

Introduction to key concepts and definitions

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Learning activities

- Cost analysis, health outcomes, cost-effectiveness analysis (CEA), cost-utility analysis
- Why health economics is important
- Examples of CEA

AJPH Author of the Year 2009

The Prophylactic Extraction of Third Molars: A Public Health Hazard

| Jay W. Friedman, DDS, MPH

Ten million third molars (wisdom teeth) are extracted from approximately 5 million people in the United States each year at an annual cost of over \$3 billion.

In addition, more than 11 million patient days of “standard discomfort or disability”—pain, swelling, bruising, and malaise—result postoperatively, and more than 11000 people suffer permanent paresthesia—

IN THE UNITED STATES,

prophylactic removal of third molars (wisdom teeth) is advocated by almost all oral and maxillofacial surgeons and many general dentists. According to the American Association of Oral and Maxillofacial Surgeons, “if there is insufficient anatomical space to accommodate normal eruption . . . removal of such teeth at an early age is a valid and scientifi-

normally devel of which will e discomfort if n maturely. Only pacted teeth ar pathological co cysts and dama teeth.^{3,4} Most d erupting wido lent to teething on full eruptior of the gum tiss

Outline

1. Cost
2. Outcomes
3. Cost-effectiveness

Outline

1. Cost
 - Inputs
 - Perspective
 - Unit cost
 - Opportunity cost
 - Cost-of-living adjustment
 - Total, average, and marginal cost
2. Outcomes
3. Cost-effectiveness

Inputs

Health services – outpatient visit, inpatient admission, diagnostic test

Ancillary services such as information and education campaigns to create demand

Activities such as health worker training

Transportation to health facility

Perspective


A *cost analysis* identifies inputs or resources that a program uses and their costs.

Perspective is the point of view from which the costs are calculated. It addresses the issue of which inputs or resources to include.



Photo by: Charles Steinberg

O'Malley et al. *Human Resources for Health* 2013, 11:20
<http://www.human-resources-health.com/content/11/1/20>



COMMENTARY **Open Access**

Cost-effectiveness analyses of training: a manager's guide

Gabrielle O'Malley^{1*}, Elliot Marseille² and Marcia R Weaver¹

Abstract

The evidence on the cost and cost-effectiveness of global training programs is sparse. This manager's guide to cost-effectiveness analysis (CEA) is for professionals who want to recognize and support high quality CEA. It focuses on CEA of training in the context of program implementation or rapid program expansion. Cost analysis provides cost per output and CEA provides cost per outcome. The distinction between these two analyses is essential for making good decisions about value. A hypothetical example of a cost analysis compares the cost per trainee of a

Training program budget

	Cost per unit	5-day computer-based training plus 3-day workshop		10-day training plus on-site visits	
		Units	Cost	Units	Cost
Trainer	\$100 per day	3	\$300	10	\$1,000
On-site	\$1,000 per site	0		5	\$5,000
[..]					
Training program budget			\$7,350		\$12,250

Donor perspective

	Cost per unit	5-day computer-based training plus 3-day workshop		10-day training plus on-site visits	
		Units	Cost	Units	Cost
Training program budget			\$7,350		\$12,250
Hotel contract	\$225 per day	3	\$675	10	\$2,250
Donor cost			\$8,025		\$15,000

Societal perspective

	Cost per unit	5-day computer-based training plus 3-day workshop		10-day training plus on-site visits	
		Units	Cost	Units	Cost
Training program budget			\$7,350		\$12,250
Contract with venue	\$225 per day	3	\$675	10	\$2,250
Trainees' time	\$20 per day	200	\$4,000	275	\$5,500
Total cost			\$12,025		\$20,000

Perspective

Majority of cost analyses are from two perspectives:

1. Health sector
2. Societal

Unit cost

- **Cost** is a general term that can refer to the value of resources/inputs used to produce a good or service.

For cost analysis, it's often easier to count units of inputs such as number of days, and multiply them by a unit cost such as cost per day

- **'Unit cost'** commonly refers to the average cost of a service or output.

Opportunity cost

Opportunity cost is the value of the most beneficial alternative use of the resources.

Financial cost – For goods and services that are traded on a competitive market, the opportunity cost is simply the price

Economic cost – Value of goods and services that are not purchased such as trainee time or for which the price is distorted



Cost of living adjustment

When the time frame for cost analysis is longer than 12 months, the unit cost should be adjusted for inflation across years.

Cost of living adjustment

- Makes dollars worth the same amount in terms of what they can purchase.
- Adjustment is usually based on local Consumer Price Index

Kenyan Consumer Price Index (CPI) - Feb 2009 = 100

Month	Overall CPI from http://www.knbs.or.ke/
Oct-16	172.62
Nov-16	173.85
Dec-16	176.18
Jan-17	176.94
Feb-17	179.98
Mar-17	182.98
Apr-17	186.24
May-17	187.64
Jun-17	185.39
Jul-17	183.6
Aug-17	184.72
Sep-17	183.66
Oct-17	182.50

Cost of living adjustment - Example

Training cost:

KS 30,000 in Feb 2009 and
KS 60,000 in Oct 2016

Convert KS Oct 2016 60,000 to KS Feb 2009

$$172.62 / 100 = \text{KS } 60,000 / X$$

$$X = \text{KS } 60,000 / (170.62/100) = \text{KS } 34,758$$

Cost of living adjustment - Example

Training cost:

KS 60,000 in Oct 2016

KS 63,000 in Oct 2017

Convert KS 63,000 in Oct 2017 to KS Oct 2016

Kenyan Consumer Price Index (CPI) - Feb 2009 = 100

Month	Overall CPI from http://www.knbs.or.ke/
Oct-16	172.62
Nov-16	173.85
Dec-16	176.18
Jan-17	176.94
Feb-17	179.98
Mar-17	182.98
Apr-17	186.24
May-17	187.64
Jun-17	185.39
Jul-17	183.6
Aug-17	184.72
Sep-17	183.66
Oct-17	182.50

Cost of living adjustment - Example

Training cost:

KS 60,000 in Oct 2016

KS 63,000 in Oct 2017

Convert KS 63,000 in Oct 2017 to KS Oct 2016

$$182.50/172.62 = \text{KS } 63,000 / X$$

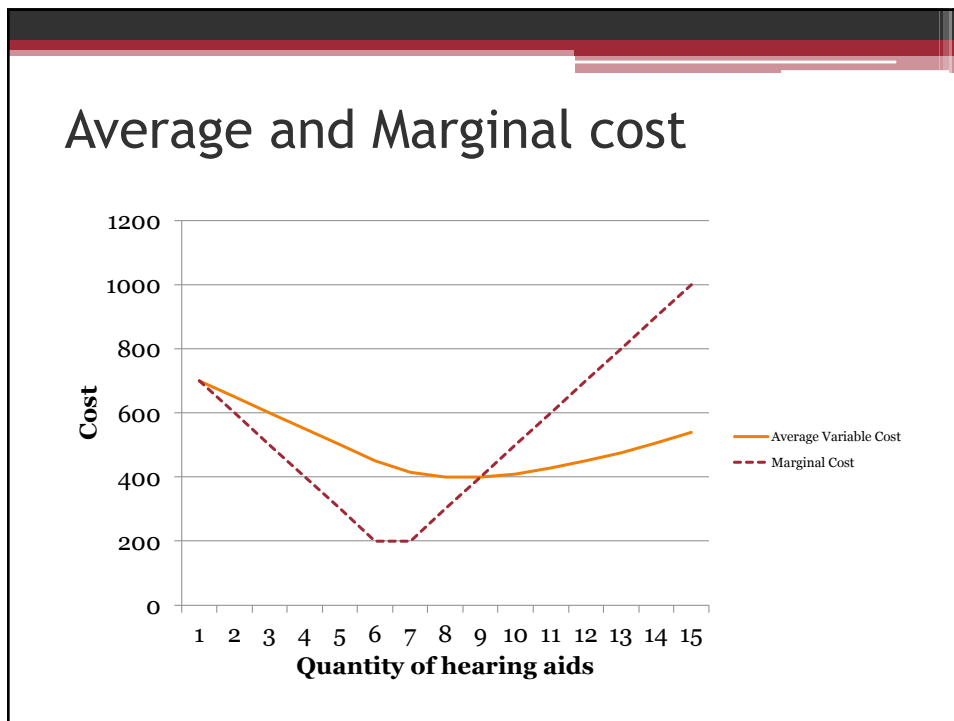
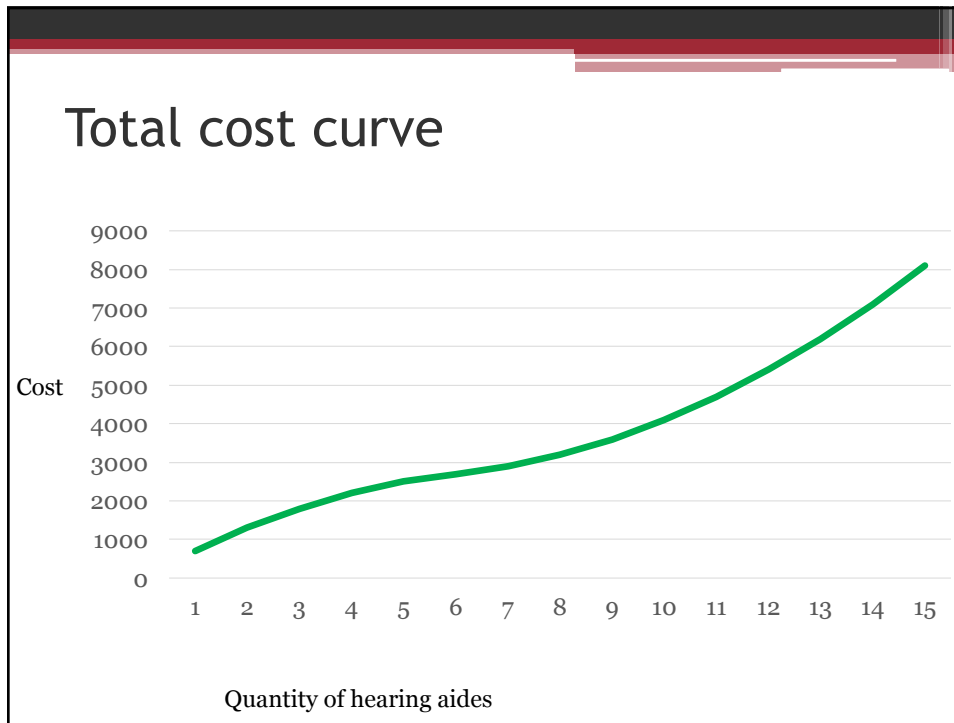
$$X = \text{KS } 63,000 / (182.50/172.62) = \text{KS } 59,589$$

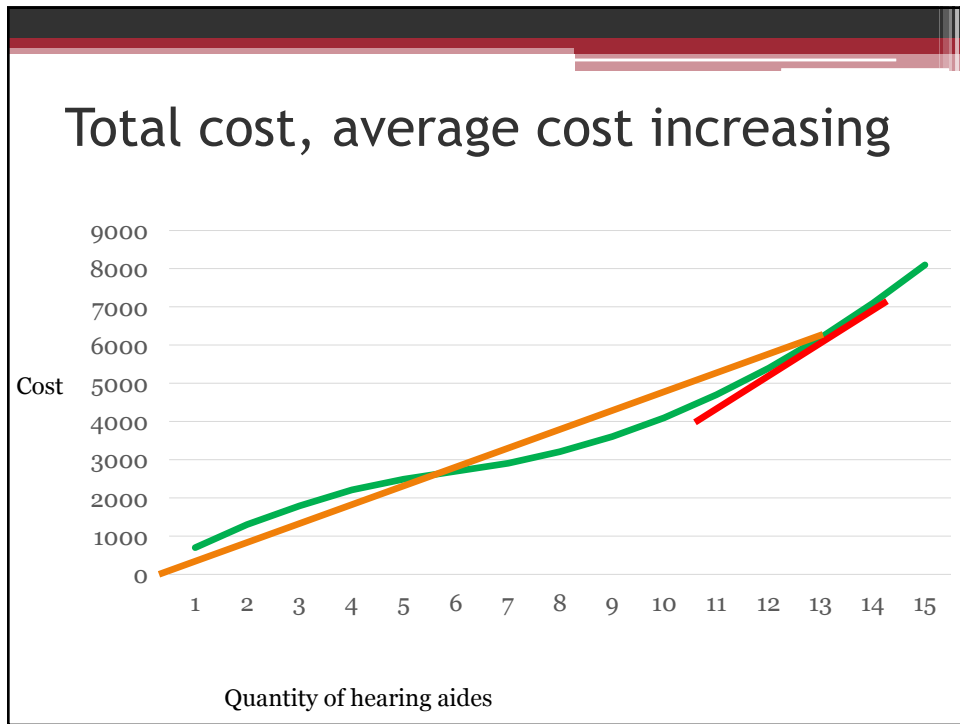
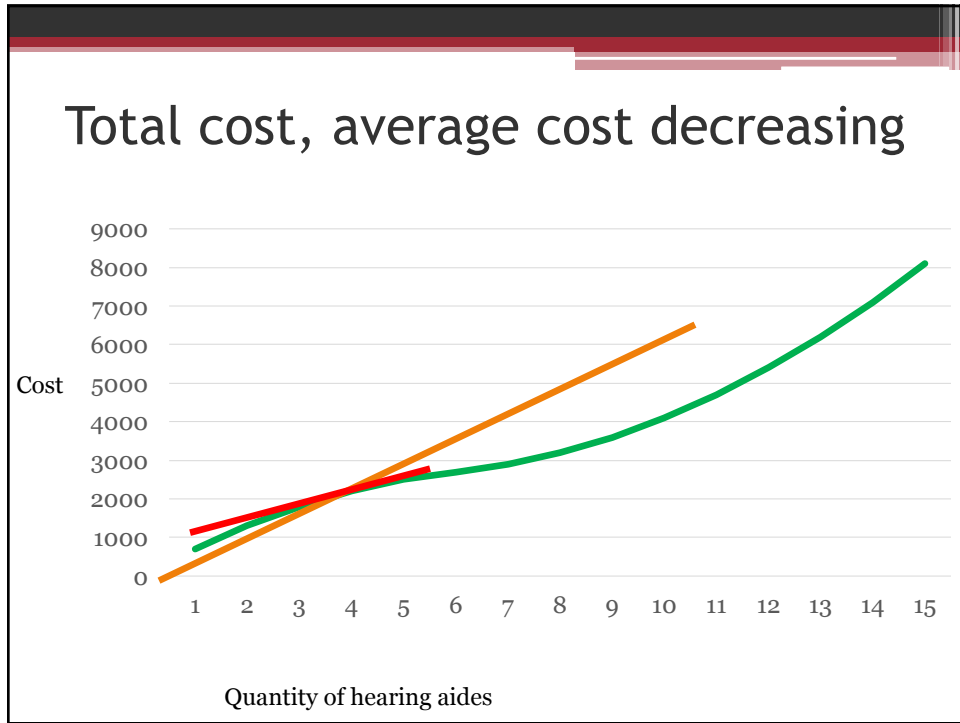
Now comparing KS 2016, does the 2016 or 2017 program have the lowest cost?

Total, marginal, and average cost

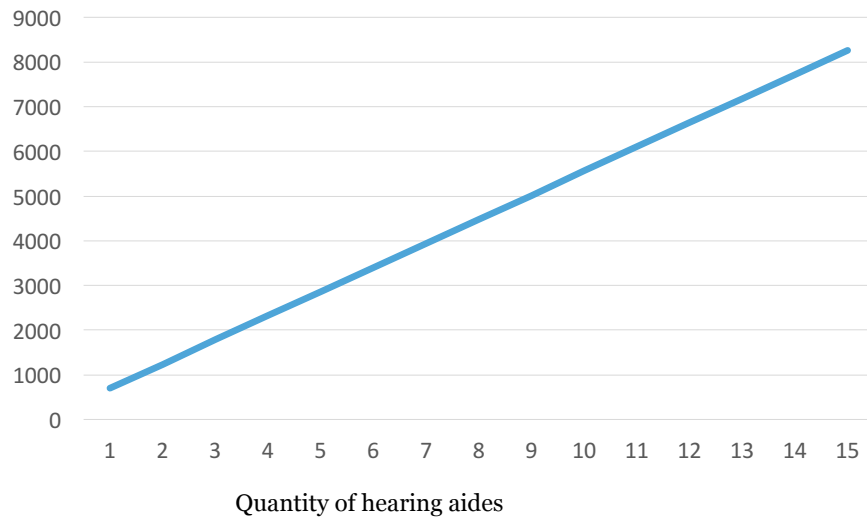
Concept of “economies of scale”

- When providers become more efficient with more patients then average costs will fall as scale increases
- At a certain scale average costs may increase again => “diseconomies of scale”





What are the average and marginal costs for this total cost curve?



Outline

1. Cost
2. Outcomes
 - Output vs. outcome
 - Health outcomes
 - DALYs and QALYs
3. Cost-effectiveness

Output vs. outcome

1. The cost per unit of output is valid when the two programs being compared are equally effective.
2. A cost per unit of outcome can address differences in effectiveness across programs.
3. The scope of the analysis is determined by the denominator. Only programs with a common denominator can be compared.



Photo by
Charles Steinberg, MD

Cost per unit of output

	5-day computer-based training plus 3-day workshop	10-day training plus on-site
Cost of transfer of learning		
Training	\$12,025	\$20,000
Supervision	\$8,000	\$2,000
Total cost	\$20,025	\$22,000
Cost per trainee	\$20,025/25=\$801	\$22,000/25=\$880

Cost per unit of intermediate outcome

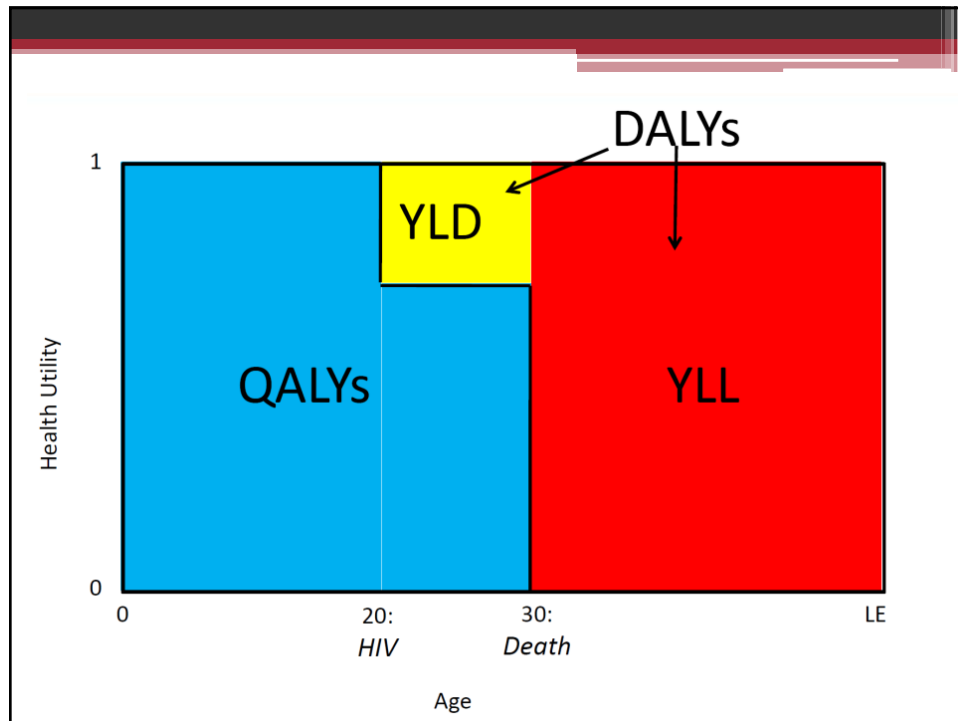
	5-day computer-based training plus 3-day workshop	10-day training plus on-site
Cost of transfer of learning		
Training	\$12,025	\$20,000
Supervision	8,000	\$2,000
Total cost	20,025	\$22,000
Trainees who meet standard	15	22
Cost per trainee who met standard	\$20,025/15 = \$1,335	\$22,000/22 = \$1,000

Health outcomes

- Some journals such as PLOS Med prefer manuscripts with health outcomes rather than intermediate outcomes
- HIV-related deaths or HIV infections averted can be used for CEAs
- DALYs or QALYs are used to compare interventions across different diseases

DALYs and QALYs

- Both are measure units of life as a combination of mortality and morbidity with weights for years lived with morbidity.
- QALYs measure quality of life where death is zero and full health is one.
- DALYs measure disability where zero is full health and one is death.
- Differ in objectives, how units of life are characterized, and methods for calculating the weights.



Summary

- **Cost analysis:** Compares the cost per unit of output when two programs are equally effective
- **Cost-effectiveness analysis (CEA):** Compares cost to outcomes, e.g. HIV infections averted or DALYs
- **Cost-utility:** Special case with effectiveness measured as QALYs

Outline

1. Cost
2. Outcomes
3. Cost-effectiveness
 - Incremental cost-effectiveness ratio
 - Threshold
 - Sensitivity analysis

Incremental cost-effectiveness ratio (ICER)

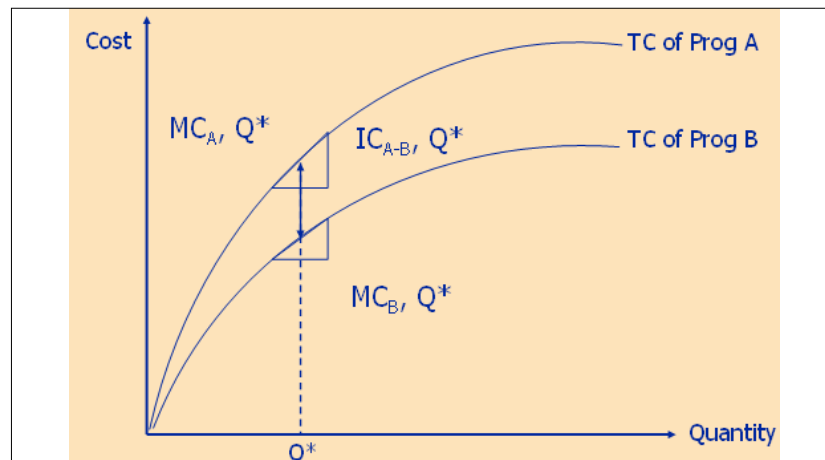
Δ Change in health care cost

Δ Change in health outcomes

Incremental costs

- Incremental costs are different from marginal costs.
 - Incremental cost is the cost of adding a new service or technology or intervention to current health services
 - Marginal cost is the cost of reaching one more person or producing one more output with a current health service

Incremental vs. Marginal Cost



PMTCT Cost per HIV infection averted

	Pre-training	Post-training
Program cost		
Remuneration	\$80,000	\$84,000
Supplies	15,000	18,000
Capital	5,000	10,000
Total Cost	\$100,000	\$112,000
Number of mother-infant pairs	1,000	1,200
Base case-vertical transmission	25%	25%
Number of HIV infections averted	$1,000 * .25 * .63 = 158$	$1,200 * .25 * .63 = 189$
Incremental cost	$\$112,000 - \$100,000 = \$12,000$	
Incremental effectiveness	$189 - 158 = 31$	
ICER	$\$12,000 / 31 = \381	

Determining the optimal HIV testing program

Program	Discounted cost (\$)	Discounted effectiveness (QALYs)	Incremental cost	Incremental effectiveness	ICER
Facility HIV testing	500,000	1,000			
Facility + home HIV testing	900,000	1,300			
Facility, home, and mobile HIV testing	1,200,000	1,400			

Willingness to pay threshold: \$1,400 per QALY gained

Determining the optimal cervical cancer prevention strategy

Program	Discounted cost (\$)	Discounted effectiveness (QALYs)	Incremental cost	Incremental effectiveness	ICER
Pap smear screening every 5 years	1,200,000	600			
HPV DNA testing every 5 years	2,500,000	900			
HPV DNA testing every 3 years	3,000,000	1,000			
HPV DNA testing every 2 years	3,600,000	1,070			

Willingness to pay threshold: \$5,700 per QALY gained

Thresholds

- Maximum that a country is willing to pay per QALY/DALY gained
- No consensus on threshold
- Commonly cited threshold for developing countries is country's GDP per capita
- Common threshold for high income countries is \$50,000-100,000 per QALY gained
- Recent research in England suggests it may be closer to \$20,000

Sensitivity analysis

- Calculation of alternative cost-effectiveness results when there is uncertainty about one or more parameters.
- It shows the extent to which uncertainty about a parameter would substantially affect the estimate.



PMTCT CEA with uncertainty

	Pre-training	Post-training
Total Cost	\$100,000	\$112,000
Number of mother-infant pairs	1,000	1,200
Base case-vertical transmission	25%	25%
Lower bound	19%	19%
Upper bound	30%	30%
Incremental cost	\$112,000 - \$100,000 = \$12,000	
ICER – base case		\$12,000/31 = \$381
Lower bound		\$12,000/24 = \$501
Upper bound		\$12,000/38 = \$317

Questions?



Photo by: Charles Steinberg

Contact

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CE Acceptability Curve

