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Cost-Consequences Analysis (CCA) of Echocardiography Digital Artificial Intelligence (AI) Monitoring Application Developed at HosmartAI (HORIZON 2020 FUNDED)

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Background

- Echocardiography (ECHO) is a type of ultrasound scan used for examining cardiac function.
- The left ventricle ejection fraction (LV-EF) and left ventricle global longitudinal strain (LV-GLS) measurements from ECHO scans have significant clinical value.
- The estimation of both measures is usually performed semi-manually and requires a non-negligible amount of time, while accuracy depends on the cardiologist's experience and the quality of scans, leading to intra- and inter-observer variability.
- There is a clear unmet need for a new technology to reduce the time needed to estimate LV-EF and LV-GLS accurately.

Objective

The study aims to assess the economic and clinical performance of an AI-based tool that automatically estimates LV-EF and LV-GLS from ECHO scans.

Methods

- The selected Key Performance Indicators (KPIs) to capture the accuracy of the new technology were a) clinical performance (sensitivity, specificity, Youden's J index) b) system usability, c) the average duration for measurement of LV-EF and LV-GLS by a non experienced and experienced physicians.
- To measure the performance of the AI, the AI measurements for LV-EF and LV-GLS were compared with the respective ground-truth measurements which were created by expert cardiologists on a newly collected dataset. The expert participants were asked to characterize as normal or pathological a set of ECHO cases with and without the assistance of the AI. The outcomes were compared with the ground-truth and the performance, i.e., the sensitivity, specificity, and Youden's J index, was calculated. The responses were analyzed for each experience group individually.
- Youden's J index aggregates performance in one metric and is calculated using the following formula

$$J = sensitivity + specificity - 1$$

- Usability was assessed with System Usability Scale (SUS).
- The duration of the ECHO examination was also reported (average time in minutes), separated in experienced and non experienced cardiologists followed by the number of physicians (senior or resident) needed to perform the examination.
- A micro-costing analysis was performed, based on the perspective of the Greek healthcare system, to identify the following cost elements:
  - costs of development of the new AI technology,
  - cost of maintenance and infrastructure of the technology
  - cost of ECHO examination assessment (physician time in minutes).
- The comparison with the current technology was performed incrementally (both costs and effects) to enable the cost-consequence analysis of the AI based tool that automatically detects the ECHO findings.
- The chosen economic evaluation 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.[1] 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.

Results

- The accuracy was based on the mean absolute errors of LV-EF and LV-GLS measurements produced by the AI-based tool were compared to errors in the same reference measurements estimated semi-manually by expert cardiologists. The time required by the AI-based tool and by the comparator cardiologists to produce the measurements was also assessed. Pearson correlation analysis was performed to evaluate the agreement between the AI-based measurements and reference measurements (Figures 2 & 3).

Figure 2. External Validation of AI-based estimation of LV-EF correlation analysis (Pearson r=0.88, p-value ≤0,001)

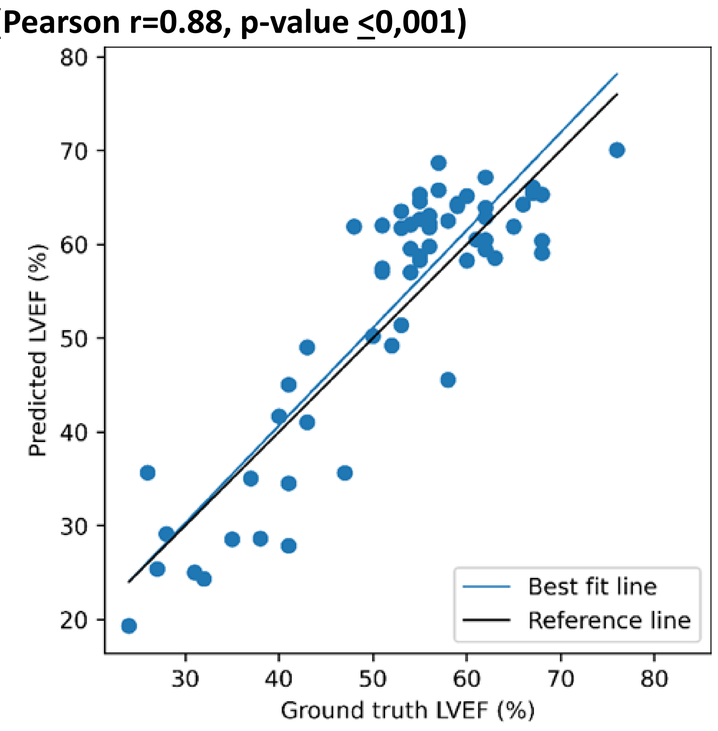
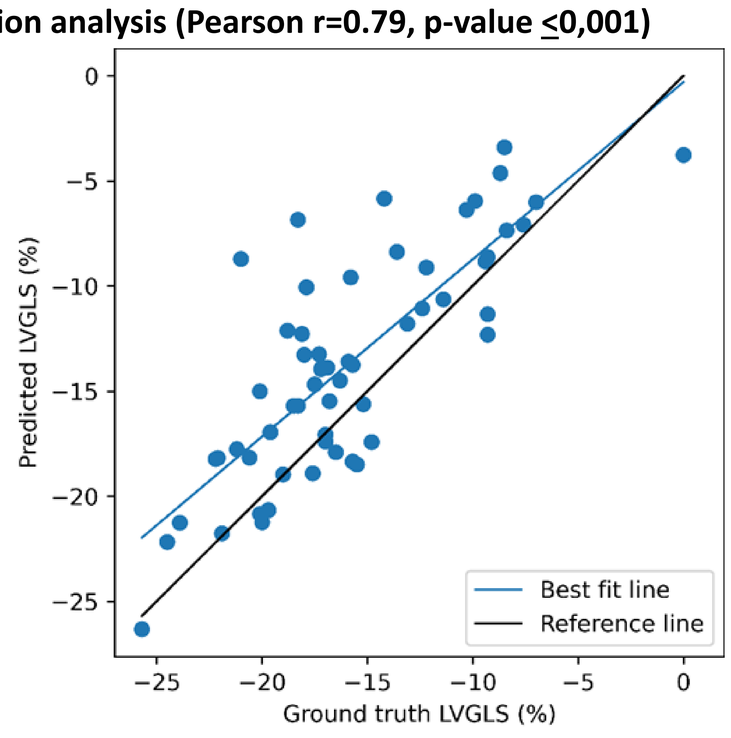


Figure 3. External Validation of AI-based estimation of LV-GLS correlation analysis (Pearson r=0.79, p-value ≤0,001)



- In table 2 the results of the cost consequences analysis are presented. The annual cost of the new echocardiography technology costs more than current practice (€9.409 vs. €2.116) which is attributed to the introduction of the new AI technology and although it needs fewer working hours on behalf of cardiologists, still the low physician salaries are not able to counterbalance the cost difference. The important aspect is that the new technology enables junior cardiologists to perform more accurately the review of the echocardiography. Moreover, the results of the clinical precision are greater in comparison to the current technology scenario and the user satisfaction rate is inacceptable level of 75%.

Table 2. Cost-Consequences Analysis of Echocardiography AI system

COST-CONSEQUENCES ANALYSIS PILOT 1 - ECHOCARDIOGRAPHY SCENARIO			
Cost/Outcomes Categories	**HOSMARTAI Intervention (Annual Cost)**	**Current Practice (annual cost)**	**Difference**
Cost of AI Technology (personnel)	5.000 €	0 €	5.000 €
Cost of Maintenance	3.000 €	0 €	3.000 €
Cost of AI Infrastructure	300 €	0 €	300 €
Physician Cost of LV-EF Measurement (n=2880 patients annually)	634 €	1.382 €	-749 €
Physician Cost of LV-GLS Measurement (n=1440 patients annually)	475 €	734 €	-259 €
Total Cost per year	9.409 €	2.116 €	7.292 €
Consequences Categories	**HOSMARTAI Intervention**	**Current Practice**	**Difference**
System Usability (SUS)	75.00%	-	75.00%
Mean absolute error (MAE) of automatic measurement of LVEF	5.55	-	5.55
Accuracy of the Automated analysis	3.03	-	3.03
Diagnostic accuracy for a low experienced physician (Low experienced physician<5years) (Youden's J index)	0.80	0.54	0.26
Diagnostic accuracy for a high experienced physician (High experienced physician>5years) (Youden's J index)	0.82	0.64	0.18
Average time for measurement of LVEF by a high experienced physician (in min)	1.00	2.00	-1.00
Average time for measurement of LVEF by a low experienced physician (in min)	1.00	1.00	0.00
Average time for measurement of LVGLS by a low experienced physician (in min)	1.50	4.00	-2.50
Average time for measurement of LVGLS by a high experienced physician (in min)	1.50	3.00	-1.50

Conclusions

The new technology enables junior cardiologists to perform more accurately the review of the echocardiography with good acceptance and user satisfaction levels. Soon enough this technology will become the new standard of care.

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. Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. Intl. Journal of Human–Computer Interaction, 24(6), 574-594.
3. https://www.hosmartai.eu/

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