The Importance and Challenges of Cost-effective Analysis for Cochlear Implantation

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Learning Objectives

● Describe the basic concepts of cost effective analysis (CEA)

● Recognize the importance of disability weights in DALY-based cost effective analysis

● Discuss issues related to cost effectiveness of cochlear implants

● Describe ways that cost-effectiveness can be improved
A Noble Concept

Biggest “Bang for the Buck”
Why should we care?
Global Congenital Profound SNHL

How Big is the Problem?

- WHO - 0.2% of world’s pop. are deaf – 14 million
- GBD - 30% of 11.7 mil w/ profound SNHL - 3.9 million
- Newborn screening rates - 3.78 million

Unmet need - Many children receive no treatment

- Nicaragua – 2/3 of deaf children receive no services
- Africa – only 9% of failed screenings receive audiograms (Odomi et al)
- Inadequate workforce – surgeons / audiologists / therapists

Only a small fraction receive cochlear implants
~300,000 implants including ~100,000 children

100,000 / 3.9 million = 2.5%
Ranked Level of Concern
Survey of 198 US Cochlear Implant Surgeons

Avg Ranked Score

Audio Support
Rehab Services
Cost utilization
Post-op Care
Infection
Extrusion

Cochlear Implantation in Developing Countries as Humanitarian Service: Physician Attitudes and Recommendations for Best Practice

James Saunders, MD¹, and David Barrs, MD²
The dominant belief...

“...cochlear implants are just too expensive to ever be cost effective in low resource countries.”
Why should we care?

Low & Middle Income Countries (LMIC)
- WHO-CHOICE: Cost Effectiveness and Strategic Planning 2002 - Cost Effectiveness threshold based on GDP

High income countries:
- United Kingdom: National Institute for Health and Care Excellence Guidelines on Bilateral Cochlear Implantation 2009 (simultaneous only)
- United States: Patient Centered Outcomes Research Institute 2009 “Comparative Effectiveness Research (CER)”

Legislating against Use of Cost-Effectiveness Information
Peter J. Neumann, Sc.D., and Milton C. Weinstein, Ph.D.
“The Value Equation”

Value = \frac{\text{Quality (Benefit)}}{\text{Cost}}
Cost Effectiveness Analysis

Cost Effectiveness = \frac{\text{Cost}}{\text{Quality (Benefit)}}
Cost Effectiveness Analysis

Cost Effectiveness = \frac{\text{Cost}}{\text{Quality (Benefit)}}

Auditory Thresholds
IT-MAIS
AZ-BIO

Quality Adjusted Life Years (QALY)
Disability Adjusted Life Year (DALY)
HALYs and QALYs and DALYs, Oh My: Similarities and Differences in Summary Measures of Population Health

Marthe R. Gold¹, David Stevenson², and Dennis G. Fryback³

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³Department of Population Health Sciences, University of Wisconsin-Madison, Madison, Wisconsin 53705-2397; e-mail: Dfryback@facstaff.wisc.edu
QALY vs DALY

QALY = Years Lived x Quality (Utility) Gained
+ Years of Life Gained

DALY = Years Lived with Disease x Disability Weight
+ Years of Life Lost (YLL)
QALYs
- 0 = death, 1.0 = full health
- Utility / Benefit defined by patient experience
  - HRQOL
  - HUI
  - Eur QOL (EQ5D)
- Equal weight for years

DALYs
- 0 = health, 1.0 = death
- Standardized set of disability weights (DW)
- Comparisons (countries and diseases)
- Excludes non-health effects
- Age weighting of disability
- Discounting (3%)

Perfect Health

<table>
<thead>
<tr>
<th>Health</th>
<th>QALY</th>
<th>DALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 0.0    |      |      | 1.0  | Death 0.0

Cost Effectiveness of Cochlear Implants

Costs of implantation vs. special education
Based on Quality of Life Years (QALY)
QALY Utility Gain (0.22 – 0.49)

United Kingdom Cost / Benefit dependent on:
- Age at implantation
- Duration of deafness

Germany (age of implantation)
- <2 yrs: $113,100
- 2-3.9 yrs: $152,000

France / Korea - multi-center analysis

United States – mainstream / cost-effective

Using the DALY

Standardized Disability Weights for Different Diseases

- Excludes “non-health related” outcomes – i.e. economical / educational

Comparison of different populations and diseases

International standard – WHO-CHOICE Developing Countries

Increasing use in US and Europe

- NIH / NCBI – preferred “if possible” for developing countries
- CDC webcast - “best predictor of funding”

Research Articles

Assessing the Burden of Disease in the United States Using Disability-Adjusted Life Years

Matthew T. McKenna, MD, MPH, Catherine M. Michaud, MD, PhD, Christopher J.L. Murray, MD, DPhil, James S. Marks, MD, MPH
DALY Age-Weighting

Young adult life-years are given a higher value
Discounting

- Both costs and health benefit (DALY)
- 3% discounting rate (most common)
- Costs are distributed over years
Cost Effectiveness of Congenital Profound SNHL Treatments: DALYs Averted

Discounted Cost per DALY averted:

- No treatment
- Deaf Education
- Cochlear Implant

World Health Report (WHO-CHOICE) 2002:
Discounted Cost / DALY averted < 3x GDP per capita
### Economic Evaluation of Health Interventions for Hearing Loss: Disability Weights*

<table>
<thead>
<tr>
<th>Severity</th>
<th>Disability Weight GBD 2000</th>
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<tbody>
<tr>
<td>Mild (26 – 40 dB)</td>
<td>0.00</td>
</tr>
<tr>
<td>Moderate (41 – 60 dB)</td>
<td>0.12</td>
</tr>
<tr>
<td>Severe – Profound (61+ dB)</td>
<td>0.33</td>
</tr>
<tr>
<td>Severe (61 – 80 dB)</td>
<td></td>
</tr>
<tr>
<td>Profound (81 – 95 dB)</td>
<td>0.33</td>
</tr>
<tr>
<td>Complete (95+ dB)</td>
<td></td>
</tr>
<tr>
<td>Moderate with Hearing Aid</td>
<td>0.04</td>
</tr>
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<td>Severe to Profound with Hearing Aid</td>
<td>0.12</td>
</tr>
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*Based on 2000 Global Burden of Disease Estimates

\[
\text{DALY Averted} = 0.29
\]
# Economic Evaluation of Health Interventions for Hearing Loss: Disability Weights

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<th>Disability Weight GBD 2010</th>
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<tr>
<td>Mild (26 – 40 dB)</td>
<td>0.00</td>
<td>0.012</td>
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<tr>
<td>Moderate (41 – 60 dB)</td>
<td>0.12</td>
<td>0.022</td>
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<tr>
<td>Severe – Profound (61+ dB)</td>
<td>0.33</td>
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<tr>
<td>Severe (61 – 80 dB)</td>
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<td>0.052</td>
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<tr>
<td>Profound (81 – 95 dB)</td>
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<td>0.062</td>
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<tr>
<td>Complete (95+ dB)</td>
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<td>0.068</td>
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<tr>
<td>Moderate with Hearing Aid</td>
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<td>0.005</td>
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Revised 2013 Disability Weights pending ~ 0.27 for Profound HL
<table>
<thead>
<tr>
<th></th>
<th>Total Program Cost</th>
<th>Individual Cost</th>
<th>Individual Discounted DALY</th>
<th>DALY Averted (discounted)</th>
<th>Cost Effectiveness Ratio (CER) Costs per DALY averted</th>
<th>Cost Effectiveness Ratio per Gross Domestic Product (CER/GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochlear Implantation</td>
<td>$49,475,475</td>
<td>$40,815</td>
<td>2.79</td>
<td>6.92</td>
<td>$5,898</td>
<td>1.31</td>
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<tr>
<td>Cochlear Implantation Minimum Cost Scenario¹</td>
<td>$52,560,233</td>
<td>$32,520</td>
<td>2.79</td>
<td>6.92</td>
<td>$4,699</td>
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<td>Cochlear Implantation Maximum Cost Scenario²</td>
<td>$33,337,470</td>
<td>$44,003</td>
<td>2.79</td>
<td>6.92</td>
<td>$7,263</td>
<td>1.61</td>
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<tr>
<td>Deaf education³</td>
<td>$38,936,915</td>
<td>$32,121</td>
<td>3.9</td>
<td>5.81</td>
<td>$5,529</td>
<td>1.23</td>
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<tr>
<td>No Treatment</td>
<td>$0</td>
<td>$0</td>
<td>9.71</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
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</table>
Cost Effectiveness Analysis

Cost Effectiveness = \frac{Cost}{Quality (Benefit)}
Proportion of Implant Costs

* Includes external repairs, batteries, replacement, device failure
Conclusions

- Small fraction of potential CI candidates globally have access
- CEA may be used to inform healthcare decisions in both developed and developing countries (DALY based)
- Long term and QOL or Disability related outcomes are critical
- Should improve Disability Weight estimates for hearing loss
- Support efforts to reduce cochlear implant device costs while improving reliability
- Cost effectiveness strategies must be relevant to healthcare environment
- May improve access and cost-effectiveness with:
  - Professional development / training
  - Technology & Telemedicine