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Cost-Effectiveness and Budget Impact Analysis of Introducing Artificial Intelligence-Aided Colonoscopy for Adenoma Detection and Characterization in Spain.

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Objective

To assess the cost-effectiveness and budget impact of an Intelligent Endoscopy Module for computer-assisted detection and characterization (CADe/CADx) of colorectal cancer (CRC) compared to standard practice, from the National Health System (NHS) perspective.

Methods

miss rates⁷, and natural disease evolution was simulated by contemplating annual transition probabilities.⁸⁻¹⁰

- All-cause mortality data¹¹, and specific CRC-related mortality⁸ were applied.
- Utility values derived from EQ-5D were used for QALY estimation.^{9,12}
- Detected polyps' management involved polypectomy and histopathology in standard practice, while with CADe/CADx leave-in-situ was applied for ≤5mm rectosigmoid non-adenomas and resect-and-discard for the rest of ≤5mm polyps, according to clinical guidelines.¹³⁻¹⁴
 Unit costs¹⁵ (€,2024) included colonoscopy, €326.98; CADe/CADx, €7.59/per colonoscopy; polypectomy, €133.55; histopathology, €152.23. Annual CRC management costs were €4,211.61 (stage I), €4,700.04 (stage II), €4,714.16 (stage III) and €7,833.94 (stage IV).²

Results

- For a hypothetical cohort of 1,000 patients, CADe/CADx produced more health benefits (16.37 LYG and 14.32 QALYs per patient) compared to standard practice (16.33 LYG and 14.27 QALYs per patient) and resulted in a less costly option (€2,300.76 vs. €2,508.75 per patient) over a lifetime horizon (Table 1).
- CADe/CADx remained a dominant strategy in all one-way SA, and in 92.91% of 10,000 MonteCarlo simulations of the probabilistic SA (Figure 2).

- We performed: **1**) a cost-effectiveness analysis of a hypothetical cohort of 1,000 patients eligible for colonoscopy using a Markov model and a lifetime horizon, to estimate the total cumulative costs and health outcomes [life years gained (LYG) and quality-adjusted life years (QALY)], and **2**) a budget impact analysis of a nationwide implementation of CADe/CADx in the Spanish CRC screening program considering a 3-years' time-horizon and a 100% adoption of CADe/CADx.
- Based on screening programmes data¹⁻⁶, patients were distributed between health states according to polyp size, location, and histology.
- CADe/CADx efficacy was captured considering adenoma
- A 3% annual discount rate was applied to costs and outcomes.¹⁶
- Model's structure and inputs were validated by an expert panel and sensitivity analyses (SA) were performed to assess the model's robustness.
- Regarding the budget impact analysis, 301,284 screening colonoscopies were estimated considering a 3-years' time-horizon.
- The nationwide implementation of CADe/CADx in the Spanish CRC screening program would result in the avoidance of 15,526 polypectomies, 47,764 histopathologies, and 259 CRCs (Figure 3).
- This would lead to a cost savings of €81.36 per patient, amounting to over €8 million when considering the entire target population (Table 2).





Figure 3: Clinical outcomes considering the entire patient cohort over 3 years.



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All state

Death

A, adenoma; No-A, no adenoma; No-RS, no rectosigmoid; RS, rectosigmoid; CRC, colorectal cancer.

Table 1: Cost-effectiveness analysis base case results.

	CADe/CADx	Standard practice	Incremental	
Total LYG /QALY	16.37 / 14.32	16.33 / 14.27	0.04 / 0.05	
Total costs	€2,300.76	€2,508.75	€-207.99	
Diagnostic cost	€724.59	€704.09	€20.50	
Disease management cost	€1,576.17	€1,804.66	€-228.49	
ICER (€/LYG) / ICUR (€/QALY)	CADe/CADx resulted a dominant option			

ICER, incremental cost-effectiveness ratio; ICUR, incremental cost-utility ratio; QALY, quality-adjusted life year; LYG, life-year gained.

Figure 2: Probabilistic sensitivity analysis. Cost-effectiveness plane.



Scenario without CADe/CADx

CRC, colorectal cancer.

Table 2: Budget impact analysis.

	Scenario without CADe/CADx			
	Year 1	Year 2	Year 3	Total
Cost of colonoscopies*	€32,174,338.44	€32,851,091.01	€33,488,373.84	€98,513,803.29
Cost of CADe/CADx	€0.00	€0.00	€0.00	€0.00
Cost of polypectomies	€6,053,215.89	€6,180,538.77	€6,300,435.89	€18,534,190.56
Cost of histopathologies	€6,899,895.59	€7,045,027.46	€7,181,694.92	€21,126,617.96
Cost of CRC	€19,915,104.94	€39,173,344.79	€57,668,737.61	€116,757,187.34
Total cost	€65,042,554.85	€85,250,002.04	€104,639,242.26	€254,931,799.15
Cost per patient	€661.01	€852.47	€1,032.40	€2,545.88

	Scenario with CADe/CADx			
	Year 1	Year 2	Year 3	Total
Cost of colonoscopies*	€32,174,338.44	€32,851,091.01	€33,488,373.84	€98,513,803.29
Cost of CADe/CADx	€746,952.78	€762,664.13	€777,459.16	€2,287,076.07
Cost of polypectomies	€5,376,020.99	€5,489,099.81	€5,595,583.61	€16,460,704.40
Cost of histopathologies	€4,525,156.65	€4,620,338.45	€4,709,969.03	€13,855,464.13
Cost of CRC	€19,915,104.94	€38,894,783.49	€56,850,544.55	€115,660,432.98
Total cost	€62,737,573.79	€82,617,976.88	€101,421,930.18	€246,777,480.86
Cost per patient	€637.59	€826.22	€1,000.72	€2,464.52

PSA, probabilistic sensitivity analysis; QALY, quality-adjusted life year.

CRC, colorectal cancer. *Corresponds to the initial diagnosis.

Conclusion

From a Spanish NHS perspective, the use of CADe/CADx resulted in a dominant strategy compared to standard practice, and its implementation in the screening program could lead to cost savings in 3 years.

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