

# Artificial Intelligence in Endoscopy for Colorectal Cancer

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# Disclosures

- Redesign Health – Equity Ownership

# OBJECTIVES

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# Objectives

- Briefly review background related to artificial intelligence in endoscopic colorectal cancer screening
- Discuss novel research in:
  - Computer Aided Polyp Detection (CADe)
  - Computer Aided Polyp Diagnosis (CADx)

# AI BACKGROUND

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# How it Started



**Puppy or Bagel?**

**Chihuahua or Blueberry Muffin?**

**Labradoodle or Fried Chicken?**

Puppies Or Food? 12 Pics That Will Make You Question Reality. Bored Panda. <https://www.boredpanda.com/dog-food-comparison-bagel-muffin-lookalike-teenybiscuit-karen-zack/>.

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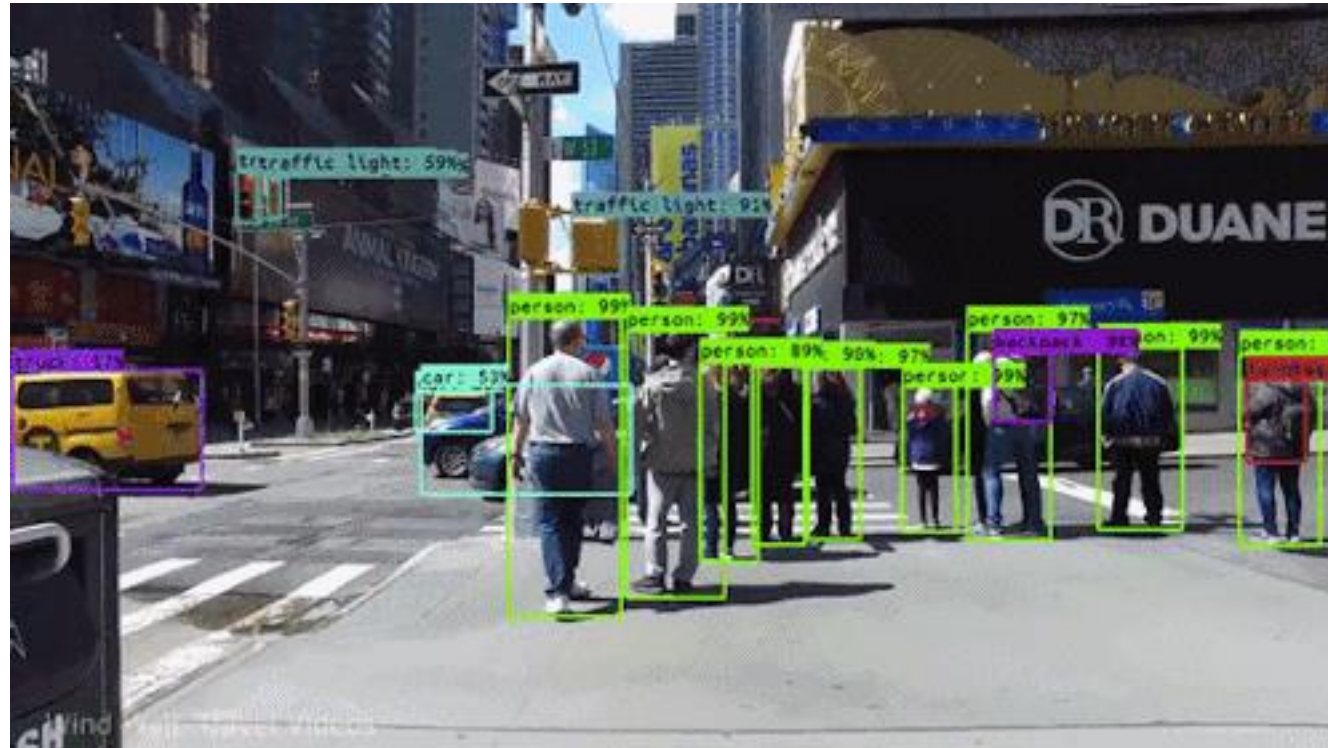


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# How it's Going



Real time object labeling

Agarwal R. Object Detection using Deep Learning Approaches: An End to End Theoretical Perspective. Medium. <https://towardsdatascience.com/object-detection-using-deep-learning-approaches-an-end-to-end-theoretical-perspective-4ca27eee8a9a>. Published April 30, 2019.

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# AI for Polyp Detection

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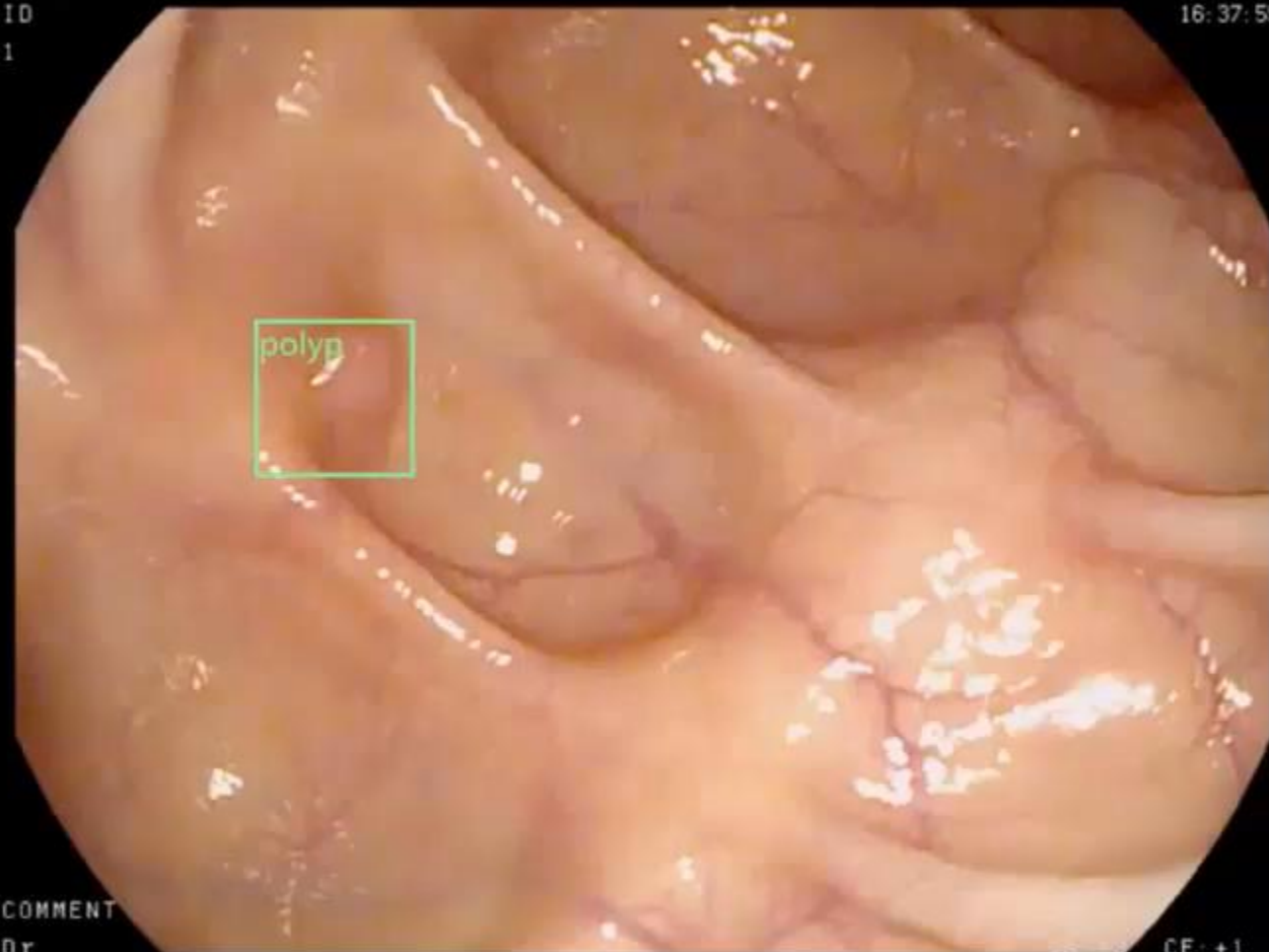
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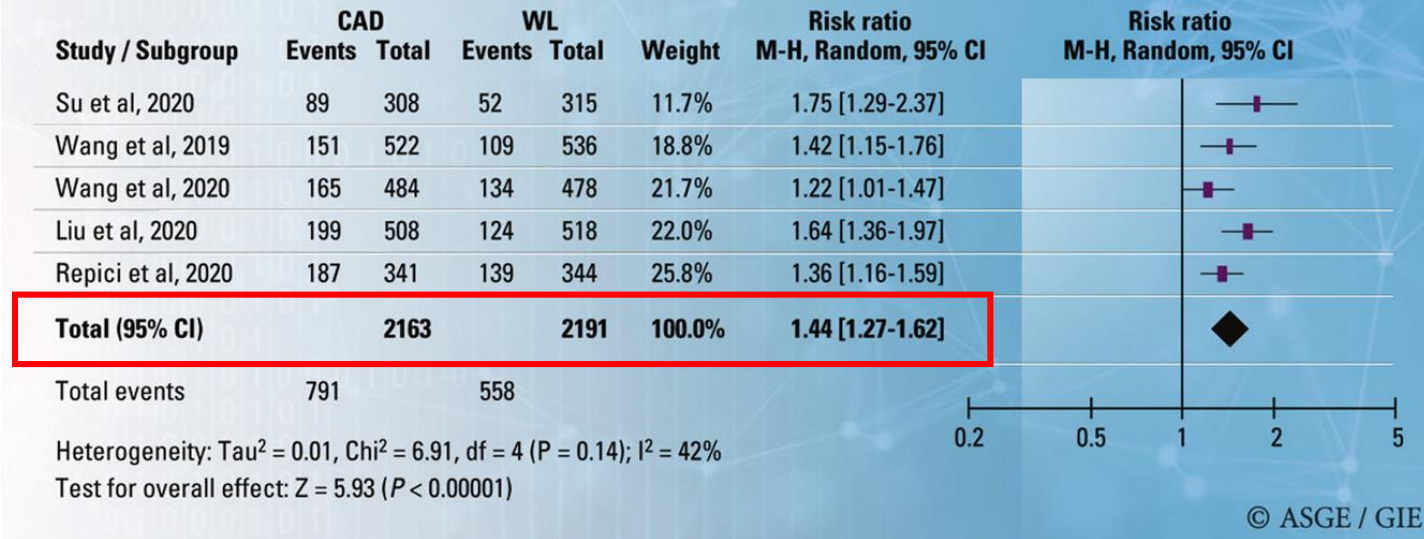
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# AI Improves ADR in RCT's

- Adenoma detection rate evaluated in multiple randomized controlled trials
- AI consistently improves ADR
  - Even in high performing groups
  - Regardless of
    - Polyp size
    - Polyp location
    - Polyp morphology

Comparative effectiveness of CAD versus control group on ADR



<b>Gong et al, 2020</b>	<b>56</b>	<b>355</b>	<b>27</b>	<b>349</b>	<b>2.04</b>
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# Polyp Detection AI is Here

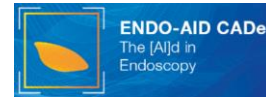
- US

- GI Genius – Medtronic
- EndoScreener – Wision A.I. (coming soon)



- Europe

- CAD EYE – Fujifilm
- Detection and Classification
- ENDO-AID – Olympus
- DISCOVERY – Pentax



- Japan

- CAD EYE – Fujifilm
- Detection and Classification
- EndoBRAIN – Cybernet
- Clinical data in Japan



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# UPDATES IN POLYP DETECTION

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# A New Multi-Center Randomized Controlled Study

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# Artificial Intelligence for adenoma detection: a multi-center RCT. Study Methods

- Multiple centers in China and Mongolia participated
  - Total of 6 centers
- Recruited subjects randomized 1:1 to AI-assisted colonoscopy or conventional colonoscopy
- Subjects were blinded
- Randomization stratified by endoscopists' experience
  - Junior endoscopist  $\leq$  5000 colonoscopies
  - Senior endoscopist  $>$  5000 colonoscopies

H Xu et al. ARTIFICIAL INTELLIGENCE ASSISTED COLONOSCOPY FOR ADENOMA DETECTION IN SCREENING COLONOSCOPY: A MULTI-CENTRE RANDOMIZED CONTROLLED STUDY.

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# Artificial Intelligence for adenoma detection: a multi-center RCT. Study Methods

- Inclusion criteria
  - Asymptomatic
  - 45-75 years old
  - Indication for colonoscopy was screening or fecal immunochemical test positive
- Exclusion criteria
  - Contraindication for colonoscopy
  - Overt symptoms of colorectal disease
  - History of inflammatory bowel disease, colorectal cancer, polyposis syndrome, prior colorectal surgery
  - Colonoscopy within 10 years

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# Artificial Intelligence for adenoma detection: a multi-center RCT. Study Methods

- Technology
  - Eagle Eye (Xiamen Innovision, Xiamen, China)
- Definitions
  - Advanced adenoma = size  $\geq$  10 mm, villous component, high grade dysplasia
- Sample size calculation
  - Baseline ADR 37% (based on studies in China) and AI-assisted colonoscopy would increase this by 5%
  - A total of 2994 subjects would be required

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# Artificial Intelligence for adenoma detection: a multi-center RCT. Study Results

- A total of 3227 patients were assessed for eligibility
  - 115 excluded or declined
- N=3059 patients were randomized
- Intention-to-treat analysis
  - n=1519 patients vs n=1540 patients
- Per-protocol analysis (patients excluded for incomplete colonoscopy vs inadequate prep)
  - n=1238 patients vs n=1289 patients

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# AI for adenoma detection: Results

Table 1. Patient baseline characteristics

	AI Group N=1519	Standard Group N=1540	p-value
Age (years), mean+/-SD	57.49 +/- 7.55	57.03 +/-7.43	0.086
Gender, male, n (%)	707 (46.5)	728 (47.3)	0.686
BMI (kg/m <sup>2</sup> ), mean+/-SD	23.91 +/- 3/24	23.91 +/-3.19	0.961
Family history of CRC, n (%)	50 (3.3)	46 (3.0)	0.629
Ever smoking, n (%)	222 (14.6)	221 (14.4)	0.836
Alcohol consumption, n (%)	139 (9.2)	139 (9.0)	0.904
Hypertension, n (%)	168 (11.1)	189 (12.3)	0.296
Diabetes, n (%)	70 (4.6)	75 (4.9)	0.733
Ischemic heart disease, n (%)	38 (2.5)	30 (1.9)	0.299
Stroke, n (%)	6 (0.4)	6 (0.4)	0.981
Liver cirrhosis, n (%)	3 (0.2)	3 (0.2)	0.987
Fatty liver, n (%)	122 (8.0)	116 (7.5)	0.606
GERD, n (%)	34 (2.2)	34 (2.2)	0.954
Colonoscopy for screening population, n (%)			
Colonoscopy for FIT Positive subjects	59 (3.9)	68 (4.4)	0.758
Colonoscopy for FIT Negative subjects	620 (40.8)	628 (40.8)	
Direct screening colonoscopy	840 (55.3)	844 (54.8)	

**Groups are well matched**

AI = artificial intelligence, SD = standard deviation, BMI = body mass index, CRC = colorectal cancer, GERD = Gastroesophageal reflux disease

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# AI for adenoma detection: ADR increased even with poor prep

Table 2. Colonoscopy findings and outcomes in AI Group and Standard Group

	AI Group	Standard Group	p-value
	N=1519	N=1540	
Overall ADR	623 (41.0)	519 (33.7)	<0.001
Mean number of adenomas per colonoscopy	0.61 +/- 0.98	0.47 +/- 0.83	<0.001
Overall ADR of SENIOR endoscopist (%)	324/754 (43.0)	241/720 (33.5)	<0.001
Overall ADR of JUNIOR endoscopist (%)	299/765 (39.1)	278/820 (33.9)	0.032
ADR among patients with BBPS <6 (%)	66/162 (40.7)	43/146 (29.5)	0.039
ADR for non-advanced adenoma	509 (33.5)	431 (28.0)	0.001
ADR for advanced adenoma	100 (6.6)	75 (4.9)	0.041
Colorectal cancer detection rate	14 (0.9)	13 (0.8)	0.819

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# AI for adenoma detection: ADR increased in small and large; proximal and distal

Table 2. Colonoscopy findings and outcomes in AI Group and Standard Group

	AI Group	Standard Group	p-value
	N=1519	N=1540	
ADR for adenoma size: <5mm	267 (17.6)	197 (12.8)	<0.001
5-9mm	243 (16.0)	236 (15.3)	0.609
≥ 10mm	99 (6.5)	73 (4.7)	0.033
ADR for pedunculated adenoma (%)	174 (11.5)	154 (10.0)	0.193
ADR for non-pedunculated adenoma* (%)	435 (28.6)	352 (22.9)	<0.001
Proximal colon# ADR, n (%)	441 (29.0)	380 (24.7)	0.007
Distal colon^ ADR, n (%)	168 (11.1)	126 (8.3)	0.007

AI = artificial intelligence, BBPS = Boston bowel prep score, ADR = adenoma detection rate

\*Non-pedunculated adenoma included flat, depressed, sessile adenomas.

#Proximal colon: from transverse colon to caecum

^Distal colon: from rectum to splenic flexure

# AI for adenoma detection: Withdrawal time increased

Table 2. Colonoscopy findings and outcomes in AI Group and Standard Group

	AI Group	Standard Group	p-value
	N=1519	N=1540	
Cecal intubation rate, n (%)	1499 (98.7)	1520 (98.7)	0.965
BBPS, median (IQR)	7 (6-8)	7 (6-8)	0.012
Adequate bowel preparation (%)	1336 (88.0)	1364 (88.6)	0.595
Immediate adverse event, n (%)	0	0	NA
Intubation time (mins), median (IQR)	4.48 (3.33-6.30)	4.17 (3.17-5.76)	<0.001
Withdrawal time (mins), median (IQR)	8.25 (6.67-12.00)	7.78 (6.45-11.00)	0.004

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# Artificial Intelligence for adenoma detection: a multi-center RCT. Conclusions

- AI assistance improved overall ADR including small and large polyps, non-advanced and advanced adenomas, and proximal and distal adenomas
- Adenomas per colonoscopy was also increased
- Effect persisted even with poor prep
- Senior and junior endoscopists both benefited
- Withdrawal time was longer with AI

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# How Does AI Perform in Combination with Other Devices?

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# Combination of CADe and a mucosal exposure device (Endocuff) Study Methods

- Single center prospective randomized controlled study
- Inclusion criteria
  - Asymptomatic patients aged 50-75 years old who underwent screening colonoscopy or colonoscopy for positive fecal immunochemical test
- Exclusion criteria
  - Inflammatory bowel disease
  - Familial polyposis syndrome
  - Prior colonic resection
  - Prior pelvic radiation

Aniwan, Satimai et al. The differences in adenoma detection rates and other indices between standard screening colonoscopy vs computer-aided detection vs mucosal exposure devices vs the combination: a randomized trial. Presentation #413

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# Combination of CADe and a mucosal exposure device (Endocuff) Study Methods

- Randomization in a 1:1:1:1 fashion
- Equipment
  - CAD-EYE (Fujifilm Japan)
  - Endocuff Vision
  - Fujifilm white light colonoscope



Aniwan, Satimai et al. The differences in adenoma detection rates and other indices between standard screening colonoscopy vs computer-aided detection vs mucosal exposure devices vs the combination: a randomized trial. Presentation #413

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# Combination of CADe and a mucosal exposure device (Endocuff) Study Results

- N = 942 patients
  - Control n=237
  - CADe alone n=237
  - Endocuff alone (EAC) n=235
  - CADe + Endocuff (CADe + EAC) n=233

Aniwan, Satimai et al. The differences in adenoma detection rates and other indices between standard screening colonoscopy vs computer-aided detection vs mucosal exposure devices vs the combination: a randomized trial. Presentation #413

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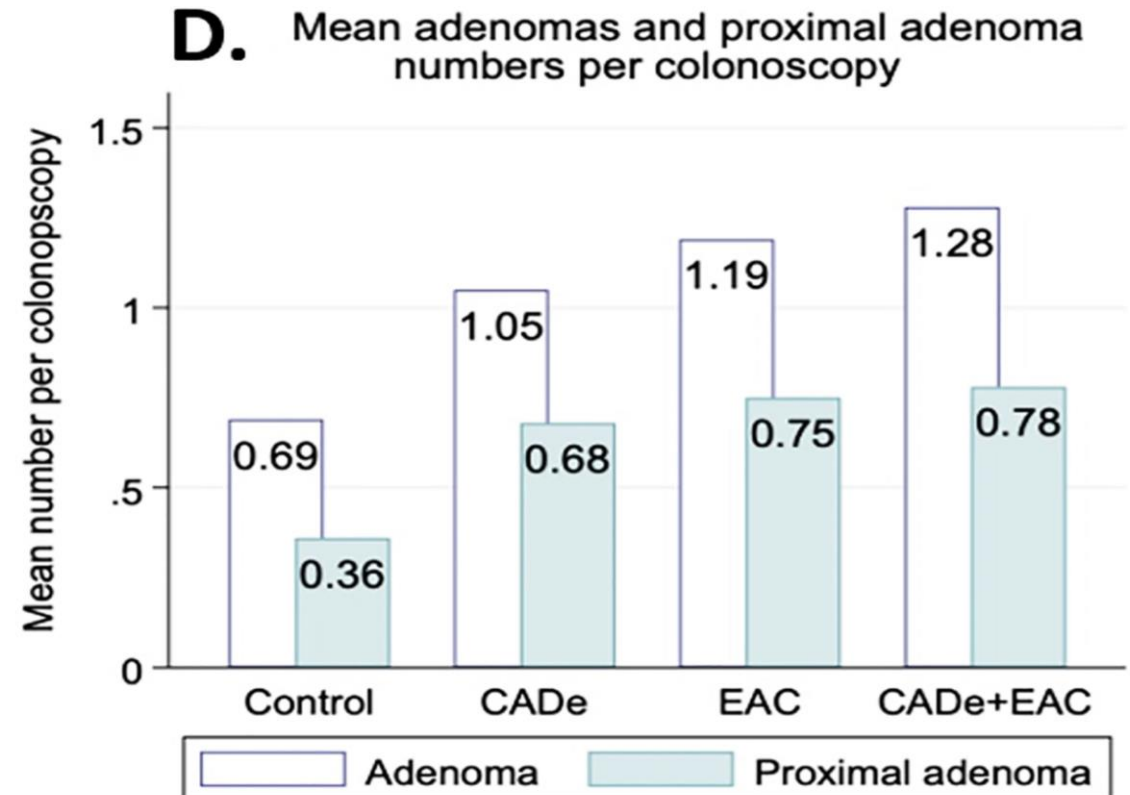
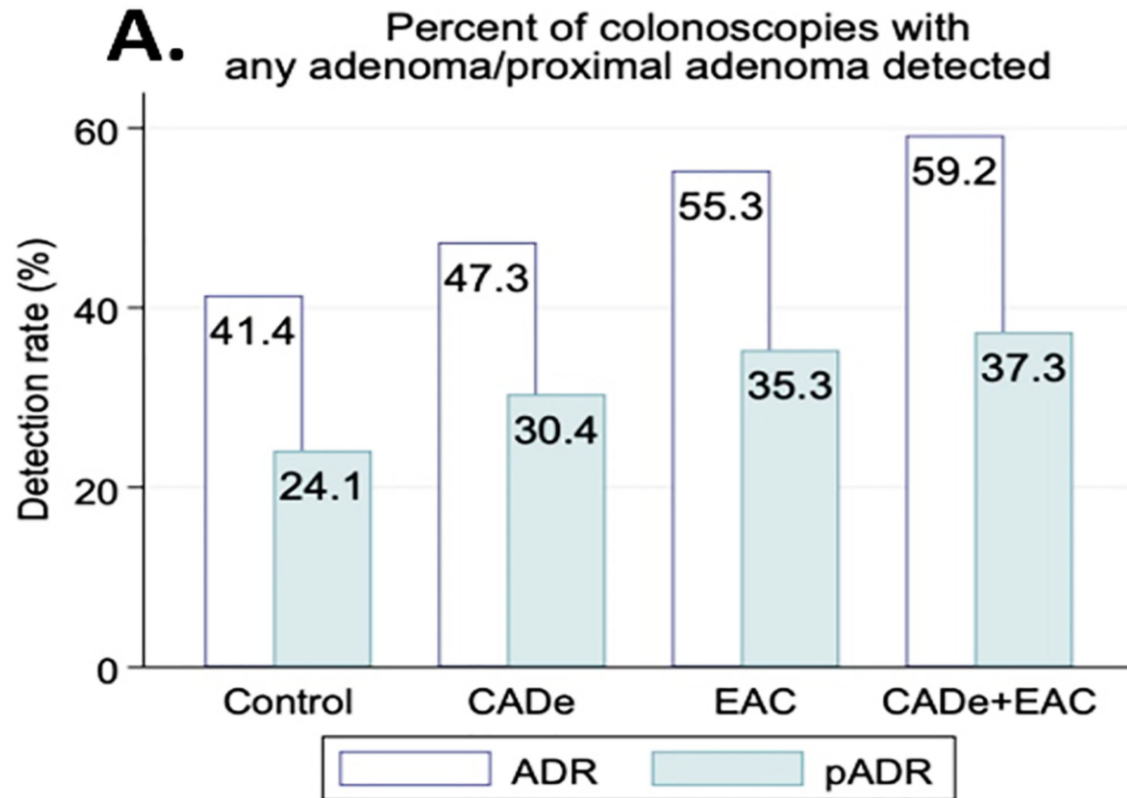
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# Combination of CADe and a mucosal exposure device (Endocuff) Study Results



CADe = computer aided detection

EAC = Endocuff

# Conclusion: mucosal exposure may be more important than polyp detection

- Both the computer aided detection device and the mucosal exposure device increased polyp detection
- Mucosal exposure device increased polyp detection more than the CADe (non-significantly)
- Although the combination was better than either alone, the marginal benefit of CADe was small

Aniwan, Satimai et al. The differences in adenoma detection rates and other indices between standard screening colonoscopy vs computer-aided detection vs mucosal exposure devices vs the combination: a randomized trial. Presentation #413

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# Cost-Effectiveness of AI for Polyp Detection

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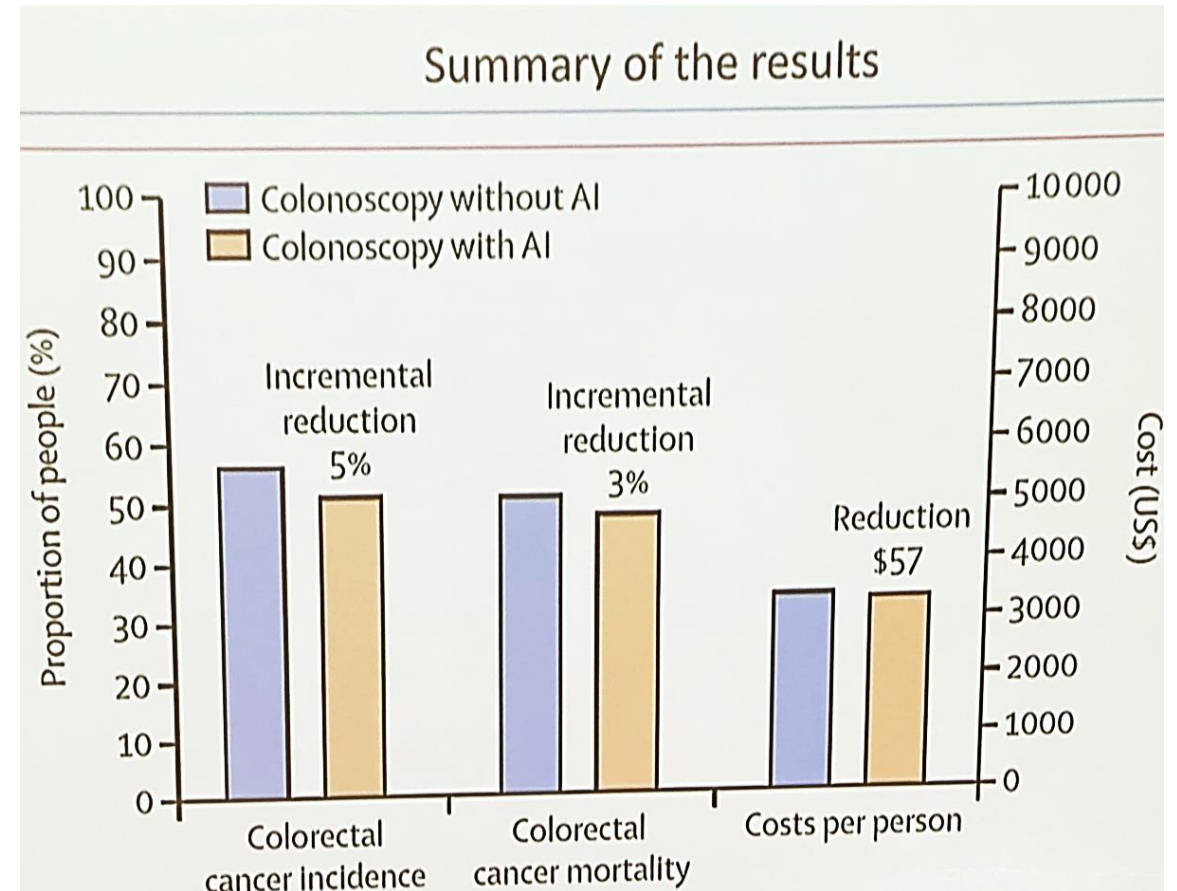
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# AI-assisted colonoscopy cost modeling study

- AI implementation in practice can be costly
  - Capital expense or monthly subscription model
  - Increased cost of pathology, repeat colonoscopies
- Mori et al. modeled reduction in colon cancer and associated costs
  - Markov model microsimulation of colonoscopy with and without AI assisted polyp detection
  - Screening with colonoscopy every 10 years starting age 50, with and without AI
  - Post-polypectomy surveillance followed current guidelines
  - Costs of AI tools and downstream treatment of detected disease were estimated

# AI-assisted colonoscopy could reduce overall healthcare costs

- Reduction in CRC incidence was improved
  - Total 5% improvement in CRC reduction
  - 8,999 cases prevented
- Reduction in CRC mortality was improved
  - Total 3% improvement in CRC mortality
  - 2,622 deaths prevented
- Total costs decreased
  - \$290 million yearly cost decrease
  - \$57 per person



# UPDATES IN POLYP DIAGNOSIS

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# Polyp diagnosis - Background

- ASGE PIVI (Preservation and Incorporation of Valuable Endoscopic Innovations) Criteria
- “Resect and discard” criteria for diminutive adenomas
  - Requirements
    - $\geq 90\%$  negative predictive value for adenoma
    - $\geq 90\%$  agreement in surveillance intervals
  - Proven to be achievable with narrow band imaging (NBI)
    - Requires training and auditing

Rex DK, Kahi C, O'Brien M, et al. The American Society for Gastrointestinal Endoscopy PIVI (Preservation and Incorporation of Valuable Endoscopic Innovations) on real-time endoscopic assessment of the histology of diminutive colorectal polyps. *Gastrointestinal Endoscopy*. 2011.

Patel SG, Schoenfeld P, Kim HM, et al. Real-Time Characterization of Diminutive Colorectal Polyp Histology Using Narrow-Band Imaging: Implications for the Resect and Discard Strategy. *Gastroenterology*. 2016

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# AI Assisted Polyp Detection for a Diagnose-and-Leave strategy to colorectal polyps

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# AI for leaving-in-situ colorectal polyps: Background

- “Resect and Discard” strategy for  $\leq 5$  mm adenomas in the colon
- “Diagnose and Leave” strategy for  $\leq 5$  mm hyperplastic polyps in the rectosigmoid colon
- Large potential for cost savings
- Not adopted in clinical practice

C. Hassan et al. ARTIFICIAL INTELLIGENCE FOR LEAVING-IN-SITU COLORECTAL POLYPS:  
RESULTS OF A CLINICAL TRIAL.. Presentation #416

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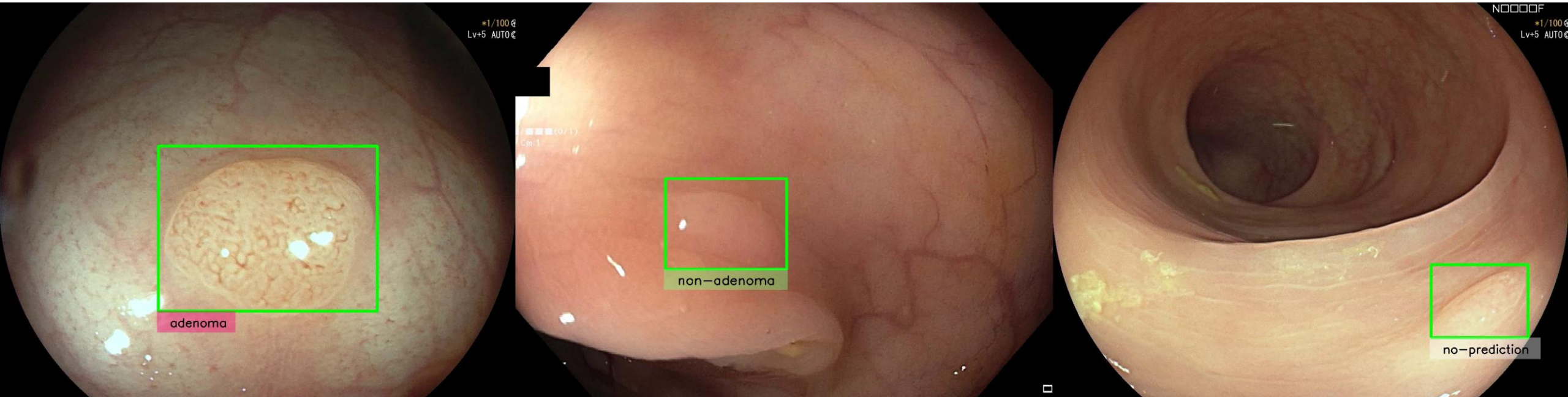
# AI for leaving-in-situ colorectal polyps: Methods

- Prospective single arm single center study
- Investigator initiated
- Open access colonoscopy (> 40 year old patients, any indication)
- Device: GI-Genius CADx module
- White-light, non-magnified colonoscopy with real-time analysis

# AI for leaving-in-situ colorectal polyps: Methods

- Primary endpoint:
  - Assess the negative predictive value (NPV) for adenomatous histology for diminutive ( $\leq 5$  mm) polyps in the rectosigmoid colon
- Secondary endpoints:
  - Post-polypectomy surveillance interval agreement according to ESGE/USMTF
  - Sensitivity, specificity, accuracy, and PPV

# AI for leaving-in-situ colorectal polyps: Results



C. Hassan et al. ARTIFICIAL INTELLIGENCE FOR LEAVING-IN-SITU COLORECTAL POLYPS:  
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# AI for leaving-in-situ colorectal polyps: Results

- Total of n=162 patients, n=305 rectosigmoid polyps
- CADx diagnostic performance for diagnose-and-leave
  - **NPV = 97.6% (94.1-99.1) (goal >90% for PIVI)**
  - Sensitivity = 82% (66.5-92.5)
  - Specificity = 93.2% (89.4-96)
  - PPV = 97.1% (94.1-98.8)
  - Accuracy = 91.7% (99-94.6)

C. Hassan et al. ARTIFICIAL INTELLIGENCE FOR LEAVING-IN-SITU COLORECTAL POLYPS:  
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# AI for leaving-in-situ colorectal polyps: Results

- Agreement with surveillance intervals with resect-and-discard strategy
  - ESGE guidelines: 95.6% agreement (90.8%-97.9%)
  - USMSTF guidelines: 95.9% agreement (89.8%-98.4%)

C. Hassan et al. ARTIFICIAL INTELLIGENCE FOR LEAVING-IN-SITU COLORECTAL POLYPS:  
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# AI for leaving-in-situ colorectal polyps: Conclusions

- Computer aided diagnosis with this system (GI-Genius) meets PIVI criteria for optical diagnosis
- This strategy has potential cost savings from reduction in pathological analysis

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# SUMMARY

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# Summary

- New RCT by Xu et al. consistently shows improved ADR across multiple polyp sizes and locations
  - Also first to report performance in poor prep
- Study by Aniwan et al. demonstrates that computer aided polyp detection can be combined with a mucosal exposure device (Endocuff)
- Cost modeling by Mori et al. shows cost savings on a population level with computer aided detection
- Study by Hassan et al. demonstrates excellent performance of computer aided diagnosis of diminutive rectosigmoid polyps

THANK YOU



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