Cochlear Implantation and Deaf Education in Sub-Saharan Africa: A Cost Effectiveness Study

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Disclosure Information

- None

Global Burden of Hearing Loss

- **Burden:** 1.2 billion worldwide
  11.2 million with profound HL $\geq$ 80dB
  80% in low- and middle-income countries

- **Known:** Cost effectiveness of cochlear implantation (CI) in high resource settings

- **Unknown:** Cost effectiveness in low resource settings

GBD 2013 Collaborators. *Lancet* 2015;386:743-800. Olusanya BO. *PLoS Med.* 2007;4(4):e74. Niparko JK et al. *JAMA.* 2010;303:1498–1506. Cheng AK et al. *JAMA.* 2000;284:850–856. Barton GR et al. *Ear Hear.* 2006;27(5):575–588. Colletti L et al. *Laryngoscope.* 2011;121(11):2455–2460. Olusanya BO, Newton VE. *Lancet.* 2007;369:1314–1317.

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Study Objective

- Compare the cost effectiveness of managing pre-lingually deaf children in six Sub-Saharan African countries using:
  – national cochlear implant program and mainstream education
  – deaf education with sign language

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Disability Adjusted Life Years (DALYs)

- Time-based measure of health

- Combine years of life lost and years lived with disability

- Effectiveness: number of DALYs averted as result of health intervention

Making choices in health: WHO guide to cost-effectiveness analysis 2003. Gold MR et al. *Annu Rev Public Health.* 2002;23(1):115–134. Mathers C et al. Global burden of hearing loss in the year 2000. *Global Burden of Disease* 2000. Available at: http://www.who.int/healthinfo/statistics/bod_hearingloss.pdf.

Model Design

- Costs derived from published data and estimates specific to each country

- Assumption: diagnosis and treatment initiation by 36 months

- Decision tree analysis estimated life-long effects for CI and deaf education

Saunders JE et al. *Otol Neurotol* 2015;36:1349-56. Making choices in health: WHO guide to cost-effectiveness analysis 2003. Mathers C, Smith A, Concha M. Global burden of hearing loss in the year 2000. Available at: http://www.who.int/healthinfo/statistics/bod_hearingloss.pdf. Moor D. *Health Policy and Planning* 2003;18:351-356.

Cochlear Implant and Deaf Education Costs Included

- Amortized training costs
- Amortized equipment
- Lifetime maintenance
- Implant cost
- Surgery costs
- Lifetime mapping and therapy
- Hearing aid trial
- Mainstream education and support
- Probability of device failure
- Cost of non-use

- Years of deaf education
- Deaf educator training costs
- Deaf educator salary
- Residential facility costs
- Other educational costs
- Mainstream education costs if transition occurs
- Interpretor training costs
- Interpreter salary

Francis HW et al. *Arch. Otolaryngol. Head Neck Surg.* 1999;125:499–505. Cullen RD et al. *Otol Neurotol.* 2008;29:214–220. Wang JT et al. *Laryngoscope.* 2014;124(10):2393–2399. Marlowe AL et al. *Otol Neurotol.* 2010;31(1):74–82. Silverman CA et al. *Otol. Neurotol.* 2010;31(6):926–931.

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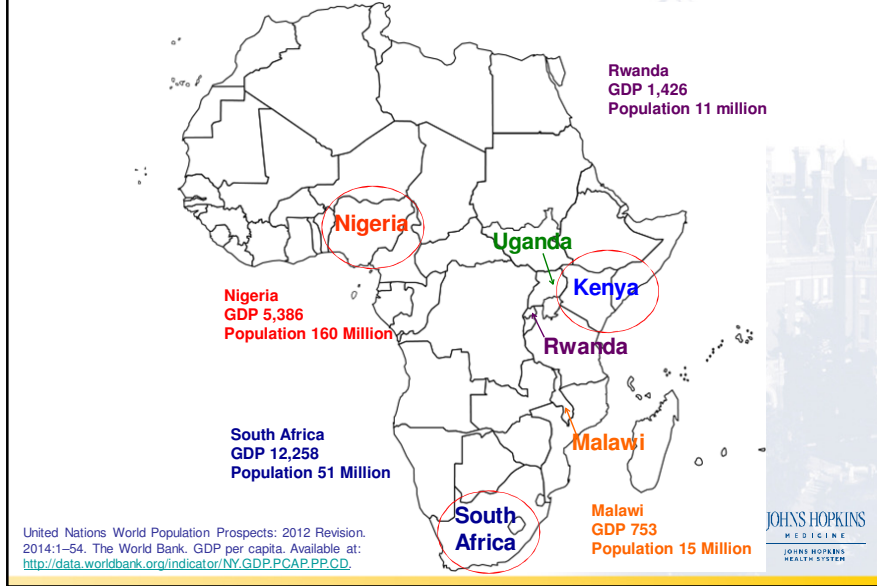HEALTH SYSTEM

Drawing Conclusions from the Model

- Sensitivity analysis: device cost, salaries, annual number of implants, and probability of device failure

- Cost effectiveness ratios (CERs) divided by GDP of each country per WHO protocol
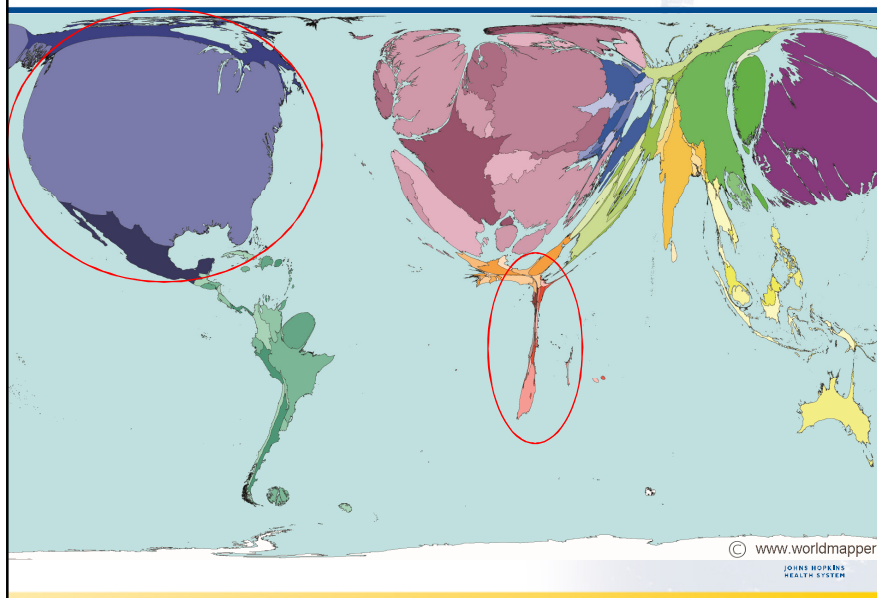
CER/GDP <3 cost effective
<1 very cost effective

WHO. Making choices in health: WHO guide to cost-effectiveness analysis. Geneva: World Health Organization; 2003. Gold MR et al. *Annu Rev Public Health.* 2002;23:115–134.

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Participating Countries

Rwanda
GDP 1,426
Population 11 million

Nigeria

Uganda

Kenya

Nigeria
GDP 5,386
Population 160 Million

Rwanda

South Africa
GDP 12,258
Population 51 Million

Malawi

South
Africa

Malawi
GDP 753
Population 15 Million

United Nations World Population Prospects: 2012 Revision.
2014:1–54. The World Bank. GDP per capita. Available at:
http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD.

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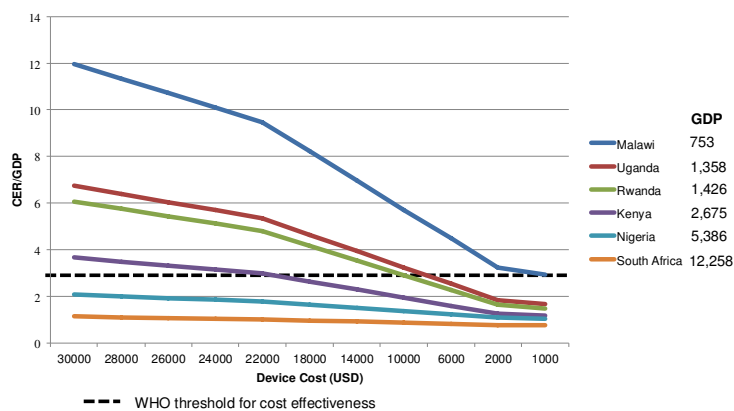# The World According to GDP

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CI and Deaf Education
Cost Effectiveness by Country

	Cost Effectiveness Ratio (CER) per Gross Domestic Product (GDP)	
	CI (Min, Max)	Deaf Education
South Africa	1.03 (0.94 – 1.12)	1.56
Nigeria	2.05 (1.77 - 2.41)	0.69
Kenya	3.27 (2.83 – 3.80)	1.11
Rwanda	4.89 (4.23 – 5.66)	0.55
Uganda	5.43 (4.67 – 6.35)	1.30
Malawi	9.62 (8.37 – 11.07)	0.89

Emmett SD et al. *Otol Neurotol* 2015; 36:1357-65.

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CI Cost Effectiveness with
Discounted Device Cost

	GDP
Malawi	753
Uganda	1,358
Rwanda	1,426
Kenya	2,675
Nigeria	5,386
South Africa	12,258

- - - WHO threshold for cost effectiveness

Emmett SD et al. *Otol Neurotol* 2015; 36:1357-65.

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Study Limitations

- Equivalent disability weights applied for hearing loss treated with CI and deaf education

- Model does not take into account differences in economic productivity

- Estimation in costs

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The Bottom Line

- Deaf education programs studied are cost effective.

- Cost effective CI programs *are* possible in Sub-Saharan Africa. Decreased device cost is important in expanding economies.

- There is opportunity for expansion of CI access. Collaboration is essential.

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