Building a tool to support the planning of Long-Term Care networks under complexity: Dealing with multiple objectives, uncertainty and policy strategies

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Agenda

1. Long-term care
2. Research objectives
3. Previous research
4. Structuring the problem
5. Methodology
6. Case study
7. Conclusions
8. Future research
I. Long-term care

European context

- Budget constraints
- Increasing Demand for LTC
- Inadequate public LTC Supply

Demographic trends
- Ageing phenomenon
- Old-age dependency ratios

Social determinants
- Changes in family structures
- Income & poverty risk

Health status
- Increasing prevalence of chronic diseases
- Functional status decay

Care provision
- Inadequate utilization of acute care services
- Private vs Public provision
1. Long-term care

European context

- Budget constraints
- Increasing Demand for LTC
- Inadequate public LTC Supply

Planning networks of LTC ranks high on the health policy agenda of many European countries...

- Ageing phenomenon
- Old-age dependency ratios
- Changes in family structures
- Income & poverty risk
- Increasing prevalence of chronic diseases
- Functional status decay

Demographic trends

Social determinants

Health status

Care provision

- Inadequate utilization of acute care services
- Private vs Public provision
1. Long-term care

... including in Portugal

NHS-based system & National Network of Long-Term Care (RNCCI) targeting coverage for all those in need from 2012 onwards

**LTC providers**

- Public hospitals
- Primary health care centers
- Private hospitals
- Private non-profit making institutions

**Services**

- Institutional care
- Home-based care
- Ambulatory care

*Misericórdias have been the largest provider in the RNCCI 52% of the total contracts within the RNCCI*

Barros et al., 2011
Ministry of Health and Ministry of Labor and Social Solidarity, 2006
II. Research objectives

Initial network of LTC

Opening/closure of services?
Who receives care, and in which service?
How many beds and human resources are needed? And how to organize it?

How to plan & reorganize a network of LTC?
II. Research objectives

Opening/closure of services?
Who receives care, and in which service?
How many beds and human resources are needed? And how to organize it?
III. Previous research

Optimization models have been widely used for supporting health care planning

Aim at minimizing or maximizing an objective function, being this objective dependent on a finite number of decision variables and constraints

Four main components:
Decision variables, Constraints, Objective & Data
III. Previous research

Optimization models have been widely used for supporting health care planning

Planning under uncertainty
- Bruni et al. (2006)
- Abdeladiz and Masmoudi (2012)
- Cardoso et al. (2015)

Multi-objective planning
- Stummer et al. (2004)
- Mitropolous et al. (2006)
- Smith et al. (2012)
- Shroff et al. (1998)
- Cardoso et al. (2016)

Impact of policy strategies
- Maenhout & Vanhoucke (2013)

Commonly making use of a limited number of objectives & Health and wellbeing benefits not commonly considered

No study comprehensively addresses all these features
III. Previous research

Optimization models have been widely used for supporting health care planning.

**Planning under uncertainty**
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- Mestre et al. (2015)
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**LTC Planning Tool**

No study comprehensively addresses all these features.

**Impact of policy strategies**

Commonly making use of a limited number of objectives & Health and wellbeing benefits not commonly considered.

**Our Proposal**
III. Previous research

And for that purpose...

Planning tool based on optimization models to support the planning of LTC networks in the context of a NHS-based system that allows...

- Planning the delivery of multiple services (institutional, home-based and ambulatory services)
- Pursuing multiple, and often conflicting, policy objectives
- Exploring the impact of uncertainty in the demand and the delivery of care
- Exploring the impact of policy strategies outside the LTC sector
IV. Structuring the problem

Structuring policy objectives

Policy Objectives

Equity

- Equity of Access
- Geographical Equity
- Socioeconomic Equity
- Equity of Utilization

Cost

Health & Wellbeing Benefits

- Health Gains
- Wellbeing Improvements

Sources: Baker (2000); Ministry of Health (2006); Kruk and Freedman (2008); Barros et al. (2011); Flynn et al. (2015)
IV. Structuring the problem

Structuring uncertainty

Number of individuals in need & LOS

Scenario tree approach

P

90% CI

Stage 1 (t=1)
Stage 2 (t=2)
Stage 3 (t=3)
IV. Structuring the problem

Structuring health policy decisions impacting LTC

- Converting acute hospitals into LTC units
- Transferring resources to the LTC sector
- Changing the LTC provision paradigm

<table>
<thead>
<tr>
<th>Policy strategy</th>
<th>Hospital conversion</th>
<th>Transfer of resources (HR, MR, or FR) from acute care to LTC</th>
<th>LTC provision paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI</td>
<td>Yes</td>
<td>Yes</td>
<td>Community-based</td>
</tr>
<tr>
<td>PS II</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS III</td>
<td>No</td>
<td>No</td>
<td>Institutional-based</td>
</tr>
<tr>
<td>PS IV</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS V</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS VI</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HR: Human Resources; MR: Material Resources; FR: Financial Resources

6 Policy Strategies (PS)
V. Methodology

Optimization model: Defining the objectives

- Maximize Equity
  - Maximize Equity of Access
  - Maximize Geographical Equity
  - Maximize Socioeconomic Equity
  - Maximize Equity of Utilization
- Minimize Costs
- Maximize Health & Wellbeing Benefits
  - Maximize Health Gains
  - Maximize Wellbeing Improvements

Which combination of objectives should be considered?
## V. Methodology

### Optimization model: Defining the constraints

<table>
<thead>
<tr>
<th><strong>Resources requirements</strong></th>
<th>Number of beds and human resources (HR) needed per type of LTC service.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reallocation constraints</strong></td>
<td>Beds and HR preferentially kept in their original service whenever a lack of resources exists in that service.</td>
</tr>
<tr>
<td><strong>Capacity thresholds</strong></td>
<td>Minimum and maximum numbers of beds and/or patients per service.</td>
</tr>
<tr>
<td><strong>Opening and closure of services</strong></td>
<td>Opening/closing a service is not allowed after deciding upon closing/opening it – only applied to IC services.</td>
</tr>
<tr>
<td><strong>Single and closest assignment</strong></td>
<td>Individuals in each demand point cannot be split, and must receive care in the closest available service.</td>
</tr>
<tr>
<td><strong>Equity satisficing levels</strong></td>
<td>Satisficing levels of equity of access, equity of utilization, socioeconomic equity and geographical equity are imposed.</td>
</tr>
</tbody>
</table>
Optimization model: Planning decisions

Decisions

- Where to open/close services?
- How much to invest in new beds?
- How should patients be allocated to LTC services?
- How much capacity should be in place (beds and human resources)?
VI. Case Study

The model was applied to the county level of the Great Lisbon region for the 2016-2018 period.
VI. Case Study

Data-set used
VI. Case Study: Data-set used

**Data-set used**

- Experts’ information
- LTC supply
- Travel time
- Costs and budget
- Number of individuals in need
- LOS

**Uncertain data**

**Deterministic data from literature**

**Proxy: Wellbeing improvements**

determined using the ICECAP-A instrument

Proxy: QALYs determined using the EQ-5D questionnaire

Health gains

Wellbeing improvements

Number of individuals in need

Costs and budget

Travel time

LTC supply

Experts’ information

**Proxy: Wellbeing improvements**

determined using the ICECAP-A instrument

Proxy: QALYs determined using the EQ-5D questionnaire

Health gains
VI. Case Study: Data-set used

Different planning contexts may arise and should be analysed!

Data-set used

Which objectives should be pursued?

Policy Objectives

Equity  Cost  Health & Wellbeing Benefits
EA  GE  SE  EU  HG  WI

Experts’ information

Policies?

Which policies should be adopted?

Objectives?

Experts’ information

Number of individuals

Travel time

Experts’ information

LOS

Deterministic data from literature

Decline of LTC supply

Costs and budget

Uncertain data

Travel time

Experts’ information

Uncertain data

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Proxy: Wellbeing improvements determined using the ICECAP-A instrument

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Number of individuals in need

Objectives?

Policies?

Which objectives should be pursued?

Which policies should be adopted?
VI. Case Study

Results

How should the LTC network be reorganized so as to minimize costs and when considering uncertainty in the demand and delivery of LTC?
How should the LTC network be reorganized so as to **minimize costs** and when considering uncertainty in the demand and delivery of LTC?

- Closure & Opening of services?
- Capacity?
- Allocation of patients?

Legend: PC – Palliative care

<table>
<thead>
<tr>
<th>Initial capacity</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisbon (2)</td>
<td>6</td>
</tr>
<tr>
<td>Loures (1)</td>
<td>30</td>
</tr>
<tr>
<td>Mafra (1)</td>
<td>20</td>
</tr>
<tr>
<td>Sintra (2)</td>
<td>5</td>
</tr>
</tbody>
</table>

Legend:
- **PC** services
- County

**Years: 2014-2016**

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisbon (2)</td>
<td>7</td>
<td>58</td>
<td>107</td>
</tr>
<tr>
<td>Loures (1)</td>
<td>5</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>Sintra (2)</td>
<td>6</td>
<td>28</td>
<td>52</td>
</tr>
<tr>
<td>Amadora (1)</td>
<td>5</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>
VI. Case Study: Results

How should the LTC network be reorganized so as to **minimize costs** and when considering uncertainty in the demand and delivery of LTC?

![Graph showing bed capacity in use in Lisbon (2) for different years and care types.]

Legend: VLI – Very Low Income
NVLI – Not Very Low Income

Legend: CC – Convalescence Care
MTRC – Medium-Term and Rehabilitation Care
LTMC – Long-Term and Maintenance Care
PC – Palliative care
How should the LTC network be reorganized when multiple policy objectives are set?

Results
VI. Case Study: Results

How should the LTC network be reorganized when **multiple policy objectives** are set?

- **Minimum expected cost and health gains**
  - K: IC, HBC and AC not fully provided
  - J: IC and AC not fully provided, HBC fully provided
  - I: IC not fully provided, HBC and AC fully provided
  - H: IC, HBC and AC fully provided
  - G: Full provision of LTC
  - F: Lowest level of LTC provision
  - E: Minimum expected cost and health gains
  - D: Expected QALYs Gained
  - C: Total Expected Cost (Million €)
  - B: 50,000
  - A: 10,000

- **Maximum expected cost and health gains**
VI. Case Study: Results

2. How should the LTC network be reorganized when multiple policy objectives are set?

Extending the LTC network in the Great Lisbon region is cost-effective!

Threshold (National Institute for Health and Care Excellence): £20,000-£30,000

<table>
<thead>
<tr>
<th>Solution</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
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<tr>
<td>ICER</td>
<td>2.83</td>
<td>2.58</td>
<td>2.40</td>
<td>2.25</td>
<td>2.14</td>
<td>2.05</td>
<td>1.97</td>
<td>1.90</td>
<td>1.81</td>
<td>1.86</td>
<td>4.19</td>
</tr>
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</table>

Additional cost (in thousands of euros) per QALY gained, i.e., Incremental Cost Effectiveness Ratios (ICERs), in comparison to the current provision.
VI. Case Study: Results

2. How should the LTC network be reorganized when multiple policy objectives are set?

IC provision under solution I & J
VI. Case Study: Results

How should the LTC network be reorganized when **multiple policy objectives** are set?

Different priorities given to IC services
VI. Case Study

Results

What if a variety of policy strategies are adopted?

4

Policy strategy | Hospital conversion | Transfer of resources (HR, MR or FR) from acute care to LTC | LTC provision paradigm
---|---|---|---
PS I | Yes | Yes | Community-based
PS II | Yes | No |
PS III | No |
PS IV | Yes |
PS V | Yes |
PS VI | No |

Policy strategy | Hospital conversion | Transfer of resources (HR, MR or FR) from acute care to LTC | LTC provision paradigm
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VI. Case Study: Results

What if a variety of policy strategies are adopted?

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<th>Investment costs</th>
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<tr>
<td>PS I</td>
<td>€18M</td>
<td>€108M</td>
<td>€126M</td>
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<td>PS II</td>
<td>€37M</td>
<td>€153M</td>
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- **Policy strategies**: PS I, PS II, PS III, PS IV
- **Investment costs**: €18M, €37M, €27M, €53M
- **Operational costs**: €108M, €153M, €118M, €170M
- **Total costs**: €126M, €190M, €145M, €223M

![Diagram showing policy strategies and their effects on hospital conversion, transfer of resources, and LTC provision paradigm.](image)
VI. Case Study: Results

4 What if a variety of policy strategies are adopted?

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Substitution of institutional care by home-based care is key to reduce costs.

What if a variety of policy strategies are adopted?
VI. Case Study: Results

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Taking advantage of existing structures in the acute care sector for LTC provision results in lower investments in additional capacity.

209 beds from Maternidade Dr. Alfredo da Costa used for LTC provision.

Hospital conversion
VII. Conclusions

1 Potential for developing the model for decision support.

2 Contribution to literature (combined) – accounts for:
   (1) Specificities of LTC;
   (2) Multiple policy objectives, including cost, equity, health & wellbeing benefits;
   (3) Uncertainty in planning models;
   (4) The impact of a variety of health policy options.

3 Results show that:
   (1) Investments in the LTC network are cost-effective;
   (2) Multiple policy objectives & policy decisions may significantly affect planning decisions in LTC.

   A trade-off exists between different policy objectives – different planning decisions arise when considering health or wellbeing benefits.

   Investments in the LTC network are more cost-effective under a community-based paradigm and when hospital conversion is allowed.
VIII. Future research

1. Developing user-friendly interfaces that facilitate the use of the tool by real planners in the LTC sector.

2. Using Multiple Criteria Decision Making methods to assist decision makers selecting the most preferred solution.

3. Applying the model to other regions in Portugal in collaboration with key players in the LTC sector, such as Regional Health Authorities and the Ministry of Health.
References

Thank you for listening!

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