • Work system design
Task Analysis

Task analysis is a technique used to describe
  – Operator behavior at various levels of detail
  – Information on the structure of the task
Useful in human factors, usability, and basic work study applications

Two primary approaches
  – Action oriented: describes observable behaviors
  – Cognitive: describes decision making and problem solving behaviors
Task Analysis

Uses in human factors & ergonomics
- Identify and eliminate preconditions for operator error
- Eliminate redundancy in task design
- Develop training approaches
- Aid in incident investigation

Two primary methods (for action oriented approaches)
- Procedural Task Analysis
- Hierarchical Task Analysis (HTA)
HTA Method

1. Identify user’s primary goals
2. Detail the steps users must perform to accomplish their goals
   - Break down tasks until you achieve enough detail
   - Typically when you do longer think significant error potential will be revealed in the next step
3. Organize tasks within each group to show the hierarchical relationships
4. Display as diagram or table format
5. Consider including a plan or conditions
   - E.g. User completes task 1 if novice, otherwise task 2
6. Validate
   - Subject matter experts and walkthroughs
Human-Machine System

**Man**
- Physician
- Nurse
- Care Coordinator

**Displays**
- Monitor
- Handheld Device
- Wearable

**Controls**
- Keyboard
- Mouse, Pointer
- Touchscreen

**Machine**
- Medical Equipment
- Remote Terminal
Interface Design & Usability

What does it mean for a system to be usable?

Five criteria: 1) Efficiency 2) Accuracy 3) Learnability 4) Memorability 5) Satisfaction
Interface Design Principles

1. Match the system to the real world
2. Be consistent
3. Clearly show system status
4. Provide the user control and freedom
5. Enable error prevention, recognition, and recovery
6. Minimize memory requirements
7. Allow for flexible and efficient use
8. Emphasize simplicity
Mental Workload

• Time Sharing – the ability to “attend to” multiple tasks at a given time (“multitasking”)
• Mechanisms that impact effective time sharing
  – Automaticity
  – Resources & Resource Allocation
  – Confusion & Similarity
• Operators have limited attentional resources
• Need to determine how much a task demands of these resources – measure mental workload
<table>
<thead>
<tr>
<th>Time Load</th>
<th>Mental Effort Load</th>
<th>Stress Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Often have spare time. Interruptions or overlap among activities occur infrequently or not at all.</td>
<td>1. Very little conscious mental effort or concentration required. Activity is almost automatic, requiring little or no attention.</td>
<td>1. Little confusion, risk, frustration, or anxiety exists and can be easily accommodated.</td>
</tr>
<tr>
<td>2. Occasionally have spare time. Interruptions or overlap among activities occur frequently.</td>
<td>2. Moderate conscious mental effort or concentration required. Complexity of activity is moderately high due to uncertainty, unpredictability, or unfamiliarity. Considerable attention required.</td>
<td>2. Moderate stress due to confusion, frustration, or anxiety noticeably adds to the workload. Significant compensation is required to maintain adequate performance.</td>
</tr>
<tr>
<td>3. Almost never have spare time. Interruptions or overlap among activities are very frequent, or occur all the time.</td>
<td>3. Extensive mental effort and concentration necessary. Very complex activity requiring total attention.</td>
<td>3. High to very intense stress due to confusion, frustration, or anxiety. High to extreme determination and self-control required.</td>
</tr>
</tbody>
</table>
Fatigue

Fatigue is an overwhelming sense of tiredness, lack of energy, and feeling of exhaustion with impaired cognitive or physical functioning. Different from sleepiness.

Some fatigue statistics:

- Survey of nurses found 35.3% of nurses who rotated shifts and 32.4% of nurses who work night shifts only feel asleep at work at least once per week.
- Nurses who report limited sleep are less likely to report errors and near misses.
- Nursing error is estimated to increase 3.4% when 6 or fewer hours of sleep are realized in the past 24 hours.
- Significant increase in errors when shift length exceeds 12.5 hours, regardless of reason for extended shift.
Fatigue

Types of fatigue

• Active: results from continuous activity
• Passive: results from persistent under-stimulation

Consequences of fatigue

• **Physical**: Slower movement/delayed response; Loss of coordination, muscle weakness; Build up of metabolic wastes that interrupt movement and coordination; Dizziness; Pain, strain, permanent injury
• **Mental**: Task aversion; Cognitive and social tunneling; Strong urge to sleep; Helplessness; Irritability
Fatigue

Methods to prevent or control workplace fatigue

• Fatigue management systems or programs
• Fatigue countermeasures
  – Machines
  – Drugs
• Work redesign
  – Rest breaks
  – Task redesign – vigilance tasks/arousal mechanisms
  – Napping; sleep inertia
• Employee education
  – Sleep hygiene
  – Self-regulation
Process Modeling and Performance Analysis
Process Integration and Improvement

Potential Problems with Processes can Reduce Revenue

Low tech version

High tech version
Flowcharts

• Understand your process from start to finish and build common understanding of the process
• Improve your process
• Standardize your process
• Communicate to stakeholders
• Identify the key individuals, technologies (hardware and software), interdependencies, etc.
• Map the process in a flowchart
• Test the validity of the flowchart
• Continually redesign the flowchart as needed
Flowcharts Engineering 101

Does it Move?

NO

Should it?

Yes

Should it?

No

No Problem

Yes

No

No
Capturing Process information

- Sequence of activities
- Duration of activities
- Constraints such as precedence relations.
- Variability of activity times.
Synchronous (face to face) Process Analysis

Synchronous Individual Session

Spoke Clinic Coordinator
- Prepare Handouts, Scans Patient ID Card, escorts patient to room [expon(5)]

Hub Clinic Coordinator
- Enroll patient in therapy session [expon(10)]
- Prepar[es specialist for session, gathers patient information, [expon(5)]
- Runs session and stays in room with patients during session [60 min.]
- Stays after session attend to patient needs, paperwork [expon(8)]
- Processes specialist’s recommendations and sends to spoke site [expon(10)]
- Check out patient and provide follow-up and treatment. [expon(5)]

General Practitioner
- Prepares for Session [expon(20)]
- Runs Session [60 min.]
- Session follow-up, paperwork, billing, recommends additional treatment [expon(20)]

Specialist
- Reviews primary care provider’s referral to therapy [expon(10)]
- Prepares for Session [expon(20)]

Spoke Clinic Tech
- Prepare AV Equipment in Room [expon. 10]

Hub Clinic Tech
- Prepare AV Equipment for Specialist [expon. 10]
Spoke Clinic Coordinator

- Enrolls patient in therapy
- Prepares specialist for session, gathers patient information
- Communicates specialist’s questions to Spoke
- Checks in patient, prepares referral, sends Patient ID Card, escorts patient to room
- Sends recorded response to Specialist

Hub Clinic Coordinator

- Checks out patients and provides follow-up and treatment

General Practitioner

- Review primary care provider’s referral to group therapy
- Prepare questions for the session

Specialist

- Reviews primary care provider’s referral to group therapy
- Prepare questions for the session
- Watches and records response to specialist questions
- Processes specialist’s recommendations and sends to spoke

Spoke Clinic Tech

- Prepare AV equipment in room

Hub Clinic Tech

- Checks in patient, prepares referral, sends Patient ID Card, escorts patient to room
- Checks in patient, prepares referral, sends Patient ID Card, escorts patient to room
- Watches and records response to specialist questions
- Processes specialist’s recommendations and sends to spoke
- Sends recorded response to Specialist
- Checks out patients and provides follow-up and treatment

Asynchronous Individual Session

- Prepare questions for the session
- Prepare AV equipment in room
Simulation Demo
Synchronous Process Performance

Employee Utilization for Synchronous Individual Telemedicine

- Spoke CC
- Specialist
- GP
- Hub CC
- SpokeTech
- HubTech
- AV Equip

Number of Scheduled Patients Per Week vs. Percent Employee Utilization
Asynchronous Process Performance

Employee Utilization for Asynchronous Individual Telemedicine

- Spoke CC
- Specialist
- GP
- Hub CC
- SpokeTech
- HubTech
- AV Equip

Percent Employee Utilization vs. Number of Scheduled Patients Per Week
Asynchronous Process Performance

Appointment Execution for Individual Therapy

- Synchronous
- Asynchronous
- Ideal

Appointments Completed vs. Appointments Scheduled
Basic Physics of Variability
Definitions:

Utilization = \frac{\text{Arrival Rate}}{\text{Effective Production Rate}}

Throughput (Patients/hr)

Waiting line (patients)
Example – Results:

Cycle time (Hours)

Waiting line (patients)
Throughput vs. Queue length

Bottleneck rate

Waiting Line Length

TH
Some ideas based on this simple case

You can improve the Throughput without changing the bottleneck rate!!!
Making the situation more dynamic

Adding Variability

• Natural variability
• Variability due to unscheduled interruptions
• Variability due to “scheduled outages”
• Flow variability.
Adding Flow Variability

Low variability arrivals

smooth!

High variability arrivals

bursty!
Variability Effect on Performance

Case I

Waiting Time

Waiting Time Cumulative

Process Number

Utilization

Utilization

Process Number

Case II

Waiting Time

Waiting Time Cumulative

Process Number

Utilization

Utilization

Process Number
<table>
<thead>
<tr>
<th>MEASURE:</th>
<th>STATION:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival Rate (parts/hr)</td>
<td>( r_a )</td>
<td>10.000</td>
<td>9.800</td>
<td>9.310</td>
<td>8.845</td>
<td>7.960</td>
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<tr>
<td>Arrival CV</td>
<td>( c_a^2 )</td>
<td>1.000</td>
<td>0.181</td>
<td>0.031</td>
<td>0.061</td>
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<tr>
<td>Natural Process Time (hr)</td>
<td>( t_0 )</td>
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<td>0.090</td>
<td>0.095</td>
<td>0.090</td>
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<tr>
<td>Natural Process SCV</td>
<td>( c_0^2 )</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
</tr>
<tr>
<td>Number of Machines</td>
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<td>1</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>MTTF (hr)</td>
<td>( m_f )</td>
<td>200</td>
<td>200</td>
<td>200</td>
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<td>200</td>
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<tr>
<td>MTTR (hr)</td>
<td>( m_r )</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td></td>
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<tr>
<td>Availability</td>
<td>( A )</td>
<td>0.990</td>
<td>0.990</td>
<td>0.962</td>
<td>0.980</td>
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<td>Effective Process Time (failures only)</td>
<td>( t_e' )</td>
<td>0.091</td>
<td>0.091</td>
<td>0.099</td>
<td>0.092</td>
<td>0.092</td>
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<tr>
<td>Eff Process SCV (failures only)</td>
<td>( c_e^2 )</td>
<td>0.936</td>
<td>0.936</td>
<td>6.729</td>
<td>2.209</td>
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<tr>
<td>Batch Size</td>
<td>( k )</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Setup Time (hr)</td>
<td>( t_s )</td>
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<td>0.500</td>
<td>0.500</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Setup Time SCV</td>
<td>( c_s^2 )</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
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<tr>
<td>Arrival Rate of Batches</td>
<td>( r_a/k )</td>
<td>0.100</td>
<td>0.098</td>
<td>0.093</td>
<td>0.088</td>
<td>0.080</td>
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<tr>
<td>Eff Batch Process Time Var (failures+setups)</td>
<td>( k^2 \sigma_0^2 / \bar{X}^2 + 2m_2 (1-A)kt_0/A \sigma_0^2 )</td>
<td>0.773</td>
<td>1.023</td>
<td>6.818</td>
<td>1.861</td>
<td>1.861</td>
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<tr>
<td>Eff Process SCV (failures+setups)</td>
<td>( c_e^2 )</td>
<td>0.009</td>
<td>0.011</td>
<td>0.063</td>
<td>0.022</td>
<td>0.022</td>
</tr>
<tr>
<td>Utilization</td>
<td>( u )</td>
<td>0.909</td>
<td>0.940</td>
<td>0.966</td>
<td>0.812</td>
<td>0.731</td>
</tr>
<tr>
<td>Departure SCV</td>
<td>( c_d^2 )</td>
<td>0.181</td>
<td>0.031</td>
<td>0.061</td>
<td>0.035</td>
<td>0.028</td>
</tr>
<tr>
<td>Yield</td>
<td>( y )</td>
<td>0.980</td>
<td>0.950</td>
<td>0.950</td>
<td>0.900</td>
<td>0.950</td>
</tr>
<tr>
<td>Final Departure Rate</td>
<td>( r_a^*y )</td>
<td>9.800</td>
<td>9.310</td>
<td>8.845</td>
<td>7.960</td>
<td>7.562</td>
</tr>
<tr>
<td>Final Departure SCV</td>
<td>( yc_d^*y )</td>
<td>0.198</td>
<td>0.079</td>
<td>0.108</td>
<td>0.132</td>
<td>0.077</td>
</tr>
<tr>
<td>Utilization</td>
<td>( u )</td>
<td>0.909</td>
<td>0.940</td>
<td>0.966</td>
<td>0.812</td>
<td>0.731</td>
</tr>
<tr>
<td>Throughput</td>
<td>( TH )</td>
<td>9.800</td>
<td>9.310</td>
<td>8.845</td>
<td>7.960</td>
<td>7.562</td>
</tr>
<tr>
<td>Queue Time (hr)</td>
<td>( CT_a )</td>
<td>45.825</td>
<td>14.421</td>
<td>14.065</td>
<td>1.649</td>
<td>0.716</td>
</tr>
<tr>
<td>Cycle Time (hr)</td>
<td>( CT_a + t_s )</td>
<td>54.915</td>
<td>24.011</td>
<td>24.445</td>
<td>10.829</td>
<td>9.896</td>
</tr>
<tr>
<td>Cumulative Cycle Time (hr)</td>
<td>( \sum_{i}(CT_{a(i)}+t_{s(i)}) )</td>
<td>54.915</td>
<td>78.925</td>
<td>103.371</td>
<td>114.200</td>
<td>124.096</td>
</tr>
<tr>
<td>WIP in Queue (jobs)</td>
<td>( r_a CT_q )</td>
<td>458.249</td>
<td>141.321</td>
<td>130.948</td>
<td>14.587</td>
<td>5.700</td>
</tr>
<tr>
<td>WIP (jobs)</td>
<td>( r_a CT )</td>
<td>549.149</td>
<td>235.303</td>
<td>227.586</td>
<td>95.780</td>
<td>78.773</td>
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<tr>
<td>Cumulative WIP (jobs)</td>
<td>( \sum_{i}(r_{a(i)}CT_{i}) )</td>
<td>549.149</td>
<td>784.452</td>
<td>1012.038</td>
<td>1107.818</td>
<td>1186.591</td>
</tr>
</tbody>
</table>
Value Stream Mapping

- Processes are not designed or implemented perfectly
- Processes have several sources of inefficiency
- Not all activities add value to the process even if all activities are necessary.
- Streamlining processes adds value
- Think about Quality Control
Consider 7 clinics:

one input (\# of beds) and one output (Admissions)
Value Stream Mapping

Current State – Necessary vs. Un
- Total Cycle Time: 3 hours 34 minutes
- Nec. Time: 2 hours 49 minutes
- Un nec. Time: 45 minutes
- % of Necessary Time: 79%

Current State – VA vs. NVA
- Total Cycle Time: 3 hours 34 minutes
- VA Time: 2 hours 23 minutes
- NVA Time: 1 hour 11 minutes
- % of VA: 66.7%
The Process Nine (P9) Sources of Inefficiency

1. Defects
2. Overproduction
3. Confusion
4. Waiting
5. Inventory
6. Motion
7. Processing
8. Underutilization of Staff/Skill
9. Failure to properly use available technology
CAPITAL
How to Manage Cash Flow

• Breakeven
• Revenue drops
• Cost rises
• Raising prices—it is possible & it is happening
  – Overcoming resistance of payors
  – Going around payors
  – Self-pay
  – Higher deductibles
How to Manage Cash Flow

Telehealth is about managing supply, demand, & margins to provide (more) effective patient care safely & efficiently.

It is not necessary to “bend the cost curve”—just need to move in the right direction from breakeven—for you.
Cash Flow - Example

Suppose that a new Telehealth communication center costs $200,000 and is expected to last 5 years and then have a salvage value of $40,000. If the effective discount rate* is 15% find:

i) the annual equivalent cost
ii) present value

\[ A = -200,000 \left( \frac{A}{P}, 15\%, 5 \right) + 40,000 \left( \frac{A}{F}, 15\%, 5 \right) = -53,728 \]  
\[ (\text{Equivalent uniform annual cost}) \]

\[ P = -200,000 + 40,000 \left( \frac{P}{F}, 15\%, 5 \right) = -180,112 \]  
\[ \text{Present value} \]
How to Manage Cash Flow

• Calculating the margin:
  – Gross revenue (per unit)
  – Cost of Goods/Services Sold (COGS to be consistent)

• Fixed Costs
• Variable costs

• How does technology move impact fixed & variable costs?
How to Manage Cash Flow
Fixed & Variable Costs

• Fixed costs do not (normally) vary across measuring periods or with business activity; rent, loan costs (non-floating), real estate taxes....

• Variable costs vary across measuring periods and with business activity; electricity, shipping, travel....
How to Manage Cash Flow

Change in Margin

Cost

Total Costs

New Total Costs

Variable Costs

Fixed Costs

Units

Cost

Total Costs

Variable Costs

Fixed Costs

Units

Cost

Total Costs

New Total Costs

Variable Costs

Fixed Costs

Units

Change in Margin

1

2

3

4
Putting It All together

Here we analyzed outcomes of different process alternatives

1. **Need Tele-presenter Certification**
   - Choice 1: **Yes**
   - Choice 2: **No OR**
     - Choice 3: **Keep a Tele-provider**
     - OR
     - Use Advanced Practice Nurse
   - OR
   - Use a PA

2. **Use an LPN**
Putting It All together
Template: Kiosks

Kiosk ROI (pro forma)

<table>
<thead>
<tr>
<th>Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Kiosk</td>
<td>$65,000</td>
</tr>
<tr>
<td>Pay to TeleProviders(1)</td>
<td>$70</td>
</tr>
<tr>
<td>Pay to PresProviders(2)</td>
<td>$50,000</td>
</tr>
<tr>
<td>Other Fixed &amp; Variable(3)</td>
<td>$650,000</td>
</tr>
</tbody>
</table>

| Costs                  | $3,225,000      |

<table>
<thead>
<tr>
<th>Revenue</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Visits/Yr</td>
<td>33,500</td>
</tr>
<tr>
<td>Av $/patient Visit</td>
<td>$70</td>
</tr>
<tr>
<td>Ancillary &amp; &quot;Captive&quot;/Visit</td>
<td>$25</td>
</tr>
<tr>
<td>Number of Lab/Yr</td>
<td>53,600</td>
</tr>
<tr>
<td>Lab/other testing (10% margin)</td>
<td>$8</td>
</tr>
</tbody>
</table>

| Gross Revenue          | $3,225,380      |

| Net Revenue ROI        | $380            |

| Open hours 365 days    | 8               |
| ThruPut Patients/Hr.   | 11              |

- TeleProviders—what level?
- PresProviders—what level?
- Rent, internet, malpractice, supplies...
- Engineered waits
- B9
- p9
- Location analysis
- Amortization
- Can income ad hoc help prior practice?
### Putting It All Together

**Template: Kiosks (PA Variant)**

- TeleProviders—what level?
- PresProviders—what level?
- Rent, internet, malpractice, supplies...
- Engineered waits
- B9
- P9
- Location analysis
- Amortization
- Can income *ad hoc* help prior practice?

### Kiosk ROI (Pro forma)

<table>
<thead>
<tr>
<th>Costs (PA Variant)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Kiosk</td>
<td>$65,000</td>
<td>$130,000</td>
</tr>
<tr>
<td>Pay to TeleProviders</td>
<td>$70</td>
<td>$700</td>
</tr>
<tr>
<td>Pay to PresProviders x 4</td>
<td>$85,000</td>
<td>$340,000</td>
</tr>
<tr>
<td>Other Fixed &amp; Variable (3)</td>
<td>$1,200,000</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td>$1,670,700</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revenue</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Visits/Yr</td>
<td>33,500</td>
<td>$2,345,000</td>
</tr>
<tr>
<td>Av $/patient Visit</td>
<td>$70</td>
<td>$837,500</td>
</tr>
<tr>
<td>Ancillary &amp; &quot;Captive&quot;/$Visit</td>
<td>$25</td>
<td>$837,500</td>
</tr>
<tr>
<td>Number of Lab/Yr</td>
<td>53,600</td>
<td>$42,880</td>
</tr>
<tr>
<td>Lab/other testing (10% margin)</td>
<td>$8</td>
<td>$42,880</td>
</tr>
<tr>
<td>Gross Revenue</td>
<td></td>
<td>$3,225,380</td>
</tr>
<tr>
<td>Net Revenue</td>
<td></td>
<td>$1,554,680</td>
</tr>
<tr>
<td>ROI</td>
<td></td>
<td>1196%</td>
</tr>
</tbody>
</table>

- Open hours 365 days
- ThruPut Patients/Hr.
- Net Revenue
- ROI
Overview Economics & Technology Efficiency Pays

“Nickels & dimes”: from practice to airlines

Non-Face-to-Face Coding & Billing

- On-demand, on-line--no CPT 99441 or 98966 rules

Balance Sheet with 10% productivity increase:

- How to do it?

Technology leads, bureaucracy lags
## Putting It All Together
### Some (of many) Medical Business Models

<table>
<thead>
<tr>
<th>Models</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate/Institutional</td>
<td>1. Customers/Patients</td>
</tr>
<tr>
<td>Insurance (all you can eat)</td>
<td>2. Value Proposition</td>
</tr>
<tr>
<td>HMO &amp; ACO</td>
<td>3. Delivery</td>
</tr>
<tr>
<td>Concierge</td>
<td>4. Relationships with Customers/Patients</td>
</tr>
<tr>
<td>Kiosks</td>
<td>5. Revenue &amp; Costs</td>
</tr>
<tr>
<td>Independent</td>
<td>6. Law &amp; Compliance</td>
</tr>
<tr>
<td>House Calls</td>
<td>7. Resources</td>
</tr>
<tr>
<td>Long Term Care Facility</td>
<td>8. Services &amp; Activities</td>
</tr>
<tr>
<td>Salary/shift work</td>
<td>9. Partners &amp; Investors</td>
</tr>
<tr>
<td>Group Appointments</td>
<td>10. Time</td>
</tr>
</tbody>
</table>

**B9**
Putting It All Together
Top 10

1. Strategy & tactic
2. Reproducible Processes
3. Commitment
4. Providers must be happy
5. Simplicity
6. Consistency
7. Collaboration & Teaching
8. Evaluation
9. Eco- & Ergo-nomics
10. Champions
Presenters:

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References

