Microeconomic Health Technology Assessment Using the Analytic Hierarchy Process: Two Case Studies

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Bio: Matthew Liberatore, Ph.D.

- John F. Connelly Chair in Management and Professor, Decision and Information Technologies
- 23 years of academic experience including 3 as Associate Dean and 6 as Department Chair
- 9 years of consulting and industry experience prior to academia (University of Pennsylvania, RCA Corp, and FMC Corp)
- Consulting and research interests in the decision-making processes (Jefferson Hospital, Graduate Hospital, Armstrong World Industries, Lockheed-Martin, Rohm and Haas)

Bio: Robert L. Nydick, Ph.D.

- Associate Professor and Chairperson, Decision and Information Technologies
- 23 years of academic experience
- Consulting and research interests in the decision-making processes (Jefferson Hospital, Graduate Hospital, Sterling Pharmaceutical, The Quaker Group)

Bio: Elliot Sloane, Ph.D.

- 28 Years of Clinical Engineering and Information Technology Expertise
  - Vice President, ECRI – 15 years
  - Vice President, MEDIQ/PRN – 10 Years
  - Professor of Information Systems, Villanova University – since 2000
- Immediate Past President, American College of Clinical Engineering

Purpose of our research

Focusing on bringing DSS application to healthcare

- Improve technology selection and management
- Improve patient outcomes
- Improve physician/provider efficiency

About the Current Healthcare Environment

- Ongoing major economic challenges created by aging population, very high expectations, reimbursement limitations, and liability pressures
  - Fewer care givers, more patients, less money..
- IOM Report of 1998 & 2001 documented major patient injuries and deaths occurring in US hospitals due to medical errors

Healthcare Environment - 2

- ePortals and direct-to-consumer advertising for drugs and procedures are increasing patients awareness, expectations
  - This is driving demand and consumption of services, as well as litigation!

Analytic Hierarchy Process (AHP): A brief introduction

- AHP is an *analytic* methodology used to prioritize: a) Criteria, and then b) Alternatives, when multiple criteria and alternatives must be considered
- AHP structures a decision problem as a *hierarchy,* or structured set of integrated levels or stages, of a decision *process*

AHP is supported by software such as Expert Choice 2000, which will be shown shortly

If you want to try this software, it is available with a new textbook:

DECISION TECHNOLOGY Modeling, Software, and Applications

by Liberatore and Nydick

J Wiley, ISBN 0-471-41712-2

October, 2002

The book includes EXPERT CHOICE 2000 (AHP), Microsoft Project 2002, and additional DSS training software!

Case Study: Using AHP to Select Neonatal Ventilators for Woman's Health Facility

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New Women's Medical Facility

- Part of one of the largest independent hospital system in north suburban Philadelphia area
  - 500+ Bed Community Teaching Hospital
  - Growing, successful facility since 1914
- Thriving Obstetrics Program
  - Innovative Birthing Unit and Residency Teaching Program
- Thriving In-Vitro Fertilization (IVF) Program
  - Contributing to growing pre-term neonates, and "high risk" pregnancies with older women

"NICU"
Neonatal Intensive Care Unit

- State of the art, 24 bed unit
  - Incubators and Bassinettes
- Quiet and organized
  - Designed to limit additional stress to critical, fragile neonates and their families
- Filled to capacity! Last year 4400 births in the DR, 425 admissions to the NICU
- Includes transfers from area hospitals

Future New Women's Health Hospital

- To be built in 2-3 years in the block north of present campus
- Specializing in all women's health services, including ob/gyn services
- The growing IVF program, and continued community service expansion, is likely to require expanded NICU support
  - New neonatal ventilators are likely to be needed

NICU Neonatal Ventilators Today

- Bear Cub, an older design that is no longer manufactured (Bear Medical was purchased several years ago)
  - Original cost, ~$15,000 each
- Siemens 300, an expensive, state-of-the-art ventilator useful for all patients, from neonate to large adults
  - Original cost, ~$35,000 each!
  - i.e., probably too expensive for routine neonatal use

Contemporary Neonatal Ventilator Requirements

- **Very precise control of small breaths, down to 100 ml levels**
  - Small, fragile lungs cannot withstand over-distension
- **Relatively high breath frequency, far above adult levels (100 bpm)**
- **Trigger sensitivities must be very low**
  - Neonates must not struggle to initiate each breath; the metabolic load may be fatal!

Current Neonatal Ventilator Choices?

- Specialized neonatal ventilators designed for NICU use, or
- High end general use intensive care ventilators for neonate-thru-adult uses

Selection is complex: Each of the dozen or so alternatives has trade-offs of features, support complexity, and cost!

A ventilator trade-off example:

- Full-range, high end ventilators
  - Very expensive and complex
  - Some users state that a hospital may be able to share between adults and neonates
    - BUT, sharing does not meet this hospital's infection control requirements, so the higher cost of such units cannot be shared with adult ICU departments
- Specialized neonatal ventilators can only be used in NICU, but cost 40-50% less than full-range ventilators

Trade-off question examples:

1. Does the versatility of the full-range ventilators offset the higher cost and increased complexity?
   - Subset question: If the cost is reduced enough by the manufacturer, will sufficient overall savings and convenience accrue from standardized physician and respiratory therapist training by using single, hospital-wide ventilator platform for all patients?

Another trade-off example:

2. Some neonatal ventilators can only be used with specific humidification systems
   - Such systems may be needed to control moisture in the breathing tubes to the patient
     - Excessive moisture and cooling causes condensation of water; condensed water can drown neonate, and/or allow fungus and bacteria to grow
   - Each humidification system has pros, cons, and differing life cycle costs to consider

Third trade-off example:

3. What is the lowest cost acceptable humidification system that can be used with each ventilator?
   - Must meet infection control, safety, and durability needs in the hospital

Clinical engineering perspectives:

1. Selection criteria becomes measurable
   - Eliminates wish lists and/or personal preferences!
2. Guides one in selecting the best hardware for the application at the best possible cost
3. Helps expose vendor options, in terms of equipment support
4. Selection criteria is supplied by all stakeholders, ensuring a team approach to the process

Analytical Hierarchy Process for Neonatal Ventilator Selection

- AHP Ratings Approach was used
  - Assigned rating categories for each criteria
    - e.g., Ventilator footprint: Small, medium, or large
  - Weighed the relative importance of each criteria against every other criteria in it's peer-group
    - e.g., "Footprint is 3 times more important than weight" or "Ease of use is 5 times more important than flexibility"
  - Assigned the value of each rating category alternative
    - e.g., "very easy to use" is 10 times more valuable than a "very difficult to use" alternative, but only 3 times more valuable than a "slightly difficult to use" alternative.)

Illustrating the process

- First pass
- After Clinical Engineering Refinement
- After Respiratory Therapy Refinement
- After Clinical Engineering Weighting
- After Respiratory Therapy Weighting
- Resulting Weighted Model
- Sample Application

Lessons learned from the ventilator case...

- Creating the hierarchy and detailing the criteria and ranking stimulated clearer thinking and increased communication
  - It takes more time than just a casual chat!
    - Some criteria “fall out” as trivial, theoretical, or useless in the light of more careful consideration.
  - It yields a more realistic and complete picture of the situation
  - It provides a tool that allows measuring the impact of trade-offs of actual ventilators

Pause for Questions?

Case Study: IV Pump Selection Project to Prevent Patient Deaths

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Issues:

- "Sentinal Events" had occurred
  - Pediatric patients died, and hospital needed to replace all IV pumps for adult, pediatric, and home use
    - No single IV pump meets ALL needs perfectly
    - Each IV pump incurs significant unique, long-term disposables costs and training issues

Process

- We facilitated a group-based IV Pump evaluation process using Expert Choice
  - Developed an iterative process to structure and then specify the model
  - Elicited judgments and obtained group consensus in a series of 4 meetings
    - ICU, ER, Admin, Home Health, Clinical Engineering, Pediatrics/NICU
  - Identified and evaluated qualifying alternatives

Outcome

- Due to the urgency, the decision/consensus process precipitated a clear, dominant choice over other alternatives
  - The decision was reached before completing the full analysis
- Hospital implemented complete changeover to new brand and model

Lessons learned from the IV pump case...

- Expertise of different participants was crucial for complete evaluation
- Graphic and numeric display formats were helpful for the consensus process
- Cost was NOT the major driver

Our DSS Case Studies

- Healthcare Technology Assessments
  - New Neonatal Ventilator for a Women's Hospital
  - Selecting an IV infusion pump to prevent deaths
- Patient Decision Aid
  - Prostate Cancer Screening Decision
- Patient Discharge Planning
  - Determining the type of care (if any) required for geriatric patients after discharge from the hospital
- Surgeon's Colorectal Patient Screening Aid
  - Identifying patients who will benefit from laparoscopic surgery (and those who won't)
- Physician practice management computer system selection
  - Selecting best alternative that meets legal and operational goals

So, to summarize, here are the key things that we have learned from our research to date...

Tips for successful application of AHP to healthcare decisions:

- We are finding that AHP can help improve many healthcare decisions when properly facilitated
  - Doctors, nurses, administrators, and engineers appreciate the systematic approach and the learning/consensus building that occurs
- Clinical engineers, or perhaps a new breed of "hospital systems engineers," can provide leadership and expertise to clinicians and administrators, as they may more time and relevant expertise to master these tools
  - They also "speak the language" of healthcare and technology

Cautionary Notes - 1

- Remember: Healthcare is a multidisciplinary area that requires group discussion, negotiation, and consensus to build usable AHP models
- Expert Choice 2000 (or another full-fledged DSS tool) can help facilitate decision process
  - Graphic and numeric modes help to flexibly elicit judgments
- Patient choices may benefit from even more simplification

Cautionary Notes - 2

- Medical decisions take a significant investment of time and energy to build a good model
  - Cannot engage in these studies unless all parties can, and will, commit the necessary time
- Sensitivity analysis may reveal flaws or opportunities
  - User must be appropriately trained

There's much more work to be done; hope you're interested!

- Thank you! We welcome your questions and comments!

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