Support Services for the Management and Utilization of Monitoring and Assessment of the EIP - MAFEIP Tool

BeyondSilos

Badalona Serveis Assitencials (BSA)

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Executive summary

Description of the intervention

The main aim of the project BeyondSilos[1] was to enable the delivery of integrated care to older European citizens to support them to live independent lives in the community by providing the ICT tools necessary to integrate care pathways across organisations and locations, in particular between social and health care providers. One of the key areas of the integration was to provide common access to home platforms for all the cross-sectorial care teams in order to improve care coordination and, therefore, the continuity of care. In particular, this use case includes the analysis of the results achieved at Badalona Serveis Assistencials (BSA)[2] in the frame of BeyondSilos by means of the MAFEIP tool.

Participants in the case study were divided in Intervention and Control groups, and in two different integrated common care pathways for homecare support: short and long term. In this report, we focus on the integrated long-term pathway for homecare support. The age of the participants ranged from 64 to 103 years and it included both females (62%) and males (38%). The participants were suffering heart failure or stroke plus another chronic disease, they lived at home (autonomous or in a dependency situation), and they had home care needs or an exclusion risk due to illness or disability of any condition.

Model input

Defining the health states and the transition probabilities

One of the assessment domains of the project included the observation of the possible changes within the instrumental activities of daily living (Barthel & IADL scales) between the patients receiving the new BeyondSilos service and those receiving usual care. The health states of the MAFEIP model were thus defined based on the change in the Barthel Index[3], concretely on whether the Index had decreased or not for patients compared to their respective initial value. The baseline state was defined as the patient *improves/stays the same* and the deteriorated health state as the patient's condition *worsens*. We calculated the incidence rate as the percentage of patients whose Barthel Index had decreased, and the recovery rate as the percentage of patients whose Barthel had increased or remained equal, for both the control and the intervention group (Table 1).

Apart from the transition probabilities, the model allows to enter the risk for mortality[4]. Since the participants started with severe health conditions, the risk for mortality is mostly higher than for the general population in the same country and age range so that we set this value to 1.005.

Computing the costs

The summary of the costs directly related to the intervention, which are costs that affect only the group that tested the new BeyondSilos service, are shown in Table 1. In particular, there are two types of costs, one-off (only incurred at the implementation point such as costs associated with devices, software and training) and the recurring costs derived from the service practice (e.g.

[1] BeyondSilos http://www.beyondsilos.eu/home.html
[2] Badalona Serveis Assistencials https://apps.bsa.cat/drupal/
[3] The Barthel Index is more suitable than the IADL because the latter refers to activities that are often externalised regardless of the health status (e.g. shopping, food preparation, etc.).
[4] The relative risk of mortality is a measure estimating the mortality in a certain population compared with the mortality in a reference population or condition.

telecommunication cost and software licences' maintenance). All costs have been homogenised per patient and per year. Thus, the costs related to a specific health professional[5] were divided by 120, the average number of patients treated concurrently within the intervention period.

Table 1 also summarises the healthcare and societal costs in each situation, usual care and intervention and for both alive health states. Healthcare costs refer to resource use within the healthcare system (i.e. time spent by professionals on service provision, consultations, cost of hospitalisations, etc.). On the other hand, societal costs include the healthcare costs plus those costs outside the healthcare sector. In this case, the costs for the intervention group include the time spent by patients using the new service. The intervention brought savings in travel time and costs for patients and their caregivers. These are computed as a cost for the control group. Looking at the costs of the intervention, the costs associated with the deteriorated health state are surprisingly lower than those for the baseline. This is due to the way the health states have been defined since each state can have patients with different Barthel Indexes and we focused on how this value changes with the intervention.

Utility

MAFEIP recommends using the EQ-5D to calculate utility, but BeyondSilos did not use this questionnaire. However, the Barthel Index can also be used to account for utility. Therefore, we mapped the Barthel Index into utility values using the formula from Kaambwa, Billingham, & Bryan (2013)[6]. For the utility, we are interested in the change during the period rather than in the absolute value because we want to estimate the effects of a worsening in the health condition compared to remaining stable or improving. Thus, we calculate the changes in utility in the four options (control/intervention in baseline/deteriorated) and add each of them to a common initial measure (established as the utility value for the whole sample before the start of the pilots). Table 1 shows the utility values used in the model.

Table 1. Input data used to populate the MAFEIP model

	Control Group	Intervention Group
Transition Probabilities		
Incidence	36 %	34 %
Recovery	64 %	66 %
Relative Risk		
Baseline State	1.005	1.005
Deteriorated State	1.005	1.005
Costs		
One-off cost per patient (Intervention)	-	1,268.89 €
Recurring cost per patient/year (intervention)	-	230.40 €
Healthcare cost – Baseline	5,198.62 €	5,664.89 €
Healthcare cost – Deteriorated	5,221.69 €	4,502.89 €
Societal cost – Baseline	5,259.14 €	5,953.15 €
Societal cost – Deteriorated	5,282.21 €	4,791.15 €
Utility		
Baseline State	0.45	0.56
Deteriorated State	0.33	0.30

[5] For the personnel cost, we use the average income for one full-time employee with employer contributions to social security.
[6] Kaambwa, Billingham, & Bryan. (2013). Mapping utility scores from the Barthel index. European Journal of Health Economics, 14(2), 231–241.

Model output

Figure 1 shows the overall impact of the intervention on the costs and effects of the whole target population. Both things combined place the incremental cost-effectiveness ratio (ICER) in the upper-right quadrant of the cost-effectiveness plane. This means that the intervention is better (more effective) than the current (standard) care, but it is also more expensive. In this case, in order to know whether the intervention is acceptable or not, there would be a need to compare the ICER to the Willingness to Pay (WTP) threshold. As shown in Figure 1, the intervention is cost-effective for all the WTP threshold options included in the model. More concretely, the solution is cost-effective if the willingness to pay is at least 6,500 € per QALY.

Figure 1. Cost-effectiveness

1. Description of the intervention

The main aim of the BeyondSilos project[7] was to enable the delivery of integrated care to older European citizens to support them to live independent lives in the community by providing the ICT tools necessary to integrate care pathways across organisations and locations, in particular between social and health care providers. One of the key areas of the integration was to provide common access to home platforms for all the cross-sectorial care teams in order to improve care coordination and, therefore, the continuity of care.

The project started in February 2014 and finished three years after. It was co-funded by the European Commission under the Competitiveness and Innovation Programme (CIP) and the 13 Consortium partners, each of the two parts contributing a 50%. Within that partnership, the project had 7 pilots well spread across 6 European countries including Bulgaria, Germany, Italy, Northern Ireland, Portugal and Spain. This use case includes the analysis of the results achieved at Badalona Serveis Assistencials (BSA) by means of the MAFEIP tool.

When it comes to the study design, participants were divided in Intervention and Control groups, and in two different integrated common care pathways for homecare support: short and long term (Table 2). The evaluation was conducted using the MAST multi-dimensional methodology adapted to the needs of the project.

In this report, we focus on the integrated long-term pathway for homecare support. The age of the participants ranged from 64 to 103 years[8] and it included both females (62%) and males (38%). The participants were suffering heart failure or stroke plus another chronic disease, they lived at home (autonomous or in a dependency situation) and they had home care needs or an exclusion risk due to illness or disability of any condition. The control group received usual care and the intervention group the new BeyondSilos service in addition to the usual care. It is important to stress that BSA has already been providing social and health care services in an integrated way for quite a long time. With BeyondSilos, BSA aimed at increasing the effectiveness of the integration beyond current levels through the introduction of a telemonitoring solution and the formalisation of the relationship with third sector care providers. During the intervention, 9 people in the intervention group dropped out. They have not been included in this analysis.

Table 2. Participants in BeyondSilos, BSA pilot site.

	Long-term pathway	Short-term pathway
Intervention	77	20
Control	80	20
Total	157	40

[7] http://www.beyondsilos.eu/home.html
[8] One of the observations was much younger than the rest (55 years old) and it was deleted from the sample.

2. Model input

2.1. Defining the health states and the transition probabilities

One of the assessment domains of the project included the observation of the possible changes within the instrumental activities of daily living (Barthel & IADL scales) between the patients receiving the new BeyondSilos service and those receiving usual care. Therefore, the health states of the MAFEIP model are defined based on the change in the Barthel Index[9], concretely on whether the Index decreased or not for patients compared to their respective initial value. The baseline state was defined as the patient *improves/stays the same* and the deteriorated health state as the patient's condition *worsens*[10]. We calculated the incidence rate as the percentage of patients whose Barthel Index had decreased, and the recovery rate as the percentage of patients whose Barthel had increased or remained equal for both the control and the intervention group (Table 3).

Table 3. Transition probabilities

	Period 0[11]	Value in Period 1:		Transition probabilities	
		Improves/stays the same	Worsens	Recovery Rate	Incidence Rate
Intervention group	68	45	23	66%	34%
Control group	80	51	29	64%	36%

Since the participants started with severe health conditions, the **risk for mortality** is mostly higher than for the general population in the same country and age range. Therefore, we increased a bit the relative risk for all 4 groups (to 1.005). In total, eight care recipients died during the BeyondSilos' trial, six in the intervention group and two in the control group. However, there was no significant difference between groups, and an analysis of the causes showed that they were not related to the intervention but to the normal evolution of their chronic conditions.

2.2. Computing the costs

The following table shows a summary of the costs directly related to the intervention, which are costs that affect only the group that tested the new BeyondSilos service. There are two types of costs, one-off (only incurred at the implementation point) and the recurring costs derived from the service practice. All costs have been homogenised per patient and per year. Thus, the costs related to a specific health professional[12] were divided by 120, the average number of patients treated concurrently within the intervention period.

[9] The Barthel Index seems more suitable than the IADL because the latter refers to activities that are often externalised regardless of the health status (e.g. shopping, food preparation, etc.).
[10] The deceased were included here
[11] Period 0 refers to the period before the implementation of BeyondSilos.
[12] For the personnel cost, we use the average income for one full-time employee with employer contributions to social security. The average hourly wages are 29.23€ for a physician, 20.79€ for a nurse, and 18.19 for a social care worker. The equivalent for the time spent by the patients and informal caregivers is 6.07€.

Table 4. Intervention costs

Intervention one-off costs (per patient)	
Time spent by professionals (overhead 18%)	**187.40**
Time spent by Physician (service development, receiving training, adaptation)	40.63
Time spent by Nurse (service development, receiving training, adaptation)	112.06
Time spent by Social worker (service development, receiving training, adaptation)	5.49
Time spent by Physicians and Nurses on training provision to clients / patients	0.63
Installation of the software for Physicians and Nurses	**2.50**
Cost of the set of devices and the software for clients/patients	**1,079.00**
TOTAL	**1,268.89**
Intervention recurring costs (per patient and year)	
Telecommunication costs	144.00
Software costs	86.4
TOTAL	**230.40**

Healthcare costs refer to resource use within the healthcare system in each situation, usual care and intervention. It includes the time spent by health professionals on service provision, consultations, etc. Moreover, the project collected data on the number of hospitalisations for patients in the control and intervention groups, which allowed us to calculate the number of bed days per group[13]. This was then multiplied by an estimation of the cost per bed-day in Spain[14]. We calculated this value for both states, baseline and deteriorated (Table 5).

[13] Those that dropped out were not included.

[14] The estimation of cost per bed-day is 733.56 €, which has been obtained by dividing the *Expenditure for Inpatient curative care in hospitals* by *Hospital bed-days in services of curative care* (both variables are available in Eurostat, *hlth_sha11_hc* and *hlth_co_dischls*).

Table 5. Healthcare Costs (per patient and year in €)

Control Group baseline health	
Total time spent by professionals in usual care (overhead 18%)	**509.02**
Time spent by Physicians in usual care (assessment and care planning, consultations)	58.46
Time spent by Nurses in usual care (assessment and care planning, consultations)	291.06
Time spent by Social workers in usual care (care provision, home consultation) compared to BeyondSilos	81.86
Travel costs in usual care (overhead 18%)	**7.79**
Travel costs in usual care (service provider visits to the patient's home)	3.60
Travel costs of Social workers' trips in usual care compared to BeyondSilos	3
Hospitalisation cost	**4,681.81**
TOTAL	**5,198.62**
Control Group deteriorated health	
Total time spent by professionals in usual care (overhead 18%)	**509.02**
Time spent by Physicians in usual care (assessment and care planning, consultations)	58.46
Time spent by Nurses in usual care (assessment and care planning, consultations)	291.06
Time spent by Social workers in usual care (care provision, home consultation) compared to BeyondSilos	81.86
Travel costs in usual care (overhead 18%)	**7.79**
Travel costs in usual care (service provider visits to the patient's home)	3.60
Travel costs of Social workers' trips in usual care compared to BeyondSilos	3
Hospitalisation cost	**4,704.88**
TOTAL	**5,221.69**
Intervention Group baseline health	
Total time spent by professionals in intervention (overhead 18%)	**627.80**
Time spent by Physicians in intervention	292.30
Time spent by Nurses in intervention	207.90
Time spent by Social workers in intervention	31.83
Hospitalisation cost	**5,037.09**
TOTAL	**5,664.89**
Intervention Group deteriorated health	
Total time spent by professionals in intervention (overhead 18%)	**627.80**
Time spent by Physicians in intervention	292.30
Time spent by Nurses in intervention	207.90
Time spent by Social workers in intervention	31.83
Hospitalisation cost	**3,875.09**
TOTAL	**4,502.89**

Looking at the costs of the intervention, the costs associated with the deteriorated health state are surprisingly lower than those for the baseline. This is due to the way the health states have been defined since each state can have patients with different Barthel Index and we focused on how this value changes with the intervention.

The societal costs include the healthcare costs plus those costs outside the healthcare sector. In this case, the costs for the intervention group include the time spent by patients using the new service. Moreover, the intervention brought savings in travel time and costs for patients and their caregivers. These are computed as a cost for the control group (Table 6).

Table 6. Societal Costs (per patient and year in €)

Control Group baseline health	
Extra travel time spent by patients in usual care compared to BeyondSilos	22.76
Extra travel costs and time for informal carers in usual care compared to BeyondSilos	37.76
Healthcare costs	5,198.62
TOTAL	**5,259.14**
Control Group deteriorated health	
Extra travel time spent by patients in usual care compared to BeyondSilos	22.76
Extra travel costs and time for informal carers in usual care compared to BeyondSilos	37.76
Healthcare costs	5,221.69
TOTAL	**5,282.21**
Intervention Group baseline health	
Time spent by patients using the service	288.26
Healthcare costs	5,664.89
TOTAL	**5,953.15**
Intervention Group deteriorated health	
Time spent by patients using the service	288.26
Healthcare costs	4,502.89
TOTAL	**4,791.15**

2.3. Utility

MAFEIP recommends using the EQ-5D to calculate utility, but BeyondSilos did not use this questionnaire. However, the Barthel Index can also be used to account for utility. In fact, some papers have compared both indexes. Thus, we mapped the Barthel Index into utility values using the formula from Kaambwa, Billingham, & Bryan (2013)[15].

Here we are interested in the change during the period rather than in the absolute value because we want to estimate the effects of a worsening in the health condition compared to remaining stable or improving. Therefore, we calculate the changes in utility in the four options (control/intervention in baseline/deteriorated) and add each of them to a common initial measure (established as the utility value for the whole sample before the start of the pilots, which was 0.44) (Table 7).

[15] Kaambwa, Billingham, & Bryan. (2013). Mapping utility scores from the Barthel index. European Journal of Health Economics, 14(2), 231–241.

Table 7. Utility

	Utility Before	Utility After	Change in Utility
Control			
Baseline	0.52	0.53	0.01
Deteriorated	0.61[16]	0.50	-0.11
Intervention			
Baseline	0.21	0.33	0.12
Deteriorated	0.48[8]	0.33	-0.14
Whole sample	0.44		
Baseline	0.38	0.44	0.06
Deteriorated	0.55[8]	0.42	-0.12

Estimated utility after intervention	Control	Intervention
Baseline	0.45	0.56
Deteriorated	0.33	0.30

[16] The utility of the deteriorated state before is higher than the utility of the baseline state because both health states are composed of patients with different Barthel Index and we are focused more on how this value changes with the intervention rather than in the Barthel Index scale.

3. Model output

The incremental costs by age are positive, implying that the intervention is more expensive than usual care (Figure 2). Moreover, costs decrease with age, implying that the solution is cheaper for older people. The fact that the costs are lower as age increases could be because the mortality of older people with chronic diseases is higher so they spend less number of cycles in the simulation, resulting in lower accumulated costs. The cumulative incremental costs over the model horizon for the whole population[17] increase moderately during the first 20 years and then the growth becomes much smaller (Figure 3).

The incremental effects by age are positive, which means that the intervention managed to increase patients' utility (Figure 4, Figure 5).

Figure 2. Incremental cost by age

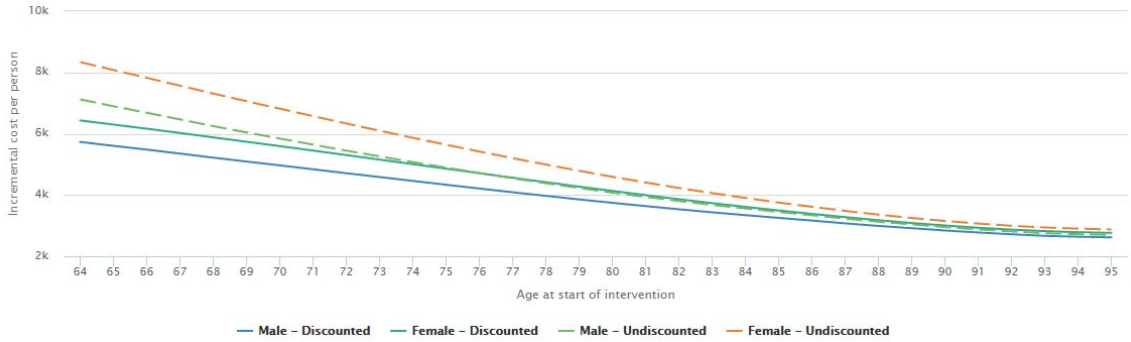


Figure 3. Cumulative incremental cost

[17] This is the population +65 that lives in the area where BSA operates (Badalona, Tiana, Montgat) (INE, census 2016).

Figure 4. Incremental effects by age

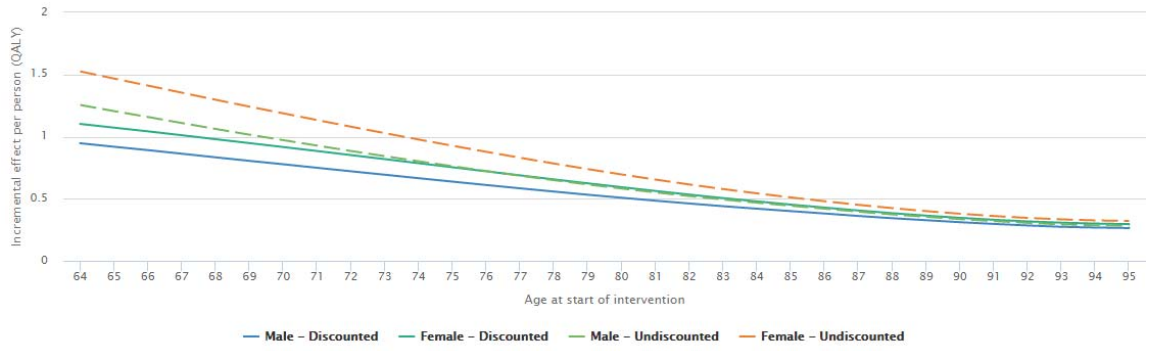
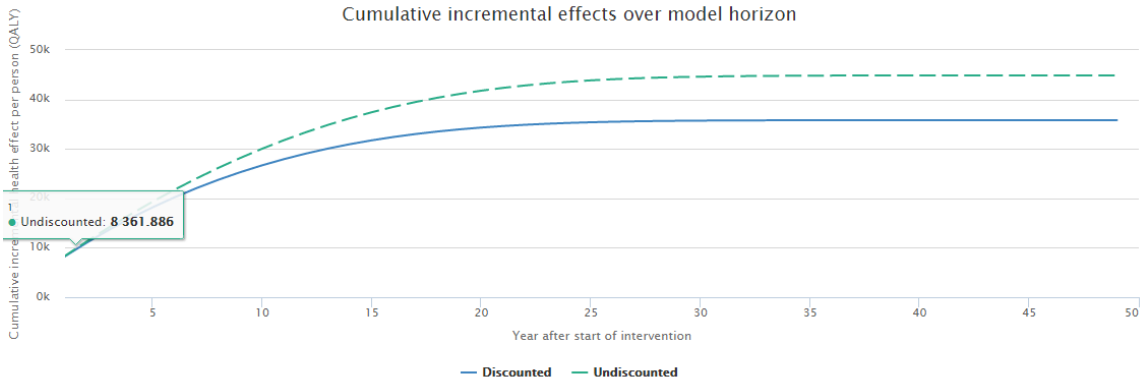


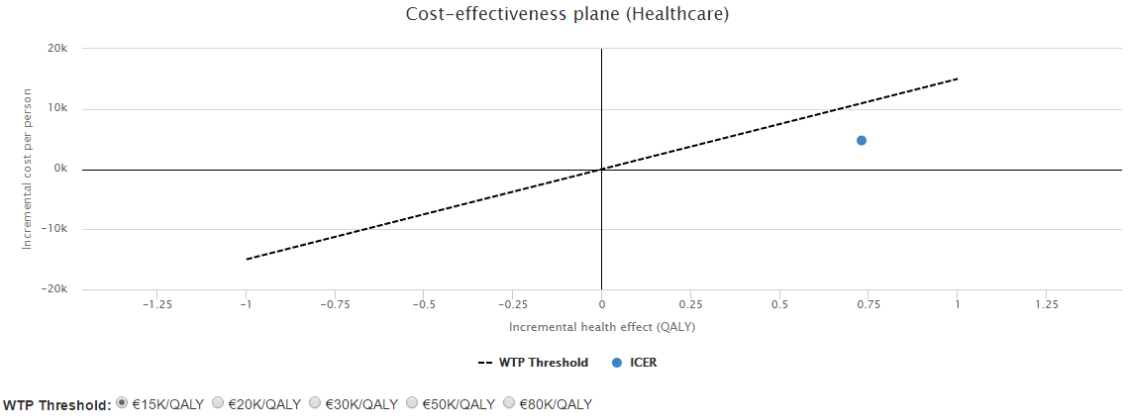
Figure 5. Cumulative incremental effects



The combination of the incremental cost and effects place the incremental cost-effectiveness ratio (ICER) in the upper-right quadrant. This means that the intervention is better (more effective) than the current (standard) care, but it is also more expensive. In this case, in order to know whether the intervention is acceptable or not, there would be a need to compare the ICER to the Willingness to Pay (WTP) threshold. As shown in Figure 6, the intervention is cost-effective for all the WTP threshold options included in the model. More concretely, the solution is cost-effective if the willingness to pay is at least 6,500 € per QALY.

Figure 6. Cost-effectiveness plane

Incremental cost and HRQoL effects	
Incremental cost (Healthcare)	4755.05
Incremental effects	0.731
Incremental cost-effectiveness ratio (Healthcare)	6505.52



WTP Threshold: €15K/QALY €20K/QALY €30K/QALY €50K/QALY €80K/QALY

The following figures (Figure 7, Figure 8) show how the transition between states is very similar in intervention and current care, but the latter has a slightly higher probability of moving to the deteriorated health state. Their probability of dying is the same.

Figure 7. Patient flow through model states (Alive states)

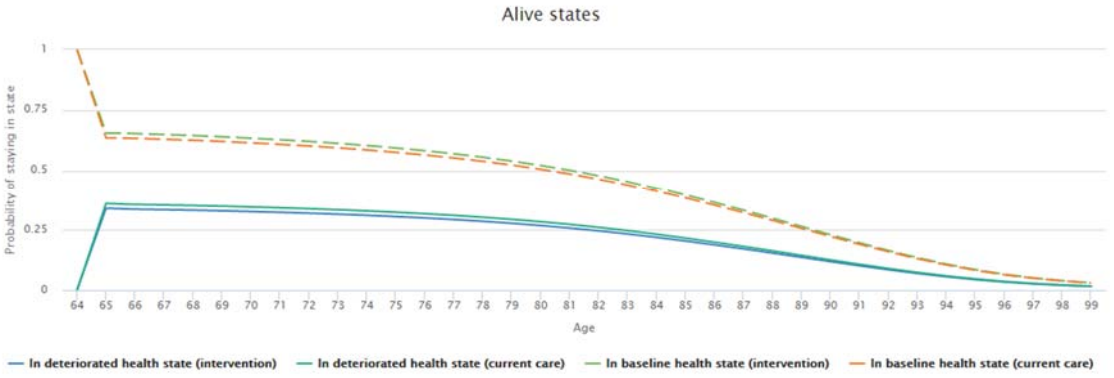
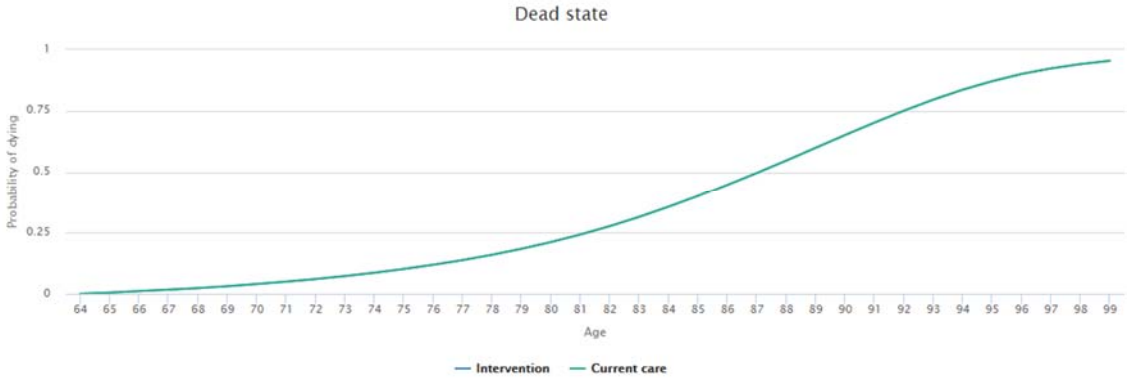


Figure 8. Patient flow through model states (Dead state)



The sensitivity analysis allows us to assess how the output varies when one parameter changes. In particular, this analysis shows that a 10% reduction in the utility in the baseline health for the intervention group would place the ICER above the WTP threshold for 15€/QALY (Figure 9). Similarly, a 10% increase in the healthcare costs for the same group would put the ICER closer to the 15€/QALY threshold (Figure 10).

Figure 9. Univariate sensitivity analysis with a ±10% change in utility in baseline health for the intervention group

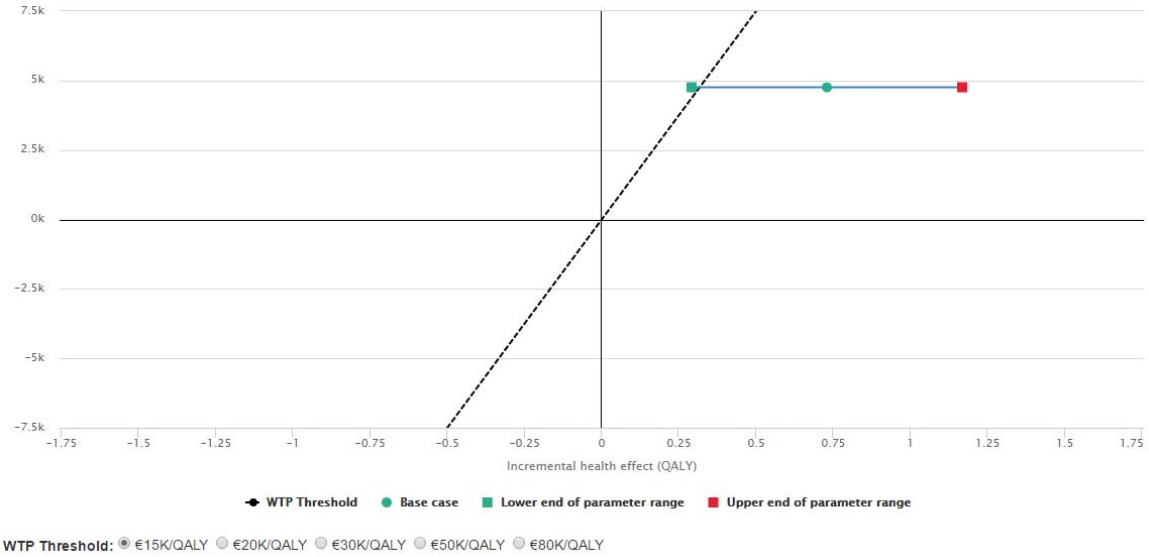
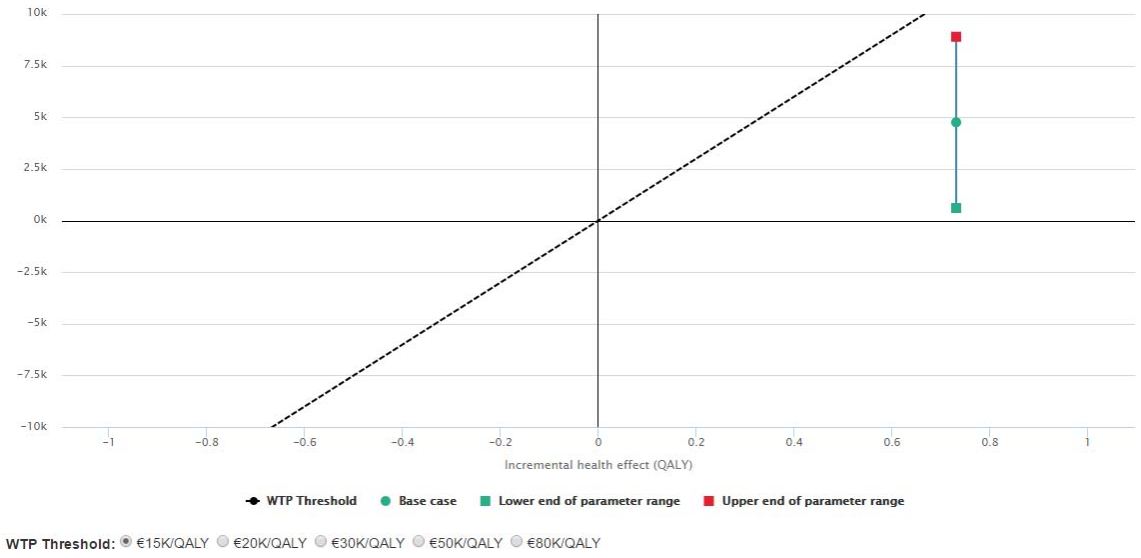


Figure 10. Univariate sensitivity analysis with a ±10% change in healthcare costs in baseline health for the intervention group



The figures below show how a change in several parameters affects the incremental costs (Figure 11) and the incremental effects (Figure 12). Concretely we applied a ±10% change in each parameter. The results show that the variable that has a stronger impact on incremental costs is the healthcare cost in the baseline health (Figure 11). On the other hand, the variation in the

variable *utility of baseline health* in intervention is the one that would imply a larger change in incremental effects (Figure 12).

Figure 11. Parameter impact on incremental costs

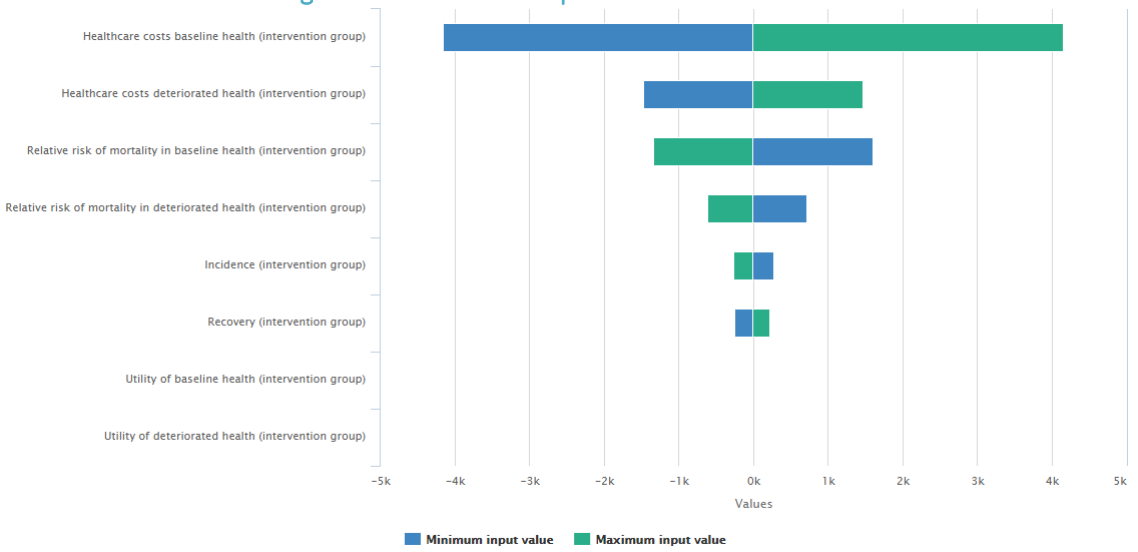
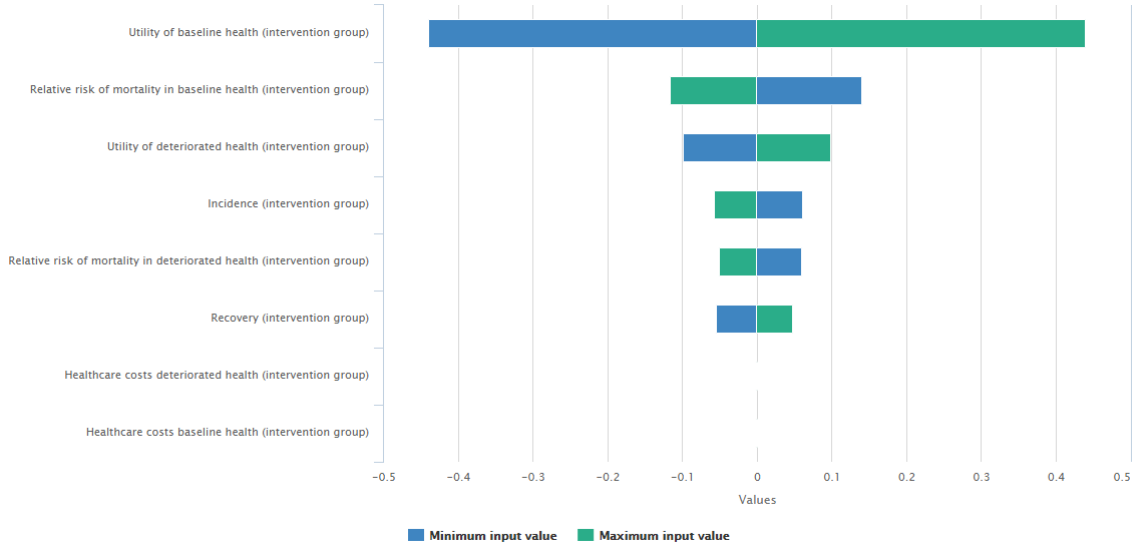


Figure 12. Parameter impact on incremental effects



4. Lessons learned

This section summarises the main difficulties we have encountered in adapting the intervention performed in the frame of BeyondSilos to the Markov model used in MAFEIP. These difficulties are detailed below:

- The Markov model underlying MAFEIP is based on three health states, namely baseline health, deteriorated health, and dead. The idea is that users can define the two 'alive' states in such a way that they represent the state of the population that receives the intervention and the condition that the intervention aims to prevent, improve or achieve. However, the number of states used in this version of the tool does not correctly adapt to the intervention. The intervention caused an improvement in the outcome variable (Barthel Index) but these changes were not enough to move from the deteriorated state to the baseline state, and, hence, the positive effects of the intervention were not displayed in the model results. Therefore, the health states were defined based on the change in the Barthel Index to better analyse the impact of the intervention. The inclusion of additional health states will be therefore a possible improvement of the tool.
- In the current version of the tool, individuals start the simulation, by default, in the baseline health state and they may then transition into the state labelled as 'deteriorated health', or into the 'dead' state respectively. This implies that the baseline situation should always be one of better health and that individuals always transition into a state of reduced health. In the BeyondSilos intervention evaluated in this use case, participants were suffering heart failure or stroke plus another chronic disease. Therefore, specifying starting health states will increase the flexibility of the tool.
- Concerning the utility values, MAFEIP recommends to use EQ-5D. However, the pilot conducted in BSA did not use this questionnaire so that we used the Barthel Index as a proxy. In addition, the control group presented higher utility values before the intervention. To make sure that differences in utility were related to the intervention, and not to pre-existing differences between the control and the intervention groups, we were interested in the utility change during the period rather than in the absolute value to estimate the effects of a worsening in the health condition compared to remaining stable or improving. Thus, we calculated the changes in utility in the four options (control/intervention in baseline/deteriorated) and added each of them to a common initial measure.
- The relative risk factor allows users to adjust the baseline mortality for the specified target population, as it provides a proportional measure estimating the mortality in a certain population compared with the mortality in a reference population or condition. In BeyondSilos the participants had special health conditions, so the risk for mortality should be a bit higher than for the general population in the same country and age range. For this reason, we set the value of the relative risk a bit higher than 1, but it was difficult to determine how to correctly adjust this value.

These lessons learned can be applied for the further development of the MAFEIP tool.