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Impact of an Artificial Intelligence-Based Computer Aided Detection System (CADe) on Colonoscopies Performed in Hawai‘i

Ankur Jain, MD, Aadi Jain[1], Diya Jain[1], Shilpa Jain, MD, Ian Pagano, PhD[2]

[1] Punahou School, [2] University of Hawai‘i Cancer Center

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Abstract

The demand for colonoscopies has increased over the last few years due to an aging population combined with a post COVID-19 backlog as well as an ongoing rise in younger patients with colorectal cancer (CRC). Quality indicators ensure that high quality colonoscopies are being performed by endoscopists, thus decreasing the risk of post-colonoscopy CRC arising from lesions missed on the index exam. One common outcome measure is known as the adenoma detection rate (ADR), which is the likelihood that an endoscopist will detect a pre-cancerous polyp during colonoscopy. The Artificial Intelligence (AI) program known as computer-aided detection system (CADe) was designed to improve the ADR of endoscopists by helping them identify colon polyps. Previous studies have evaluated the clinical outcomes of CADe but none were conducted in Hawai‘i. This study was designed to determine the impact of GI Genius (Medtronic), the first CADe introduced in Hawai‘i. Data was collected on aggregate ADR for both male and female patients before and after implementation of GI Genius in several ambulatory surgery centers in Hawai‘i and then a cost-estimate analysis was performed. The GI Genius software program resulted in a statistically significant increase in ADR for both male and female patients. Furthermore, the addition of this program was found to be cost-effective when compared with standard colonoscopy alone due to an anticipated decrease in CRC related health care costs. CADe is a promising new tool for endoscopists, but further studies are needed to determine the long-term benefits on CRC incidence and mortality.

Abbreviations and acronyms

ADR = adenoma detection rate
AGA = American Gastroenterological Association
AI = artificial intelligence
ASC = ambulatory surgery center
CADe/CADx = computer aided detection system
CRC = colorectal cancer
EOCRC = early onset colon cancer
LYG = life years gained
QALY = quality-adjusted life year
SSLDR = sessile serrated lesion detection rate
USPSTF = United States Preventive Services Task Force

Introduction

Since its introduction into health care in the mid-1950s, Artificial intelligence (AI) has revolutionized the field of medicine.[1] From AI-assisted mammogram reading which can detect breast cancer at earlier intervals to robotic surgeries which have improved surgical outcomes, AI has directly impacted patient care by helping health care providers make more precise decisions for their patients.[1] More recently, an AI software program known as a computer-aided detection system (CADe) has been helping gastroenterologists detect pre-cancerous colon polyps called adenoma during colonoscopy.[1]

Polyps are growths in the colon that can develop into colorectal cancer (CRC).[2] CRC is the 3rd most common cancer and 2nd leading cause of cancer-related deaths among both men and women.[3] Due to the ongoing rise of early-onset colorectal cancer (EOCRC), CRC is predicted to be the leading cause of cancer-related deaths in people younger than 50 over the next decade.[4,5] The United States Preventive Services Task Force (USPSTF) recommends that all patients at average risk for CRC begin screening at age 45.[6]

There are various forms of CRC screening, but colonoscopy remains the gold standard because it is the only screening modality which can both detect CRC and prevent it through the removal of adenoma.[2] Specialized training is required to perform colonoscopies and various quality measures have been identified that ensure high quality colonoscopies are being performed by endoscopists. These include: cecal intubation rate, average withdrawal time, bowel preparation adequacy rate, sessile serrated lesion detection rate (SSLDR), as well as adenoma detection rate (ADR).[7]

ADR is the percentage of first-time colonoscopies performed by an endoscopist in which at least one adenoma is detected.[7] An endoscopist's ADR is directly correlated with his or her ability to detect and remove adenoma and thus prevent CRC. Specifically, each 1% increase in ADR is associated with a 3% decrease in subsequent CRC.[8] Recent guidelines recommend that physicians maintain an average ADR of at least 35% (20-30% for female patients and 30-40% for male patients), although the actual rates vary widely from provider to provider.[7]

GI Genius (Medtronic, Minneapolis, MN) was the first commercially available CADe.[9] This software program was approved for marketing by the United States Food and Drug Administration on April 9, 2021 and introduced in Hawai‘i in 2022.[10] Citing the results of previous studies, the manufacturer reports an increase in ADR for endoscopists who use GI Genius through improved detection of polyps during colonoscopy.[11-13] Some previous studies on the efficacy of CADe in clinical practice have shown negative results, however.[14,15]

The authors of this study examined the clinical impact of GI Genius on ADR by colonoscopies performed across several ambulatory surgery centers (ASC) in Hawaiʻi. ADR rates before and after implementation of CADe were reviewed and a cost-effectiveness analysis was then performed.

Methods

This is a retrospective study of aggregate ADR for male and female patients at 3 of United Surgical Partners International's (USPI's) Hawaiʻi based outpatient ASCs: Endoscopy Institute of Hawaiʻi (EIH), Pacific Endoscopy Center (PEC), and The Endoscopy Institute of Hilo (TEH) from 1st quarter of 2021 to 1st quarter of 2025. The GI Genius software was implemented at each of these 3centers in the 1st quarter of 2023.

After receiving approval from USPI's Market President, Tenet Health care's National Research Budget Office, and the MetroWest Institutional Review Board, de-identified information on ADR at the endoscopy centers was provided by USPI's Pathology Department. No patient details, which can identify individuals, were accessible to the researchers at any time during data acquisition, storage, and comparison.

To test for year-over-year (2021-2025) differences in ADR, a generalized linear mixed model (GLMM) was used to analyze ADR by year, stratified by sex. The model assumed a Poisson (count data) distribution with a log link function, incorporating the natural logarithm of colonoscopy counts as an offset to adjust for varying procedure volumes. The year of colonoscopy served as a fixed effect, with 2021 as the reference category; and a random intercept at the physician level accounted for clustering within physicians. The quadrature method facilitated parameter estimation, calculating least squares means with confidence limits for the year effect. The SAS software, version 9.4 (SAS Institute Inc., Cary, NC) GLIMMIX procedure was used for the analyses.

A Markov cohort analysis was then conducted via the SAS IML procedure to evaluate the cost-effectiveness of CADe compared to standard colonoscopy in hypothetical cohorts of 1000 patients undergoing colorectal screening starting at age 45. Over a 50-year horizon (50 annual cycles), the model simulated lifetime outcomes, including total costs (with a 3% annual discount rate applied to reflect the time value of money and preference for earlier benefits), quality-adjusted life years (QALYs), life years gained (LYG), and new CRC cases.

The model incorporated 9 mutually exclusive health states with the initial state distribution taken from previous studies: (1) Healthy (66.8%), (2) Small Adenoma (⩽5 mm; 16.8%), (3) Medium Adenoma (6-9 mm; 14.2%), (4) Large Adenoma (⩾10 mm; 2.0%), (5) CRC Stage I (0.07%), (6) CRC Stage II (0.09%), (7) CRC Stage III (0.06%), (8) CRC Stage IV (0.04%), and (9) Death (0%).[5,16-18] Transitions between states were governed by a 9x9 transition probability matrix, identical for both strategies to reflect the same natural history of disease progression. Key transition probabilities included annual progression rates from healthy to small adenoma (0.012), small to medium adenoma (0.035), medium to large adenoma (0.022), and large adenoma to CRC Stage I (0.050), with background mortality (0.008-0.574 depending on state) and CRC stage-specific progression.[16,19]

Also included in the model were CRC disease stages. According to the Centers for Disease Control and Prevention (CDC) the distribution on presentation in the US is 31.9% for Stage 1, 38.4% for Stage 2-3, 22.4% for Stage 4, and the remaining 6.2% have an unknown stage.[3] For cost of disease, the following state-specific annual values in US dollars were assigned after a literature search of approximate costs for varying stages of CRC: $0 for non-CRC states (1-4 and 9); $50 100 for CRC I; $144 275 for CRC II; $161 279 for CRC III; and $207 540 for CRC IV.[20,21] Procedure-specific costs included colonoscopy ($1105.00), polypectomy ($451.32), histopathology ($514.45), and CADe/CADx add-on ($12.26).[16,22] Sidecar Health provides a publicly available Care calculator (Sidecar Health, El Segundo, CA) which includes the average total cash price of colonoscopy performed at an ambulatory surgery center in Hawaiʻi, regardless of insurance status.[22]

At model initiation (cycle 1), adenoma were detected and removed during the screening colonoscopy, with detected cases transitioned back to the healthy state. Histopathology was applied to all detected adenomas in the standard arm but only to those >5 mm in the CADe/CADx arm according to a "resect and discard protocol" advocated by Bustamante-Balen, Taghiakbari, and others for CADe assisted cases.[16,23] CADx is an additional software program that can provide real-time identification of the histology of a polyp.

To estimate cumulative QALYs utility values from previous studies were included to represent the health-related quality of life associated with each health state, ranging from 0 (death) to 1 (perfect health). Values were 0.88 for non-CRC adenoma states, 0.74 for CRC I-II, 0.59 for CRC III, 0.25 for CRC IV, and 0 for death.[16] Adenoma miss rates were set at 32% for standard colonoscopy and 16% for CADe/CADx, also based on previous data, reflecting improved detection sensitivity in the intervention arm.[16,24]

Results

Effectiveness

Between Quarter 1 2021 and Quarter 1 2025, a total of 20 777 colonoscopies were performed and 9248 adenoma were detected across all 3 USPI centers (**Table 1**).

Using 2021 as a baseline, there was a statistically significant increase in ADR for male patients in 2023 (44.4% versus 50.3%, 95% CI 45.3% to 55.9%, *P*=.006) and 2024 (44.4% versus 53.7%, 95% CI 48.4% to 59.5%, *P* <.001) **(Figure 1)**. For female patients there was a statistically significant increase in ADR in 2023 (29.2% versus 40.2%, 95% CI 35% to 46.1%, *P* <.001) which persisted through 2024 (29.2% versus 38.5%, 95% CI 33.5% to 44.2%, *P* <.001) and the first quar-

Table 1. Number of Colonoscopies Performed and Adenoma Detected across all Centers[a] between Quarter 1 of 2021 and Quarter 1 of 2025

Year	Sum of Total Screening Colonoscopies	Sum of Adenoma Detected
2021	4255	1682
2022	5017	2030
2023	5327	2529
2024	5080	2471
2025/Q1	1098	536
TOTAL	20777	9248

[a]Centers include the Endoscopy Institute of Hawai'i, Pacific Endoscopy Center, and Endoscopy Center of Hilo.

ter of 2025 (29.2% versus 42.1%, 95% CI 35.5% to 50.1%, *P* <.001) (**Figure 1**).

The implementation of GI Genius in the first quarter of 2023 resulted in a statistically significant increase in ADR for both male and female patients throughout the duration of this study with the exception of male patients in the first quarter of 2025. The average increase in ADR was 6.97% per year for males and 11.07% per year for females.

Cost-Effectiveness

Between the beginning of Quarter 1 2023 and the end of Quarter 1 2025, a total of 11 507 colonoscopies were performed across all 3 USPI centers (**Table 1**).

According to Sidecar Health, the average global cost of a colonoscopy done at an ASC in Hawai‘i is $1105 per colonoscopy.[22] GI Genius is leased to the 3 centers at a cost of $1 000 + tax/room/month, or $5225/month across all 3 centers, for a total cost of approximately $141 075 or $12.26 per colonoscopy performed during this period. Therefore, the addition of GI Genius increased the total cost from $1105 to $1117.26 per colonoscopy during the study period.

Adenoma detection at the initial colonoscopy was higher with CADe/CADx (277.2 total detections per 1000 patients) than standard (224.4). Sensitivity was improved across all sizes: small (141.4 vs. 114.4), medium (119.2 vs. 96.5), and large (16.6 vs. 13.5). Subsequent cycle analysis simulated natural progression without further interventions.

For a hypothetical cohort of 1000 patients eligible for a single colonoscopy, the addition of GI Genius was associated with 277 polypectomies, 136 histopathologies, and detection of 45 CRC cases (**Table 2**). In comparison, standard clinical practice was associated with 224 polypectomies, 224 histopathologies, and detection of 59 CRC cases (**Table 2**). Therefore, the use of GI Genius during colonoscopy resulted in 53 excess polypectomies but avoided 88 histopathology analyses and had 14 fewer cases of CRC (45 vs. 59) due to early-stage detection and removal of pre-cancerous lesions (**Table 2**). This was a 24% decrease in expected CRC rate.

Per-patient lifetime costs were lower with CADe/CADx ($16 512) compared to standard colonoscopy ($23 400), representing a cost savings of $6888. Effectiveness outcomes slightly favored CADe/CADx, with gains of 0.071 QALYs (20.184 vs. 20.113) and 0.065 LYG (22.975 vs. 22.910) per patient. The ICUR (incremental cost-utility ratio) was -$96 880/QALY, and the ICER (incremental cost-effectiveness ratio) was -$106 369/LYG, indicating that CADe/CADx not only reduced costs but also improved health outcomes (**Table 3**).

Discussion

Effectiveness

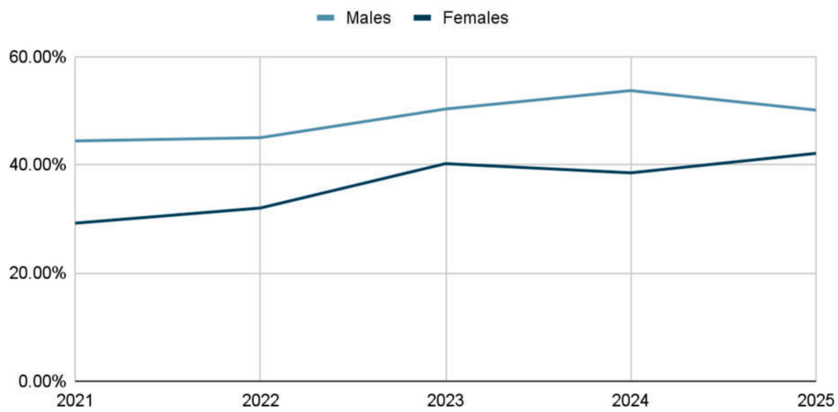
The addition of CADe to colonoscopies performed at several ambulatory surgery centers in Hawai‘i resulted in an average increase in ADR of approximately 7% per year for male patients and 11% per year for female patients. This correlates with a decrease in interval CRC rates of 21% for male patients and 33% for female patients.[8] The increase was statistically significant throughout the course of the study with the exception of male ADR in the final quarter, possibly due to a smaller sample size. One study cited by the manufacturer reported increases in ADR of up to 14.4% with the use of CADe.[9,11] However, a recent clinical practice guideline on CADe-assisted colonoscopy the American Gastroenterology Association (AGA) determined that CADe increases ADR by 8% which is similar to the results of this study.[25] The adenoma miss rate was found to be lower with CADe by 19% with an 11% increase in non-neoplastic polyps (higher false positives).[25]

Interestingly, the authors of the AGA summary found that many patients were excited about the possibility of CADe reducing CRC mortality while some providers were apprehensive about the potential increase in procedure time and cost.[26] Therefore, even if CADe is feasible to implement across different facilities, not all providers would be willing to incorporate it into their practices.

Cost-Effectiveness

Previous cost-savings models have shown that reducing CRC incidence in the United States by 15% per year could potentially save up to 150 000 life years and $624 million in health care costs.[26] Cost-analysis studies from Spain, Canada, and Japan, all with nationalized health care systems, have determined that CADe is financially beneficial due to enhanced detection of adenoma and subsequent CRC prevention.[16,27,28] Using a modeling system of health care associated costs in the United States, this study found that in a hypothetical cohort of 1000 patients across the US undergoing colorectal screening the lifetime savings was approximately $7000 per patient when comparing CADe-assisted colonoscopy with colonoscopy alone, largely due to a predicted 24% decrease in CRC rate after the addition of CADe. These findings suggest that integrating CADe/CADx into routine screening at age 45 within the United States could also yield substantial economic as well as clinical benefits nationwide.

The enhancements in ADR and corresponding reductions in interval CRC rates are projected to yield individual gains in life years and QALYs, with modeling studies es-



Sex	Year	Aggregate ADR (95% CI)	Absolute difference	P[a,b]
Males	2021	44.4% (39.8%-49.5%)	-	-
	2022	45.0% (40.4%-50.0%)	+0.6%	.79
	2023	50.3% (45.3%-55.9%)	+5.9%	**.006**
	2024	53.7% (48.4%-59.5%)	+9.3%	**<.001**
	2025/Q1	50.1% (43.1%-58.3%)	+5.7%	.10
Females	2021	29.2% (25.3%-33.8%)	-	-
	2022	32.0% (27.8%-36.9%)	+2.8%	.07
	2023	40.2% (35.0%-46.1%)	+11.0%	**<.001**
	2024	38.5% (33.5%-44.2%)	+9.3%	**<.001**
	2025/Q1	42.1% (35.5%-50.1%)	+12.9%	**<.001**

Figure 1. Aggregate Adenoma Detection Rates (ADR) for Male and Female Patients by Year between Quarter 1 of 2021 and Quarter 1 of 2025

[a]Based on a *t*-test
[b]*P*-values in bold indicate statistical significance

Table 2. Disease Progression in a Hypothetical Cohort of 1000 Patients Undergoing Colonoscopy Alone (Standard Practice) versus Colonoscopy with Computer Aided Dection (CADe/CADx)

	Standard Practice	CADe/CADx	Difference
Colonoscopies	1000	1000	-
Polypectomies	224	277	53
Histopathologies	224	136	-88
New Colorectal Cancer Cases	59	45	-14

timating incremental benefits of approximately 0.07 life years and 0.07 QALYs per patient screened. While the individual gains (equivalent to about 26 days for each) may appear modest, they become more meaningful when aggregated across large populations. When applied to 1000 screened individuals, it translates to 70 additional years overall, representing significantly enhanced health, reduced morbidity, and potential cost savings in colorectal cancer management at the societal level.

Downsides of AI

As with any other AI program, there are some concerns about the use of CADe in colonoscopy including higher costs, overreliance on technology, and job displacement. Currently less than half of facilities in the United States, most commonly academic centers, use this software program.[29] The additional monthly costs associated with CADe may be too high for some facilities to absorb. The authors of the cost-effectiveness study from Spain felt that the short-term increase in health care costs associated with CADe

Table 3. Cost-effective Analysis in a Hypothetical Cohort of 1000 Patients Undergoing Colonoscopy Alone (Standard Practice) Versus Colonoscopy with CADe/CADx Using Markov Model

	Standard Practice	CADe/CADx	Difference
Total LYG/QALY	22.91/20.11	22.98/20.18	0.07/0.07
Total costs	$23 399.67	$16 511.78	-$6 887.89
Diagnostic cost	$1105.00	$1117.26	$12.26
Disease management cost	$22 294.67	$15 394.52	-6 900.15
ICER ($/LYG)	-$106 369.39/LYG		
ICUR ($/QALY)	-$96 879.91/QALY		

LYG=Life Years Gained
QALY=Quality Adjusted Life Years
ICER=Incremental Cost-Effectiveness Ratio
ICUR=Incremental Cost-Utility ratio

would be balanced in the long term by CRC management savings.[16] If cost-effectiveness is demonstrated in additional studies, it is possible that more facilities or insurance companies themselves may be willing to invest in this program.

An additional concern is the higher pathology costs due to detection and removal of non-clinically significant polyps. In an abstract presented at the American College of Gastroenterology Annual Conference in 2024, Herman and her colleagues reported a higher percentage of benign lesions detected by CADe (30.9%) versus standard colonoscopy alone (22.7%), without removal of any precancerous adenoma.[30] To counteract this, some experts have suggested a "resect and discard" or even "leave in situ" strategy for polyps less than 5mm in size detected by CADe, particularly in the rectosigmoid area.[16,24,31,32] This method was used in the hypothetical model, but not in the actual patient cohort.

New fellows in gastroenterology must be able to demonstrate adequate polyp detection and removal before successfully completing a training program. With the advent of CADe, experienced endoscopists may lose their polyp detection skills. This concept is known as "deskilling" and has been seen in recent studies.[33,34] Instead, it may be most beneficial to target those endoscopists with low ADR rates when implementing CADe. In fact, a very recent observational study found that only endoscopists with a baseline ADR of less than 26% will have a lower interval CRC risk when their ADR improves.[35] The authors of this present study chose to blind the individual endoscopists to protect physician privacy.

Finally, some physicians are concerned that advancing AI technology may take away jobs in the health care sector. Both of the CADe scenarios "resect and discard" and "leave in-situ" require fewer specimens to be removed and sent for histopathologic analysis, thus potentially decreasing staffing in ambulatory surgery centers and pathology departments.

Study limitations

Limitations of this study include retrospective analysis of ADR rates, lack of data on adenoma size and histology, estimated values and "resect and discard" strategy used for modeling study, and the need for long-term effects on mortality.

Due to the retrospective design of this study, the ADR rates of endoscopists performing CADe-assisted colonoscopy could not be compared in a head-to-head fashion with those performing colonoscopy without CADe. The same endoscopists performed colonoscopies throughout the 5-year study period, however, which allowed a direct comparison of their ADR rates before and after implementation of GI Genius. In addition, the 2-year follow-up period helped increase the power of the study.

SSLDR, or the percentage of first-time colonoscopies performed by an endoscopist in which at least one sessile serrated adenoma is detected, is another important quality measure.[6] Serrated adenoma are flatter polyps that are usually located in the proximal colon and are often more difficult to identify.[2] A recent study by Seager and others found that the addition of CADe increased the SSLDR by 3.3% with an odds ratio of 1.49.[36] In the summary by AGA, an increase in SSLDR of 1% was reported.[25] The AGA also noted a 2% increase in detection of advanced adenoma for CADe-assisted colonoscopies .[25] Advanced adenoma include polyps >1cm, adenoma with tubulovillous/villous histology, and adenoma with high-grade dysplasia and carry a higher malignant potential.[2]

The modeling study is based only on estimated values including adenoma missed rates and cancer related costs. Furthermore, the "resect and discard" protocol avoided the known costs associated with CADe-assisted detection and analysis of small, non-clinically significant polyps. Future studies are needed to determine if CADe is indeed a cost-savings tool which can help combat the ongoing rise in national health care costs. Finally, the immediate increase in ADR will need to be followed out for a longer period to determine the true impact on CRC rates and subsequent patient mortality.

Conclusion

The implementation of GI Genius in several ambulatory surgery centers in Hawai'i resulted in a statistically significant increase in ADR. Furthermore, the addition of this software was found to be cost-effective when compared with standard colonoscopy alone. Additional long-term studies are needed to determine if CADe will help decrease CRC associated mortality.

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Conflict of interest

None of the authors identify any conflict of interest.

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