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Cost-Consequences Analysis (CCA) of the HosmartAI Virtual Coach for Continuity of Care Among Older Adults (HORIZON 2020 FUNDED)

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Background

- In Europe, 31% of older people live alone or isolated facing a double threat: living alone and subjective loneliness experienced as a set of negative feelings, with serious repercussions on their health.
- The Modular Virtual Assistant will serve as a screening and intervention tool, to detect and prevent cognitive deterioration and to plan and follow rehabilitation.
- The virtual coach for a continuity of cared utilizes a modular system to enhance continuity of care aiming to prevent cognitive decline and frailty in older adults by promoting healthy lifestyles and health monitoring.

Objective

The study aimed to analyze the economic and clinical performance of the virtual coach (social robot & tablet) on cognitive performance, mood and quality of life among older adults.

Methods

- 132 patients participated in the study with the following inclusion criteria:
  - Mini Mental State Examination (MMSE) (≥ 23 y ≤ 30)
  - Age >60 years old
  - Provision of informed consent
  - Agreement to have support on a) using technologies, b) mood testing, c) cognitive stimulation, Sensorial difficulty that hinders the use of the device.
- A micro-costing analysis was performed for two settings, i) the Dwelling Setting and ii) the Clinical setting based on the perspective of the Spanish healthcare system, to identify the following cost elements:
  - cost of personnel
  - cost of maintenance
  - cost of AI infrastructure examination
- The selected Key Performance Indicators (KPIs) to capture the effectiveness of the new technology were a) improvement in Minimental (MMSE), b) improvement in patient frailty at Geriatric Depression Scale (GDS), c) Assessment of patients' quality of life (EQ-5D).
- The comparison with the current practice was performed incrementally (both costs and effects) to enable the cost-consequence analysis of the virtual coach application and Robot.
- The chosen methodology was cost-consequence analysis (CCA) since it enables the presentation of various impacts of an intervention individually, rather than combining them into a single metric, This approach enables a more holistic understanding of the effects, while leaving it to the decision maker to determine the relative significance of each aspect (Figure 1).[1]

Figure 1. Components of costs and consequences in cost consequence analysis

Comparator
- Virtual Coach Robot was set as intervention and as a comparator was set the current practice

Effects
- The selected Outcomes were a) Clinical improvement measured by Mini-mental (MMSE), b) improvement at Geriatric Depression Scale (GDS), c) Assessment of patients' quality of life (EQ-5D).

Costs
- The cost components considered were: **i)** personnel cost **ii)** cost of maintenance, **iii)** Cost of and infrastructure for Dwelling and Clinical Setting

- **Qualitative Analysis:** A focus group format was implemented to discuss with the participants about the devices and the HosmartAI intervention, to know aspects related with the usability, acceptance and user experience. Two focus groups were carried out: one with 5 informal caregivers and the other with 10 professionals (formal caregivers) in the social and healthcare field.
- **Linear regression models:** For the geriatric depression (GDS) and quality of life (EQ-5D-3L) scales, the log2-fold-change (LFC) was calculated to fit the linear regression models. Specifically, the following formulas were applied:

$$\log_2 \frac{\mathrm{GDS}_{post}}{\mathrm{GDS}_{pre}}; \log_2 \frac{\mathrm{EQ\ 5D\ 3L}_{post}}{\mathrm{EQ\ 5D\ 3L}_{pre}}$$

- Any change in GDS and EQ-5D-3L, positive values indicate an increase in scale in post relative to pre. Negative values indicate a decrease in scale in post relative to pre. Finally, a value of 0 indicates no change. For each variable (change in GDS, change in EQ-5D-3L, SUS, USEQ and CSUQ), a linear model with mixed effects was fitted, testing Gaussian (normal) and Gamma distributions with log link.
- For each variable (change in GDS, change in EQ-5D-3L, SUS, USEQ and CSUQ), a linear model with mixed effects was fitted, testing Gaussian (normal) and Gamma distributions with log link. In all cases, the model included, sex, age, educational level, PFO-total and MMSE. Thus, the Beyond the Optimal Model was as follows:

Change in GDS / change in EQ-5D-3L

y ~ (Sex + Age + PFO_total + MMSE_total)*Group

SUS / USEQ / PSSQ (Spanish version as CSUQ)

y ~ Sex + Age + PFO_Q1 + PFO_total + MMSE_total

Results

In table 1 the results of the cost consequences analysis are presented regarding the 3D mapping technology. The new technology seems to be a cost-saving option, by providing savings on a yearly basis of €668.720 with 10-year depreciation of the new technology. More specifically, the yearly budget impact of the department, treating 400 patients on a yearly basis cost with the new technology €2.191.280 (€5.478 per patient) versus €2.860.000 (€7.150 per patient) with the currently used intervention. It is worth mentioning that in all clinical/technological/managerial parameters captured, the new technology presents higher results in comparison to the currently used technology. This promising technology, once it is completed, following the same pattern, will become the new standard of care from medical and economic point of view.

Table 1. Cost Consequence Analysis of Virtual Coach

COST-CONSEQUENCES ANALYSIS			
Cost/Outcomes Categories	**HosmartAI Intervention (per patient cost)**	**Current Intervention (Gold Standard) (per patient cost)**	**Difference**
Cost of Technology 3D Mapping System (10 years and 400patients/year)	118 €	50 €	68 €
Magnetic/Ablation Catheter	880 €	1.800 €	-920 €
Other Catheter	2.000 €	2.000 €	0 €
Personnel Cost / Wages	1.960 €	2.800 €	-840 €
Other Materials	500 €	500 €	0 €
Power consumption	16,70 €	0 €	16,70 €
Maintenance & Consultation	3,50 €	0 €	4 €
Total Cost per patient	5.478 €	7.150 €	-1.672 €
Number of patients per year	400	400	
Yearly Cost (n=35)	2.191.280 €	2.860.000 €	-668.720 €
Consequences Categories	**HosmartAI Intervention**	**Current Intervention (Gold Standard)**	**Difference**
Procedure Duration (seconds)	285	411	-126
Network Latency (ms)	57.40	N/A	N/A
User Satisfaction (SUS)	85.50%	75.00%	10,50%
Workload (Nasa RAW TLX; 0-100)	72.5	45.75	26.75
Ease of use (custom questionnaire; worst: 1; best:5)	4.50	3.94	0.56
Accuracy and Precision (custom questionnaire; worst: 1; best:5)	4.84	4.72	0.12
Safety and Risk Perception (custom questionnaire; worst: 1; best:5)	447.00%	447.00%	0.00
Comfort and Fatigue (custom questionnaire; worst: 1; best:5)	481%	377.00%	1.04
Time and Efficiency (custom questionnaire; worst: 1; best:5)	471.00%	440.00%	0.31
Training and Learning (custom questionnaire; worst: 1; best:5)	464.00%	442.00%	0.22
Teleoperation (custom questionnaire; worst: 1; best:5)	4.16	N/A	N/A

- The SUS usability questionnaire informed that the dwelling group participants valued the system with an acceptable score (79.66%), while the clinical groups reported lower acceptance values (G1-36% and G2-45%).
- Consistent with the SUS findings, the PSSUQ scores pointed to higher scores in the dwelling setting (M=6.01), with the clinical settings scoring lower but still positive (G1-M=4.72 and G2-M=5.26, respectively).
- The user experience questionnaire, short version (UEQ-S), that ranged from 1-badly to 7-highly accepted, indicated a better user experience in the clinical settings (G1-5.42 and G2-5.25) compared to the dwelling group (G3-3.72).
- Important contextual differences included the user interface (UI) - G3 used the tablet at their dwelling, G1 and G2 used the robot alongside a healthcare professional). The duration of the intervention also differed, with G3 having the system for 2.5 months, whilst the G1 and G2 for 1 month.
- **Cognitive Performance: Cognitive performance** was tested by applying the MMSE and resulted that **the intervention group significantly influenced cognitive performance changes (p=0.042),** with the most substantial changes noted in the dwelling setting group.
- Regarding Quality of Life and Mood aspects no significant differences observed among the groups.

Conclusions

Ensuring that the virtual coach is readily accessible and easy to use in various settings can enhance its integration into the daily lives of older adults, promoting sustained engagement and better outcomes.

References

1. NICE. Evidence standards framework for digital health technologies. Cost consequences and budget impact analyses and data sources. In: National Institute for Health and Care Excellence London, UK; 2019.
2. https://www.hosmartai.eu/

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