DECISION ANALYTIC MODEL FOR COST-EFFECTIVENESS ANALYSIS OF BARIATRIC SURGERY: A SYSTEMATIC REVIEW

Septiara Putri

Center for Health Economics and Policy Studies
Institute of Health and Wellbeing, The University of Glasgow
Introduction

• Obesity has considered as one of public health concerns

• World Health Organization (WHO) defines obesity as a condition when a person has BMI (Body Mass Index) more or equal to 30 kg/m², and considered overweight where the BMI is greater or equal to 25 kg/m²

• Overweight and obesity also associated to increasing risks of several chronic diseases, including: diabetes, hypertension, stroke, heart disease, digestive complications, cancers, gall bladder, kidney, and liver complication
Introduction

- Weight loss surgery, familiarly bariatric surgery became alternative approach for obesity treatment. This surgical procedure is able to prevent some calories and nutrients absorption, restrict food intake and stimulates hormonal change for severely obese people.
- Bariatric surgery furthermore considered providing potential clinical effectiveness in terms of lower mortality risk and complications.
- The American Society for Metabolic and Bariatric Surgery reported that this procedure performed about 200,000 per year during 2008 to 2009.
- Although some evidence presented that bariatric surgery is a favorable treatment, there is still relatively a costly procedure. Additional costs also may exist after surgery.
- Therefore, economic evaluation and the information of its analysis become the important part in order to provide high level of evidence for this weight loss treatment.
Objective

• To summary and review critically the evidence for cost-effectiveness of bariatric surgery, particularly those that were conducted with decision model approach.

• All related-summarized evidence are expected to be captured and systematically assessed, to provide the description of evidence qualities for cost-effectiveness study of bariatric surgery.
Methods

The criteria for this systematic review were following the PICOS (Population, Intervention, Comparator(s), Outcome(s) and Study Design approach).

Table. 1 Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th></th>
<th>Inclusion</th>
<th>Exclusion</th>
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<tbody>
<tr>
<td>Population</td>
<td>Adults</td>
<td>Pregnant condition</td>
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<tr>
<td></td>
<td>Obesity/overweight, severe/morbid obesity</td>
<td>Only focus in diabetics patient</td>
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<tr>
<td></td>
<td>BMI ≥ 30 kg/m²</td>
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<tr>
<td>Intervention</td>
<td>Bariatric surgery</td>
<td>-</td>
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<tr>
<td>Comparators</td>
<td>Conventional/conservative, non-surgical strategy, do nothing, diet,</td>
<td>Other types of surgical procedures, standard</td>
</tr>
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<td></td>
<td>Standard treatment for obesity</td>
<td>treatment for diabetes</td>
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<td>Outcomes</td>
<td>ICER*, all related utilities (i.e: QALY**, DALY***, life years gain,</td>
<td>-</td>
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<td></td>
<td>weight reduced)</td>
<td></td>
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<tr>
<td>Study Design</td>
<td>CEA**** (decision tree, Markov, other decision analytic model), full</td>
<td>Except CEA, review, guidelines, systematic review</td>
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<tr>
<td></td>
<td>text original researchj, no limit for sample size and time horizon</td>
<td>of economic evaluation, non-English studies</td>
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</tbody>
</table>

*Incremental Cost Effectiveness Ratio  
**Quality Adjusted Life Years  
*** Disability Adjusted Life Years  
**** Cost effectiveness analysis
Methods

Data sources and searches

• The evidence searching was conducted into two parts, electronic searching and manual/reference lists searching. Databases that were used: MEDLINE, EMBASE and The Cochrane Library.

• The search was carried out in December 2014. In electronic database searching, it was limited for publication year, only from 2000 until 2015.

• Appropriate terms that applied (with appropriate truncations and Boolean connectors): “bariatric surgery”, “obesity”, “economic evaluation”, “cost effectiveness analysis”. Note that all synonyms related were applied (i.e: overweight, and all types of surgery such as laparoscopic, gastric banding, Roux-en-Y and so on).
Methods

Data extraction and synthesis

• Duplication, data abstraction, and management of studies obtained were using EndNote X6 application. The summary of data were extracted and summarized following PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guideline.

Data analysis

• All full-text evidence (except abstracts) that had been collected were critically appraise and qualitatively reported using critical appraisal form by Drummond et al. The simple matrix is described following Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist form - describing the rapid assessment of studies obtained.
Screening

Records after duplicates removed (n = 96)

Records screened (n = 72)

Full-text articles assessed for eligibility (n = 24)

Studies included in qualitative synthesis (n = 13)

Studies included in quantitative synthesis (meta-analysis) (n = -)

Eligibility

Included

Identification

MEDLINE (16)
EMBASE (50)
Cochrane (32)
Total (n=98)

Reference lists (n = 4)

Records excluded (n = 24)

Full-text articles excluded (n = 11)
### Results

Table 2. Summary of studies

<table>
<thead>
<tr>
<th>Study author</th>
<th>Year</th>
<th>Country</th>
<th>Intervention(s) / comparator(s)</th>
<th>Model types</th>
<th>Perspectives</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clegg et al. [16]</td>
<td>2002</td>
<td>UK</td>
<td>Surgery vs nonsurgical management</td>
<td>Decision model</td>
<td>UK healthcare system</td>
<td>ICER around £20,000/QALY</td>
</tr>
<tr>
<td>Craig and Tseng [17]</td>
<td>2002</td>
<td>USA</td>
<td>Gastric bypass vs no treatment</td>
<td>Decision tree</td>
<td>Payer</td>
<td>ICER US$5000 to US$16,100/QALY (women); US$10,000 to US$35,600/QALY (men)</td>
</tr>
<tr>
<td>Salem et al. [18]</td>
<td>2008</td>
<td>USA</td>
<td>Laparoscopic adjustable gastric banding (LAGB) and Laparoscopic Roux-en-Y gastric bypass (LRYGB) vs non operative</td>
<td>Decision tree</td>
<td>Payer</td>
<td>ICER LRYGB and LAGB &lt; $25,000/QALY</td>
</tr>
<tr>
<td>Picot et al. [19]</td>
<td>2009</td>
<td>UK</td>
<td>Bariatric surgery vs non-surgical treatment</td>
<td>Markov</td>
<td>UK healthcare system</td>
<td>ICER &lt;£20,000/QALY</td>
</tr>
<tr>
<td>Campbell et al. [20] Chang et al. [21]</td>
<td>2010</td>
<td>USA</td>
<td>LAGB or LRYGB or no treatment</td>
<td>Markov</td>
<td>n/a</td>
<td>ICER LAGB/LRYGB &lt; US$ 25,000/QALY</td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td>USA</td>
<td>Bariatric Surgery in different population</td>
<td>Decision Tree</td>
<td>n/a</td>
<td>ICER US$2413/QALY (ORD group), US$3872/QALY (non-ORD group) Mean cost €33,870 and €50,495</td>
</tr>
<tr>
<td>Maklin et al. [22]</td>
<td>2011</td>
<td>Finland</td>
<td>Bariatric surgeries vs standard care</td>
<td>Decision tree and Markov</td>
<td>Finnish healthcare system</td>
<td></td>
</tr>
<tr>
<td>Faria et al. [23]</td>
<td>2013</td>
<td>Global</td>
<td>Best medical management, gastric band, and gastric bypass</td>
<td>Markov</td>
<td>Societal</td>
<td>ICER €13,071 /QALY (Gastric bypass dominated best medical management and gastric band)</td>
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<td><strong>Lee et al.</strong> [25]</td>
<td>2013</td>
<td>Australia</td>
<td>Laparoscopic adjustable gastric banding (LAGB) and do nothing in different scenarios</td>
<td>Markov</td>
<td>Health sector and third parties payer</td>
<td>ICER &lt; $50 000/DALY</td>
</tr>
<tr>
<td><strong>Wang et al.</strong> [26]</td>
<td>2014</td>
<td>USA</td>
<td>Bariatric surgeries vs non-surgical treatment</td>
<td>Decision Analytic and regression</td>
<td>Healthcare system</td>
<td>ICER US$6,600, US$6,200 and US$17,300/QALY LRYGB, LAGB and ORYGB respectively vs. Non surgical intervention</td>
</tr>
<tr>
<td><strong>Borg et al.</strong> [27]</td>
<td>2014</td>
<td>Sweden</td>
<td>Gastric Bypass Surgical (GBS) vs conventional treatment</td>
<td>Markov</td>
<td>Societal</td>
<td>ICER €18,000/QALY</td>
</tr>
<tr>
<td><strong>Borisenko et al.</strong> [28]</td>
<td>2015</td>
<td>Sweden</td>
<td>Gastric Bypass Surgical (GBS) vs conservative management</td>
<td>Markov</td>
<td>Swedish healthcare payer perspective</td>
<td>ICER&lt; €35,526/QALYs</td>
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</table>

Decision tree was applied for each studies, longer and lifetime time horizon was also considered. Gastric bypass indicated cost-effective with ICER around £20,000/QALY and US$5000 to US$16,100/QALY (women); US$10,000 to US$35,600/QALY (men).

Similarly, Salem et al concluded that bariatric procedure was potentially cost-effective. All of them conducted sensitivity analysis for testing the studies’ robustness.

Several aspects that may be influencing study results were excluded, such as: comorbidities in severe obese.

The major issue from Craig and Tseng studies is they obtained data from time series study, which is subject to selection bias.

The probabilities for the model and some assumptions also could not fully representative, since there was lack of data for supporting CEA.
• Picot *et al* and Campbell *et al* confirmed the favorability of bariatric surgery.

• Both of them had potential cost-effectiveness. When compared to no treatment, incremental QALY was higher for both LAGB and LRYGB, 2.04 and 2.9 respectively.

• Picot *et al*, conducting Markov model, which are requiring data for parameters, however data for quality of life—which is the important elements were very limited, and it was impacting the result of the model.

• The clinical evidence obtained by Picot *et al* was systematically well-defined, the ICER around he ICERs ranged from £2000 to £4000 /QALY. Moreover, there is questionable explanation of cost incurred in the study.
Results

• Study by Chang et al conducted CEA with decision tree application, examined the cost-effectiveness of bariatric surgery in different specific population, in this case comparing obese patients with obesity-related diseases to obese people without comorbidities across different BMI categories.

• The effectiveness data were derived from meta-analysis. For people whose BMI more than 30 kg/m² and BMI 35 kg/m² with or without obesity-related comorbidities the intervention was cost effective.

• The study has more explanation in terms of effectiveness, for costs however there was less explanation about cost that included in the study, even it was clear enough for total cost adjustment.

• The published studies included actually could be added, it influences the ICER results, uncertainty also appeared particularly in cost data. Additionally, for the model, that seemed to be difficult for capturing disease progression due to the model was not time-varying.
• CEA with 10 years time horizon, comparing bariatric surgery (sleeve gastrectomy, gastric banding and gastric bypass) versus standard care was conducted by Maklin et al. They reported that bariatric surgery was cost-effective.

• Medical cost excluded from this study, the issue perhaps arise in cost estimation.

• Three different procedures for weight loss management was assessed by Faria et al. Those strategies are: gastric band, gastric bypass and medical management for morbidly obese patient, not only that this study conducted subgroup analyses as further assessment. Owing to cost and effect, gastric bypass is most favorable surgery and able to save approximately €13,244/patient.

• After sub group analyses, the benefit of intervention could be higher in patients with a BMI between 40 and 50 kg/m². Not too different with this study, bariatric surgery considered to be cost effective intervention.

• Song et al conducted CEA for Korean population setting and applying combination of decision tree and Markov model for analysis. The ICER was US$ 1,771/QALY. It was determined by WHO guideline because Korea did not establish the threshold yet. For epidemiological data, they used cross sectional data with small subject in selected BMI level, sample size therefore may be not representative. This study really limited in terms of generalizability.
• Cost effectiveness of LAGB for all morbidly obese people, specifically in adults, were examined by Lee et al. Two scenarios were conducted. First one is LAGB for people with BMI >35 and LAGB for BMI >40, ‘do nothing’ acted as comparator.

• In Australia, LAGB surgery is cost effective with the cost-effectiveness threshold in Australia that is $50 000/DALY. Several parameters were unavailable in sensitivity analyses, consequently the uncertainty could not fully captured.

• There are three studies published around 2014-2015, one from USA and two from Sweden. One of them used societal perspectives, two other studies on the other hand used health care system perspectives. For studies from Sweden the intervention was focusing in one type of bariatric surgery, gastric bypass.

• Wang et al evaluated the cost effectiveness of three surgical procedures, conventional (open) Roux-en-Y gastric bypass (ORYGB), laparoscopic adjustable gastric banding (LAGB) laparoscopic gastric bypass (LRYGB) compared to no surgery. All the scenarios did not exceed the ICER, that has a threshold US $50,000 per QALY gained. The ICERs for those procedures were US$ 17,300/QALY, US$ 6,600/QALY, US$ 6,200/QALY for ORYGB, LRYGB, LAGB respectively
• Borg *et al* and Borisenko *et al* concluded that bariatric surgery is cost effective. ICER resulted for both studies were ICER €18,000/QALY and ICER< €35,526/QALY respectively.

• Same as study by Song *et al*, the threshold were not determined yet, however the result was acceptable for Swedish setting. Sensitivity analyses also included important parameters that were testing the study robustness, although uncertainty remains exists in terms of BMI development.

• Moreover, for the next study, again, the main issues were lack of data about clinical aspects for the treatment whether decision analytic model is the process to represent the real information or progression of cost and effect. There was no subgroup analysis which able to define potential population related to intervention.
Results

• Generally, according to review above, bariatric surgery is potentially cost effective. Despite study qualities, the studies reporting were relatively acceptable. However, after this critical review, there are several points that could be noted.

• First, there is need further research for data availability, mostly used observational data that can produce potential bias, RCT would highly required to support decision model. The main problem is the important part in decision model, that is quality of life (QoL), consequently the less firm results appears particularly in sensitivity analysis.

• Second, there were imbalance explanation about cost and effectiveness, sometimes effectiveness evidence were fulfilled or fully explained but costs information were less clear. Inevitably, it was associated with studies’ assumptions.

• Third, there is small explanation about model analysis, for instance half cycle correction or assumption how model is established. Additionally, transition probability from published study, it is important to involved high and several number of evidence to make model more representative. Forth, longer time horizon can be investigate the magnitude both cost and effect, therefore further studies over 5 or 10 years is needed.
• The systematic review finding about the favorable of bariatric surgery is consistent with previous studies.

• Wang et al conducted literature review for cost effectiveness model of bariatric surgery. They search article only from one database, PubMed and limited the inclusion criteria only to five years.

• For study analyses, Wang et al divided the analysis into three parts of long-term model: Markov, statistical analysis and assumptions. Assumptions were applied in studies by previous studies, the Markov application, moreover were described systematically. The similarities from this study are that we determined general population of obesity people, we excluded condition related diabetes, we analyzing focusing in methods. However, this study provide longer period searching with various databases, also the focused exclusion and inclusion criteria. It is therefore expected to enrich the information in terms of cost effectiveness model of bariatric surgery.
Discussions

• A systematic review has reported by Padwal et al in 2010. They not only reported economic evaluation in bariatric surgery, but also its clinical outcomes. Similarly, they obtained 13 studies, however they did not make difference in population included in review. Patients with focus on diabetics remains included, the comparators were not only non surgical treatment but also surgical procedures.

• One report by Stephenson and Hogan also concluded that bariatric surgery was appears as cost-effective procedure. They conducted systematic review in clinical effectiveness and cost effectiveness. In contrast with this study, they included all potential evidence related for bariatric surgery, therefore the comparator was not focused in non-surgical-the report reviewed intervention compare to another intervention (general statement for economic evaluation). Overall, this study and previous studies provides a concern in terms of data limitation of quality of life.

• Overall, this study tried to capture cost-effectiveness model for bariatric surgery with focused research question, inclusion and exclusion criteria. Several updated studies from 2011-2015 enrich the findings, particularly when we see the literature included from previous studies.
Discussion

There were remains limitations in this study:

1. we only used three large databases.

2. we limited our search only in English and full text, therefore the non-English literature were unable to be captured and grey literature may provide more information.

3. our findings could not interpreted directly, since all literature included has distinguish assumptions and data used included in the model this study provides updated evidence and explicit systematic studies’ criteria for literature from years 2010-2015.
Conclusions

- Bariatric surgery procedure is considered as cost effective treatment for excess weight.

- However, in general, it remains questions in model validity and assumptions due to data availability. Decision analytic modeling mostly used published study and the purpose is to describe the real process of intervention with possible health states.

- Then, data is crucial part for modeling, as a result of limited data high uncertainty reported in several literatures. This study present the summary and assessment of current evidence of cost-effectiveness model of bariatric surgery that can be contributed to provide economic evaluation evidence for healthcare intervention.
THANK YOU