Telemedicine Costs and Benefits

Telemedicina e eSaúde
2016/17
Pedro Brandão

References

• Sources are referred using [SourceRef], the last slide holds the complete reference

• Local references also appear using:
  • Source: CitationSource
Costs and Benefits

These slides are based on the paper:

“A comprehensive review of the literature suggests that there is a lack of concrete evidence with which to fully assess the economic impact of telemedicine.”

in [EcoEval]
Costs

- Fixed (FC): do not change with short term production (e.g.: cost of 1 physician is the same regardless of days patient stays in hospital)
- Variable Costs (VC): change with the production level (e.g.: medication, meals)
- Total Cost (TC): cost to produce a specific quantity
- Cost Function f(Q): cost to produce a quantity

Costs (cont.)

- Average Cost (AC): TC/Q cost per unit
- Marginal Cost (MC):
  - TC of (x+1) – TC of (x units)
  - d(TC)/dQ in x
  - Cost of producing an extra unit
  - E.g.: Cost of keeping a patient one day longer is (usually) less than the average cost per day
Cost evaluation

- Cost analysis: only accounts for costs, assuming identical results;
- Cost Effectiveness Analysis (CEA): accounts for costs according to a specific result (non monetary units); assumes only 1 result;
- Benefit Cost Analysis (BCA): accounts for costs and several results, both using monetary units.

Benefit Cost Analysis

- Detail economical costs and results of the program;
- Convert results to monetary units.

- Net benefit = total benefit – total cost
- Ratio = total benefit / total cost
Problems with BCA

- Sophisticate;
- Intensive data wise;
- Difficult to convert results to monetary units (health improvements, etc.);
- Lack of guidelines on how to do it.

More detail later...

Economic analysis criteria analysis

- Was a well defined question posed in answerable form?
- Was a comprehensive description of the competing alternatives given?
- Was the effectiveness of the programmes or services established?
- Were the important and relevant costs and consequences for each alternative identified?
- Were costs and consequences measured accurately in appropriate physical units?
- Were costs and consequences valued credibly?
- Were costs and consequences adjusted for different timing?
- Was an incremental analysis of costs and consequences of alternatives performed?
- Was allowance made for uncertainty in the estimates of costs and consequences?
- Did the presentation and discussion of the study results include all issues of concern to users?
Limits of telemedicine evaluations

- Limited generalizability: heterogeneous telemedicine programs;
- Different evaluation methods: lack of defined methodology and guidelines;
- Few complete analysis: most evaluations focus on costs without accounting for benefits from different perspectives;
- Lack of Random Controlled Trials (RCT);
- Lack of long term studies: which limits the sustainability study;
- Lack of quality data and appropriate measures;
- Small samples: which leads to lack of statistical significance.

Costs

CEA Approach

These slides are based on the paper
Indicators

- Benefits are accounted using the usual unit (days/hours, reduced days in hospital)
- Decision-maker can analyse ratio benefit/cost using the specific units:
  - €/(reduced days in hospital) ➔ savings per day
  - Trade-off/sacrifice

ICER

- Incremental Cost-Effectiveness Ratio
  \[
  \frac{\sum \text{costs}}{\sum \text{medical benefits}}
  \]
- Benefits are only of one type (e.g.: EITHER life-years gained OR reduced days in hospital; not both)
- Can be used also to compare:
  \[
  \frac{C_1 - C_0}{B_1 - B_0}
  \]
- Where:
  - C1 – Cost of new intervention or treatment, C0 – cost in control group
  - B1 – Benefits of new intervention or treatment, B0 – control group
ICER – USA Public health

- Defining a cost or resource allocation decision, including decision making objectives, and defining the program or intervention;
- Determining the decision model of costs and benefits;
- Specifying data and measures;
- Performing appropriate statistical, modelling, and sensitivity analyses;
- Reporting results understandable by decision makers and researchers.

QALY – Quality Adjusted Life Year

- 1 year of perfect health expectancy = 1
- 1 year of less than perfect life expectancy < 1
- Based on questionnaires for the utility.
  - People’s preference for health states
  - Negative: death preferred to vegetative state
- Measures Quality of Life (QoL)

From Oxford Univ.
QALY: examples

- Example 1:
  - Treatment: additional 4 years of life at quality life 0.6 \(\rightarrow\) 2.4 QALYs
  - No treatment: 1 year of life at 0.3 (1-0.7) \(\rightarrow\) 0.3 QALYs
  - QALYs generated by the intervention 2.1

- Example 2:
  - Intervention A: three years in health state 0.75 \(\rightarrow\) 2.25 QALYs
  - Intervention B: four years in health state 0.5 \(\rightarrow\) 2 QALYs
  - A is 0.25 QALYs better

Using the EQ-5D-3L

- Scores for the EQ-5D are generated from the ability of the individual to function in five dimensions (5D).

  - “Each of the five dimensions used has three levels (3L) – no problem, some problems and major problems – making a total of 243 possible health states, to which ‘unconscious’ and ‘dead’ are added to make 245 in total.”

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No problems walking about.</td>
<td>3. Unable to perform usual activities.</td>
</tr>
<tr>
<td>2. Some problems walking about.</td>
<td></td>
</tr>
<tr>
<td>3. Confined to bed.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-care</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No problems with self-care.</td>
</tr>
<tr>
<td>2. Some problems washing or dressing.</td>
</tr>
<tr>
<td>3. Unable to wash or dress self.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Usual activities (work, study, housework, leisure activities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No problems in performing usual activities.</td>
</tr>
<tr>
<td>2. Some problems in performing usual activities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pain/discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No pain or discomfort.</td>
</tr>
<tr>
<td>2. Moderate pain or discomfort.</td>
</tr>
<tr>
<td>3. Extreme pain or discomfort.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anxiety/depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not anxious or depressed.</td>
</tr>
<tr>
<td>2. Moderately anxious or depressed.</td>
</tr>
<tr>
<td>3. Extremely anxious or depressed.</td>
</tr>
</tbody>
</table>
ICER – Example

- Telecare ICER: 10 000 € / QALY gained
- Traditional solution ICER: 25 000 € / QALY gained

- Telecare better
  - But other restrictions could exist (lack of staff, resources, etc.)

Study – indicator selection

- Decision-makers:
  - Who are they?
  - Decide at level are the indicators (organization, society)

- Related to the objectives

- Based on the system to develop
  - E.g.: For wound consults, telephone consultation is not comparable to video-conference;
E.g.: at what level were costs evaluated [CEA-Key]

- TeleHomeCare study reviewed 23 articles (from an initial selection of 9978)

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>NO.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>Patient and organization</td>
<td>12</td>
<td>52%</td>
</tr>
<tr>
<td>Patient and professionals</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Patient, organization and community</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Patient, organization and professionals</td>
<td>6</td>
<td>26%</td>
</tr>
</tbody>
</table>

E.g.: Indicators [CEA-Key]

<table>
<thead>
<tr>
<th>EFFECTIVENESS INDICATORS</th>
<th>EXPECTED IMPACT WITH THE TELEHOME CARE PROJECT</th>
<th>IMPACT IN THE EXPECTED DIRECTION (REFERENCES)</th>
<th>TOTAL NO. OF STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of THC/video visits</td>
<td>Increase</td>
<td>Yes: 18, 19, 21, 23-26, 27-30, 31-34, 37</td>
<td>12</td>
</tr>
<tr>
<td>No. of outpatient visits</td>
<td>Reduction</td>
<td>Yes: 15, 19, 20, 23-27, 31-33, 37</td>
<td>9</td>
</tr>
<tr>
<td>No. of home visits</td>
<td>Reduction</td>
<td>Yes: 15, 19, 20, 23-27, 31-34, 37</td>
<td>9</td>
</tr>
<tr>
<td>No. of telephone interventions</td>
<td>No consensus about impact</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>No. of ER visits</td>
<td>Reduction</td>
<td>Yes: 10, 20, 21-23, 22, 33, 37</td>
<td>9</td>
</tr>
<tr>
<td>No. of hospitalizations</td>
<td>Reduction</td>
<td>Yes: 15, 18, 19, 22, 32-34, 37</td>
<td>9</td>
</tr>
<tr>
<td>No. of readmissions</td>
<td>Reduction</td>
<td>Yes: 17, 20, 28, 29</td>
<td>3</td>
</tr>
<tr>
<td>Length of all visits (minutes)</td>
<td>No consensus about impact</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Average travel time for professionals (minutes)</td>
<td>Reduction</td>
<td>Yes: 10, 21-24, 25, 28, 30, 34, 36</td>
<td>9</td>
</tr>
<tr>
<td>Average travel time for patients (minutes)</td>
<td>Reduction</td>
<td>Yes: 15, 20-25, 30-34, 36</td>
<td>1</td>
</tr>
<tr>
<td>Average distance covered by the professionals (km)</td>
<td>Reduction</td>
<td>Yes: 23, 26, 30, 34, 36</td>
<td>5</td>
</tr>
<tr>
<td>Average length of call intervention (minutes)</td>
<td>No consensus about impact</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Average length of hospitalization (beds)</td>
<td>Reduction</td>
<td>Yes: 15, 17, 20, 21, 26, 29, 32, 33</td>
<td>8</td>
</tr>
<tr>
<td>Quality of life</td>
<td>Increase or no change</td>
<td>Yes: 10, 17, 20, 31-33, 35, 37</td>
<td>8</td>
</tr>
</tbody>
</table>

THC: telehomecare; ER: emergency room; NS: not specified.
E.g.: Cost Indicators [CEA-Key]

- Example for defining a metric to incorporate several benefit indicators
  - \[%\text{Change} = (\text{THC} - \text{SC})/\text{SC}\]

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>THC</th>
<th>SC</th>
<th>% CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of outpatient visits</td>
<td>10</td>
<td>15</td>
<td>-33%</td>
</tr>
<tr>
<td>No. of home visits</td>
<td>5</td>
<td>25</td>
<td>-80%</td>
</tr>
<tr>
<td>Average change</td>
<td></td>
<td></td>
<td>-57%</td>
</tr>
<tr>
<td>Global change score</td>
<td></td>
<td></td>
<td>57%</td>
</tr>
</tbody>
</table>

THC, telehomecare; SC, standard care.

Home visits decrease ➔ improvement
E.g.: Results [CEA-Key]

Some points

• Only one of the studies calculated ICER:

\[
\frac{\sum \text{costs}}{\sum \text{medical benefits}}
\]

• Different indicators used

• Nevertheless: telehomecare is cost efficient in in 91% of studies
Costs

BCA Approach


Evaluation points

• Perspective
  • Patient, provider, physician, tax payer, insurance company, hospital, etc.

• Costs and benefits will be different according to perspective
### Costs

<table>
<thead>
<tr>
<th>CLIENT = PATIENT</th>
<th>PROVIDER</th>
<th>OTHER STAKEHOLDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Time costs (employment, classroom time, or leisure)</td>
<td>• Equipment=technology (capital investment)</td>
<td>• Costs to the taxpayer from expanded coverage and payment of telemedicine services in Medicare and Medicaid</td>
</tr>
<tr>
<td>• Medical costs (out-of-pocket)</td>
<td>• Depreciation Facilities (office space)</td>
<td>• Costs to private insurers from expanded coverage and payment of telemedicine services and costs to their clients if, as a result, insurance premiums increase</td>
</tr>
<tr>
<td><strong>Variable Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Maintenance and repairs</td>
<td>• Loss of productivity (work absences) for the employer from workers’ participation in a program</td>
</tr>
<tr>
<td></td>
<td>• Telecommunication costs (connections, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Administrative support and supplies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wages to technicians</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wages to staff</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Other expenses</td>
<td></td>
</tr>
<tr>
<td><strong>Other costs: setup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Travel (transportation, accommodation, per diem; travel time)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Other expenses (program promotion, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

### Benefits – Patients

Indirect gains should be accounted

- Telemedicine ➔ medication compliance ➔ quicker recovery

- Medical effectiveness
  - Reduced morbidity
  - Avoided mortality

- Employment
  - Increased earnings

- Healthcare services and others
  - Increased access to healthcare
  - Increased health knowledge/ability for self-care
  - Faster/accurate diagnosis and treatment
  - Reduced waiting and/or consultation time
  - Increased medication adherence

- Decreased travel
  - Increased employment/leisure/classroom time
  - Avoided travel expenditures: transportation, accommodation, and other expenses
  - Decreased risk of job loss: less time away from work for travel
Benefits – Providers

Again, indirect gains should be accounted:

- Telemedicine ➔ medication compliance ➔ reduced hospital stay

Benefits – Others

- Worker productivity increase (less travels, less time ill, etc.);
- Avoid disease spread/infection;
- Access to healthcare to special groups (in prisons, etc.)
Converting benefits

- From the authors of [ValueStaLife]
  - Average value for a lifetime USA worker at its peak age is approx.:
    - $7 million (value in 2000)
    - $4-$10 million (2012) ([ValueStaLife2012])

\[
\text{benefit} = \frac{\text{ValueOfLife}}{\text{AvgLifetime} - \text{CurrentAge}} \times \text{QALY}
\]

This article reviews more than 60 studies of mortality risk premiums from ten countries and approximately 40 studies that present estimates of injury risk premiums. This critical review examines a variety of econometric issues, the role of unionization in risk premiums, and the effects of age on the value of a statistical life, from [ValueStaLife]

See also this article
From the NY Times

Converting Benefits (cont.)

- Direct (or nearly):
  - Hours lost/gained at work;
  - Hours of leisure lost/gained;
  - Trips done/not needed;

- QALY indirect:
  - Greater access to healthcare;
  - Quicker diagnosis;
Converting Benefits (cont.)

- Hospital Costs
  - Reduced hospital admissions;
  - Reduced lab tests;

- WTP – Willingness to Pay
  - Max value that a user is willing to pay in different scenarios;
  - Customer satisfaction “can” be measured with WTP;

WTP example [WTP-Ex]

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Time until in-person visit</th>
<th>Time until telemed visit</th>
<th>% prefer telemedicine</th>
<th>% willing to pay</th>
<th>WTP Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 weeks</td>
<td>2 days</td>
<td>73</td>
<td>95</td>
<td>$25 ($5-$500)</td>
</tr>
<tr>
<td>2</td>
<td>2 days</td>
<td>2 days</td>
<td>19</td>
<td>58</td>
<td>$25 ($10-$125)</td>
</tr>
</tbody>
</table>

- Study from 2006
- In-person questionnaire to 92 candidates
- All patients with history of psoriasis or melanoma
- Targeted for teledermatology
### Some conversion examples – Patient

<table>
<thead>
<tr>
<th>Result</th>
<th>Unity</th>
<th>Conversion factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced morbidity</td>
<td>QALY change</td>
<td>check <code>ValueOfLife</code> formula</td>
</tr>
<tr>
<td>Increase work pay</td>
<td>Hours/days not lost</td>
<td>Average work pay per day/hour</td>
</tr>
<tr>
<td>Quicker diagnosis</td>
<td>Indirect effect: QALY</td>
<td>check <code>ValueOfLife</code> formula</td>
</tr>
<tr>
<td>Reduced consult time</td>
<td>Hours/days not lost</td>
<td>Average work pay per day/hour</td>
</tr>
<tr>
<td>Trips/transport</td>
<td>Distance</td>
<td>Cost of trip/allowance</td>
</tr>
<tr>
<td>Trips/lodging</td>
<td>Average cost per day</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### Conversion examples – Provider

<table>
<thead>
<tr>
<th>Result</th>
<th>Unity</th>
<th>Conversion factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced hospital stay</td>
<td>Days</td>
<td>Specific hospitalization cost per day (speciality, etc.)</td>
</tr>
<tr>
<td>Reduced lab tests</td>
<td>Number</td>
<td>Test cost</td>
</tr>
<tr>
<td>Reduced consultations</td>
<td>Number</td>
<td>Cost of physician/specialist/nurse</td>
</tr>
<tr>
<td>Increase medication compliance</td>
<td>Indirect effect:</td>
<td>Specific cost</td>
</tr>
<tr>
<td></td>
<td>reduced hospital stay, consultations, etc.</td>
<td></td>
</tr>
<tr>
<td>Productivity increase</td>
<td>Hours or days</td>
<td>Cost of physician/specialist/nurse</td>
</tr>
<tr>
<td>Trips/transport</td>
<td>Distance</td>
<td>Cost of trip/allowance</td>
</tr>
<tr>
<td>Trips/lodging</td>
<td>Average cost per day</td>
<td>1.0</td>
</tr>
</tbody>
</table>

---

1. `ValueOfLife` formula

---
### Conversion examples – Other

<table>
<thead>
<tr>
<th>Result</th>
<th>Unity</th>
<th>Conversion factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased worker productivity</td>
<td>Hours/days of avoided absence</td>
<td>Average work pay per day/hour</td>
</tr>
<tr>
<td>More efficient access for special groups (prisons,...): transport costs, staff (wardens, etc..)</td>
<td>Distance to the healthcare facility and work days/hours</td>
<td>Trip cost and workers’ pay</td>
</tr>
<tr>
<td>Contagion decrease</td>
<td>Number of</td>
<td>Average costs per case e losses by disease</td>
</tr>
</tbody>
</table>

**MAST – Model for ASsessment of Telemedicine**

- “used as a basis for decision making in EU and the European countries in decisions on use of telemedicine applications.”
  - results from the MethoTelemed project

- **Multidisciplinary assessment:**
  - Health problem and characteristics of the application
  - Safety
  - Clinical effectiveness
  - Patient perspectives
  - Economic aspects
  - Organisational aspects
  - Socio-cultural, ethical and legal aspects
MAST Domain 5: Economic aspects

- Uses mostly BCA approach
- Estimation of costs
- Report:
  - Average use per patient of resources in programme A and B
  - Average costs per patient for each resources
  - Total costs per patient
  - Incremental analysis of costs and consequences, e.g. cost-effectiveness ratio
  - Sensitivity analysis
- Business case
  - Return On Investment (ROI)
- Data collection
  - RCT, systematic literature review, interviews, patients diaries, etc.

In summary

- Costs and benefits
- Limits on (tele)medicine evaluation
- Several methodologies for analysis
  - Cost evaluation, CEA, BCA
- Conversion of benefits to monetary units (in BCA)
End of Telemedicine Cost/benefit

Acronyms

- BCA – Benefit Cost Analysis
- CEA – Cost Effective Analysis
- EHR – Electronic Health Record
- HON – Health On the Net
- ICD – International Classification of Diseases
- ICF – International Classification of Functioning, Disability and Health
- ICHI – International Classification of Health Interventions
- ICPC – International Classification of Primary Care
- LOINC – Logical Observation Identifiers Names and Codes
- MeSH – Medical Subject Headings
- OMS – Organização Mundial de Saúde
**Acronyms**

- PIP – Picture In Picture
- QALY – Quality-Adjusted Life-Year
- RCT – Randomized Controlled Trial
- RIM – Reference information Model
- SAP – Service Access Point
- SNOMED CT – Systematized Nomenclature of Medicine Clinical Terms
- UL – Upper Layer
- UMLS – Uniform Medical Language System
- WHO – World Health Organization
- WTP – Willingness To Pay

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**Other references**

- [MAST-EconPres] Kristian Kidholm, Odense University Hospital, “Domain 5: Economic aspects”, MAST program presentation for economics
More references

  - Example of Cost

  - Example of CEA
