AI in gastrointesitnal endoscopy

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New digital concepts in Medicine

- eHealth and digital health - conceptual infrastructures of different digital technologies

- Artificial intelligence

Role of AI in endoscopy

CADe

CADx

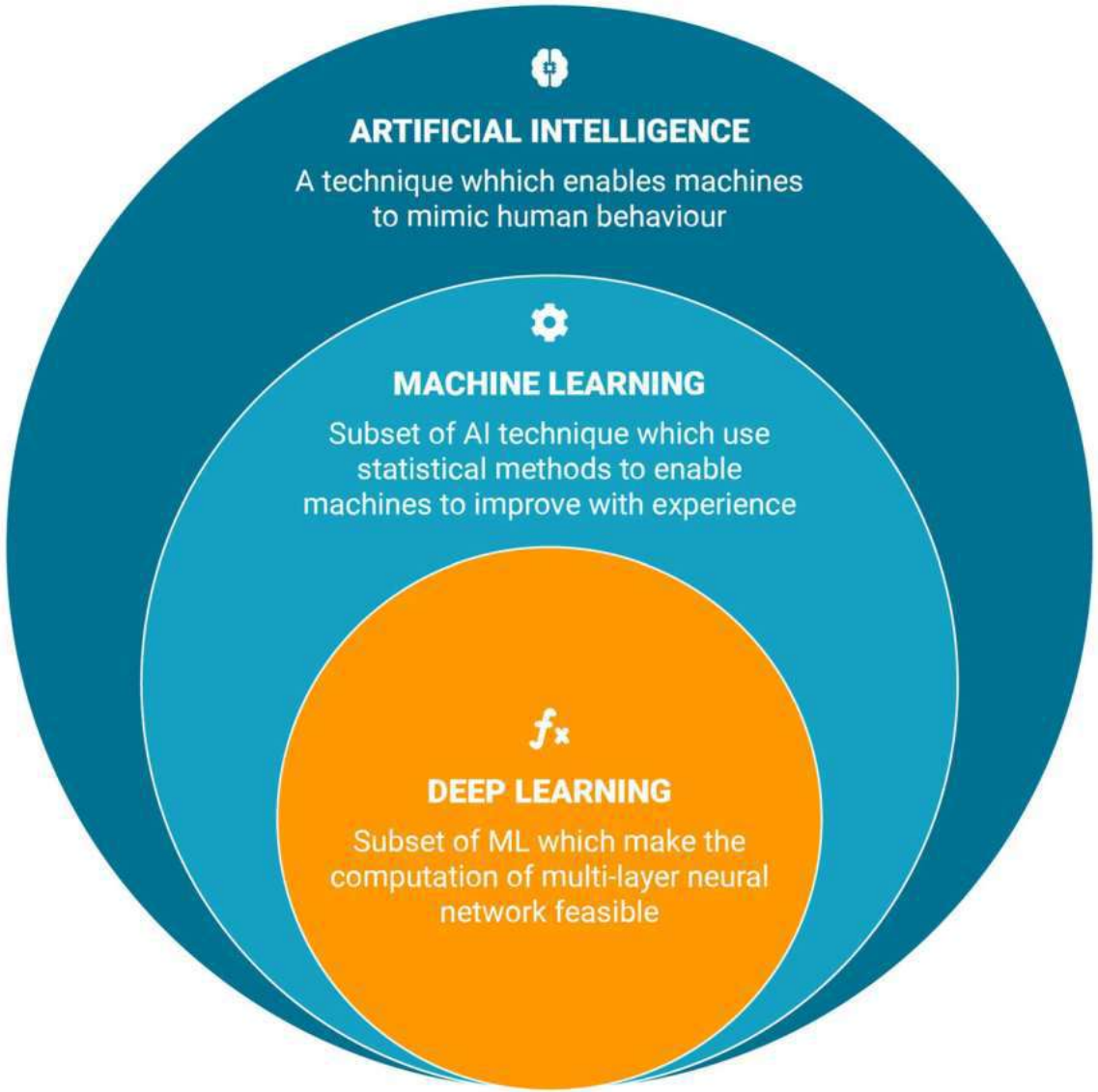
CAQ

With AI fundamental changes are underway

- AI is already all-over us in our daily activities

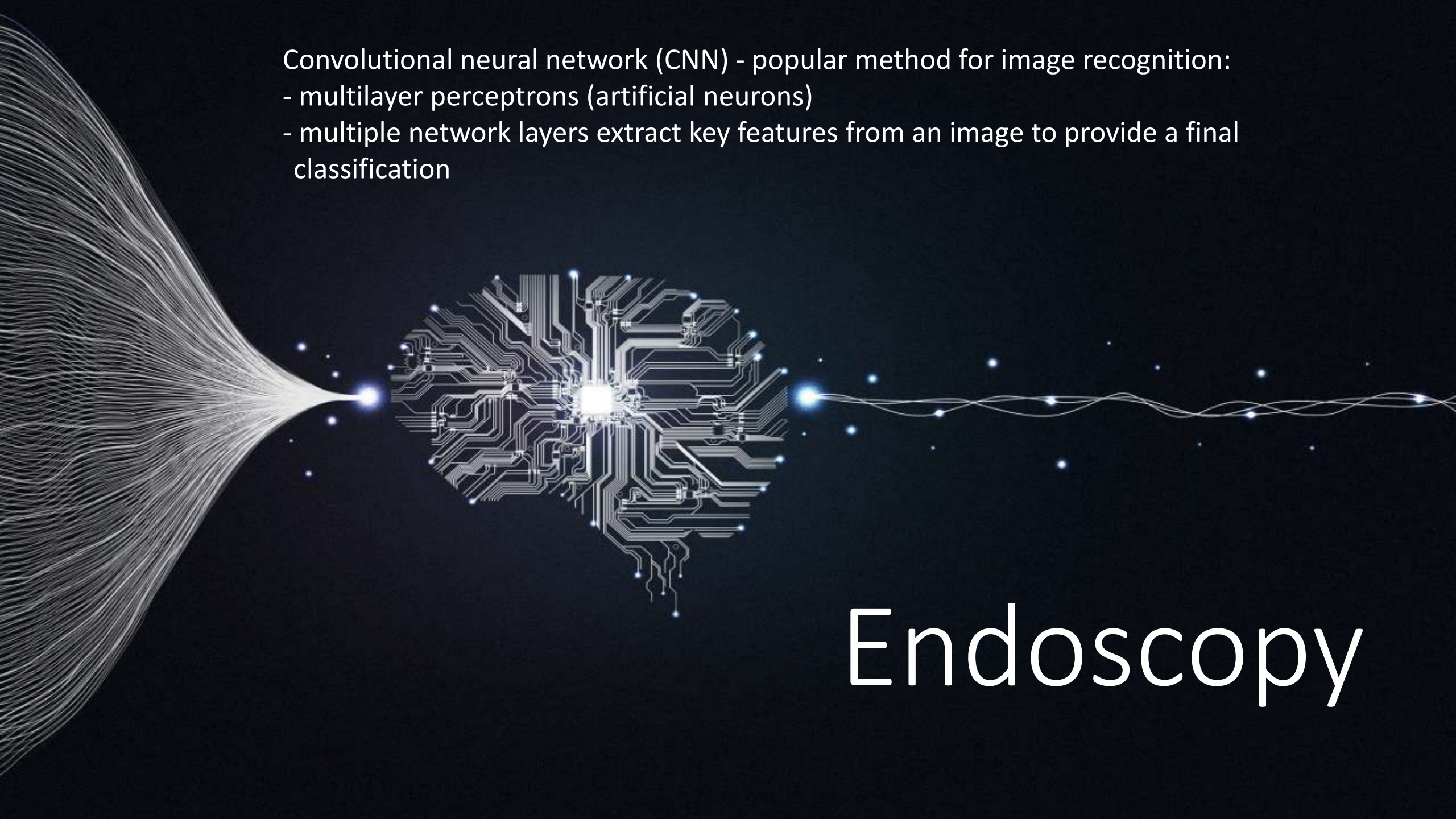
- humans are limited
- what is the normal ‘range’ of perception of something: AI says 100 %

- paradigm shift – AI replacing humans in detecting pathology and making diagnosis ≈ 100 % accuracy - no missed cases, no interval cancers, no mortality from CRC
- paradigm shift – AI replacing the need tor tissue acquisition – optimal treatment - less complications - less workload - less accessories



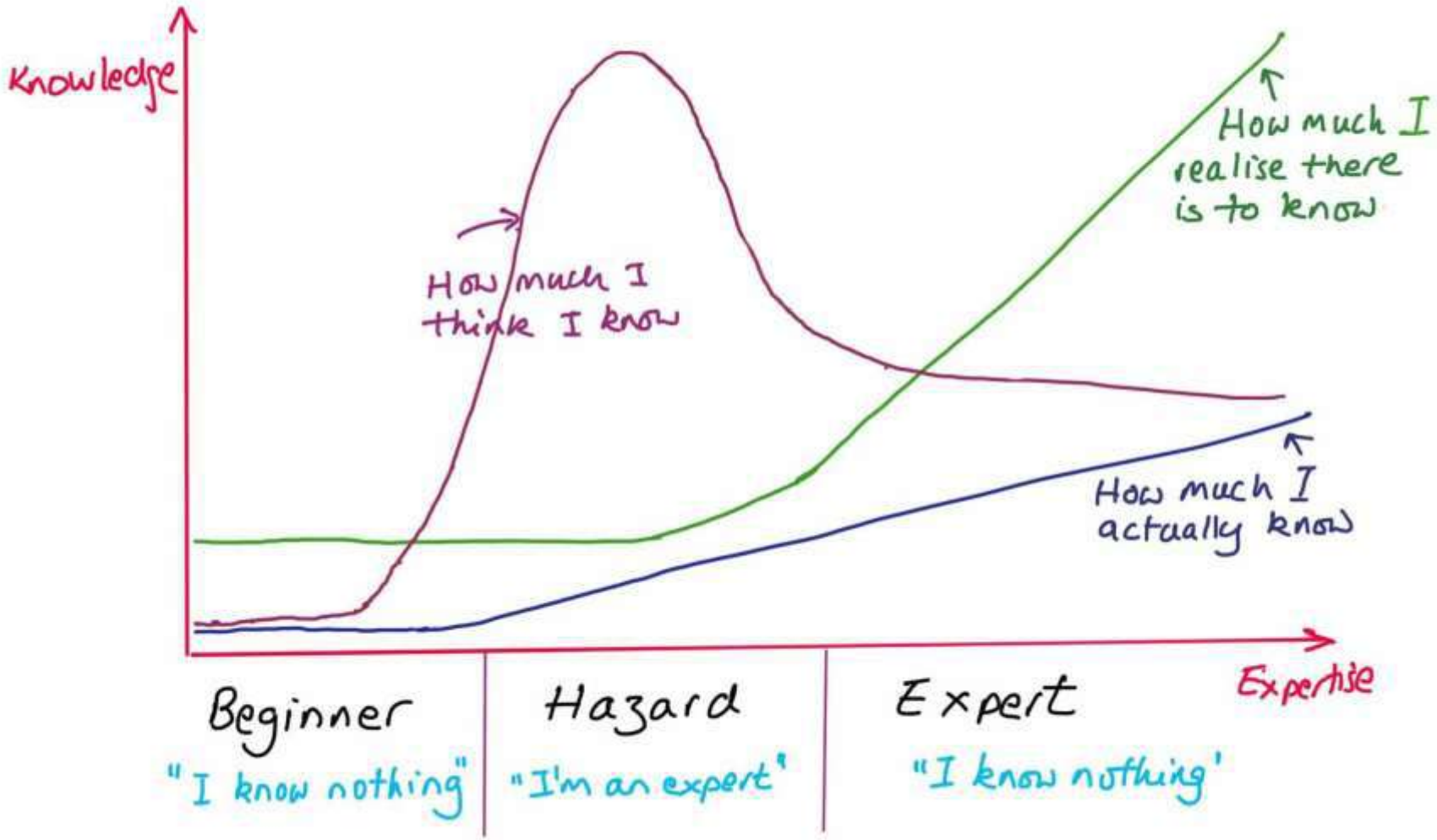
Aria Zand et al . Dig Dis Sci. 2022; doi: 10.1007/s10620-022-07506-8.

Convolutional neural network (CNN) - popular method for image recognition:
- multilayer perceptrons (artificial neurons)
- multiple network layers extract key features from an image to provide a final classification



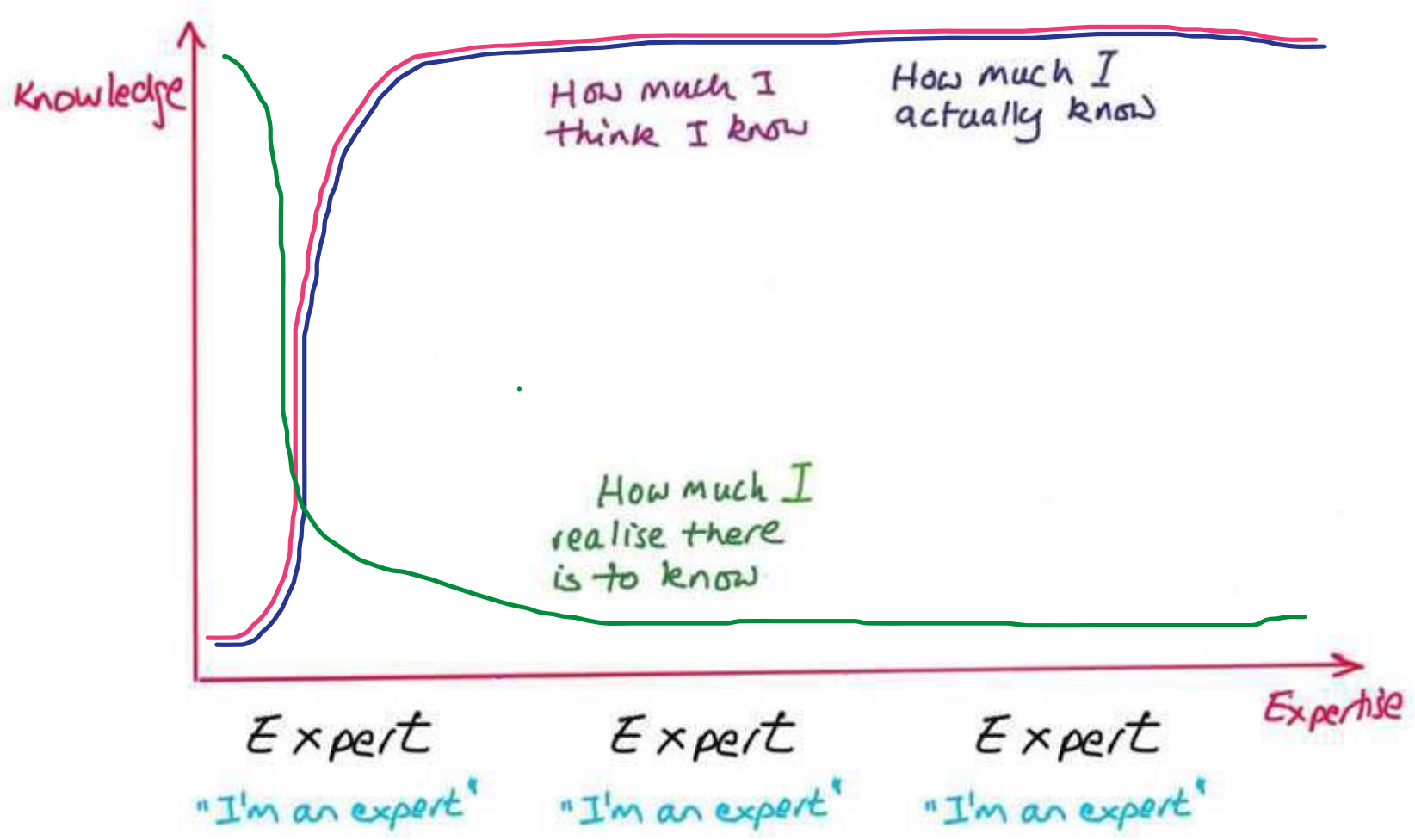
Endoscopy

Endoscopist

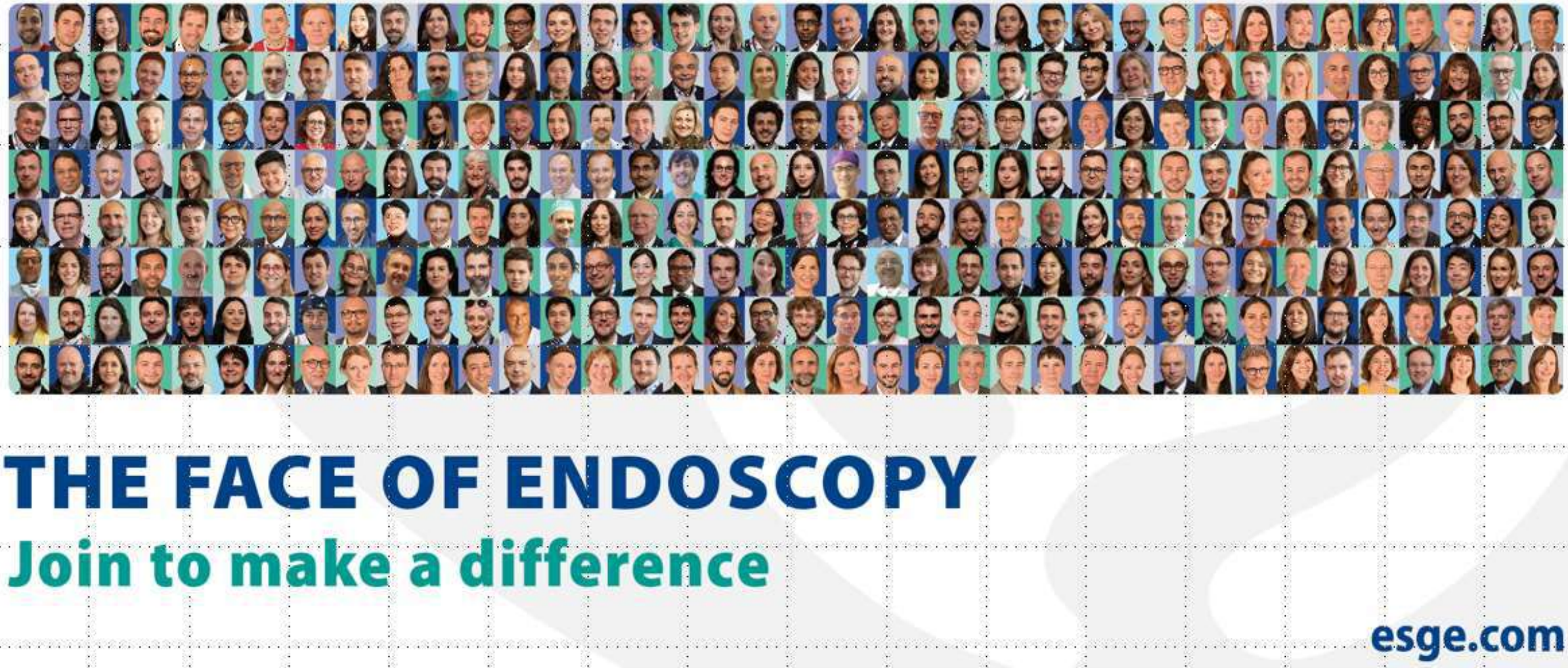


By Monz Ahmed

AI machine

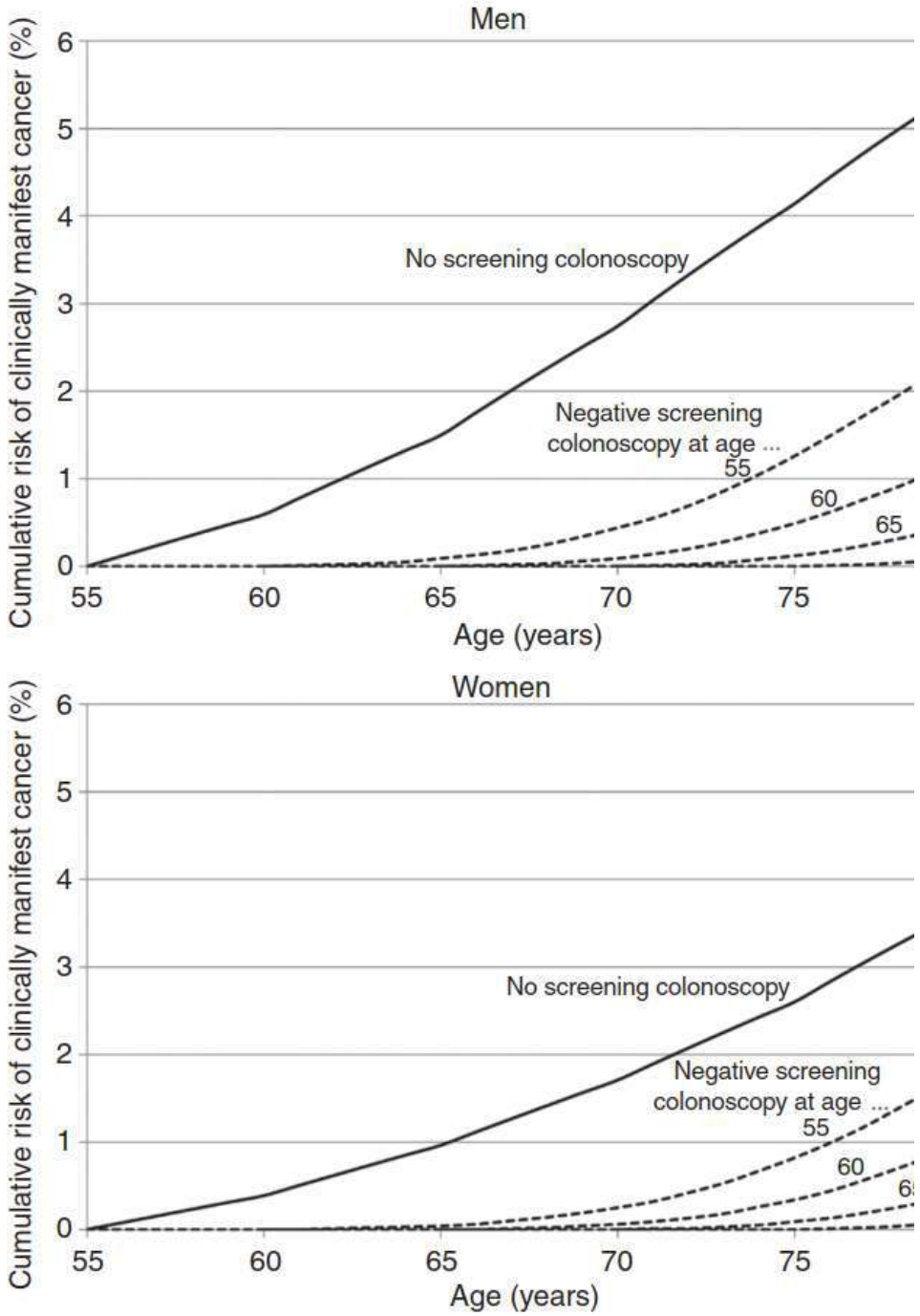


Modified by Tomislav Bokun



(considerable) differences in performance – room for improvement

Role of AI for the detection of GI lesions



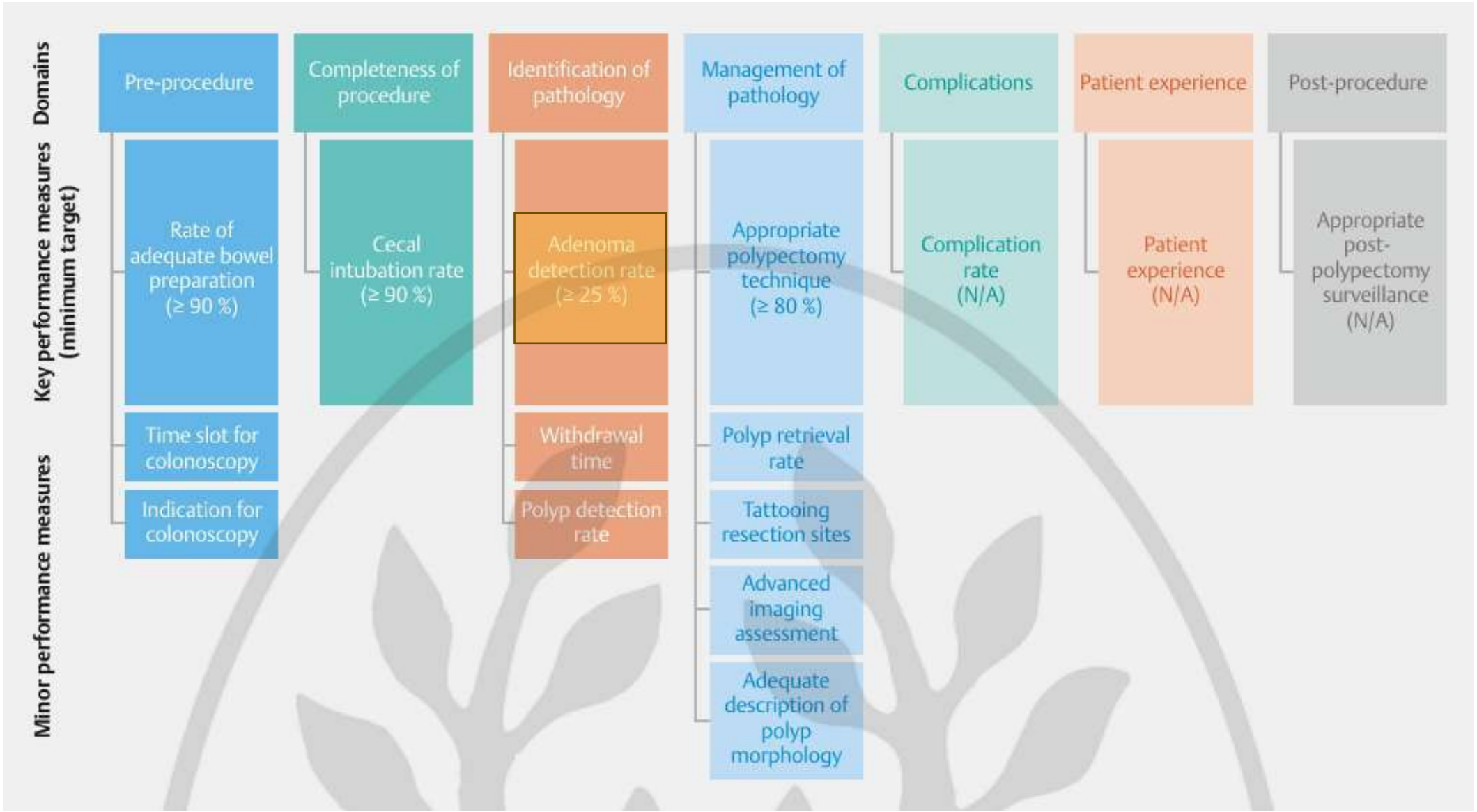
Screening colonoscopy

cumulative risk of clinically manifest colorectal cancer up to the age of 80 years among people with a negative screening colonoscopy at ages 55, 60, 65, and 70 years

compared with cumulative risk between ages 55 and 80 years among people with no screening colonoscopy

database: German screening colonoscopy registry

Brenner Hermann et al. Cancer Epidemiol Biomarkers Prev 2014;23(9):1920–7



Kaminski Michal F et al. Performance measures for lower gastrointestinal endoscopy: ESGE Quality Improvement Initiative. Endoscopy 2017; 49

Quality indicator	Strength of recommendation	Measure type	Performance target (% [unless otherwise indicated])
2. Rate of bowel preparation adequacy* Percentage of patients undergoing colonoscopy with adequate bowel preparation, preferably defined as Boston Bowel Preparation Scale score ≥2 in each of 3 colon segments or by description of the preparation as excellent, good, or adequate. The recommended screening or surveillance interval should be consistent with U.S. Multi-Society Task Force recommendations.	1C	Process	≥90
3. Cecal intubation rate* Percentage of patients undergoing colonoscopy with intact colons who have full intubation of the cecum with photo documentation of cecal landmarks.	1C	Process	≥95
4. Adenoma detection rate* Percentage of patients aged ≥45 y undergoing colonoscopy for screening, surveillance, or diagnostic indications other than positive noncolonoscopy screening tests (eg, fecal tests or CT colonography) who have ≥1 conventional adenomas detected and verified by pathology. Patients with positive noncolonoscopy screening tests, genetic cancer syndromes (eg, polyposis), IBD, or undergoing colonoscopy for therapy of known neoplasms are excluded from the calculation.	1C+	Outcome	≥35
7. Sessile serrated lesion detection rate* Percentage of patients aged ≥45 y undergoing screening, surveillance, or diagnostic colonoscopy for symptoms with ≥1 sessile serrated lesions removed and documented by pathology. Patients with positive noncolonoscopy screening tests, genetic cancer syndromes (eg, polyposis), IBD, or undergoing colonoscopy for therapy of known neoplasms are excluded from the calculation.	2C	Outcome	≥6
8. Average withdrawal time in normal colonoscopies without biopsy sampling or polypectomies in persons aged ≥45 y undergoing screening, surveillance, or diagnostic colonoscopy. Patients with positive noncolonoscopy screening tests, genetic cancer syndromes (eg, polyposis), IBD, or undergoing colonoscopy for therapy of known neoplasms are excluded from the calculation.	2A	Process	≥8 min
9. Percentage of polyp resections for which the report documents the lesion size, shape, location, and method of resection.	3	Process	≥98

Screening (non-positive FIT), surveillance, and diagnostic colonoscopy:

-> 40% for men

-> 30 % for women

positive FIT:

-> 50%

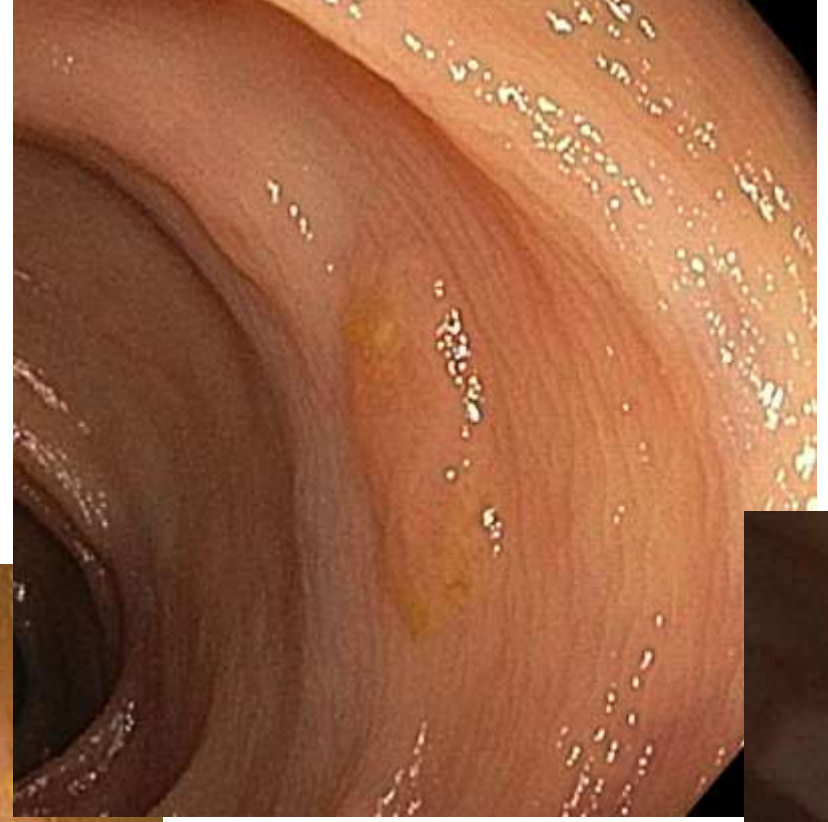
Rex DK et. Quality indicators for colonoscopy. Gastrointest Endosc. 2024 Sep;100(3):352-381

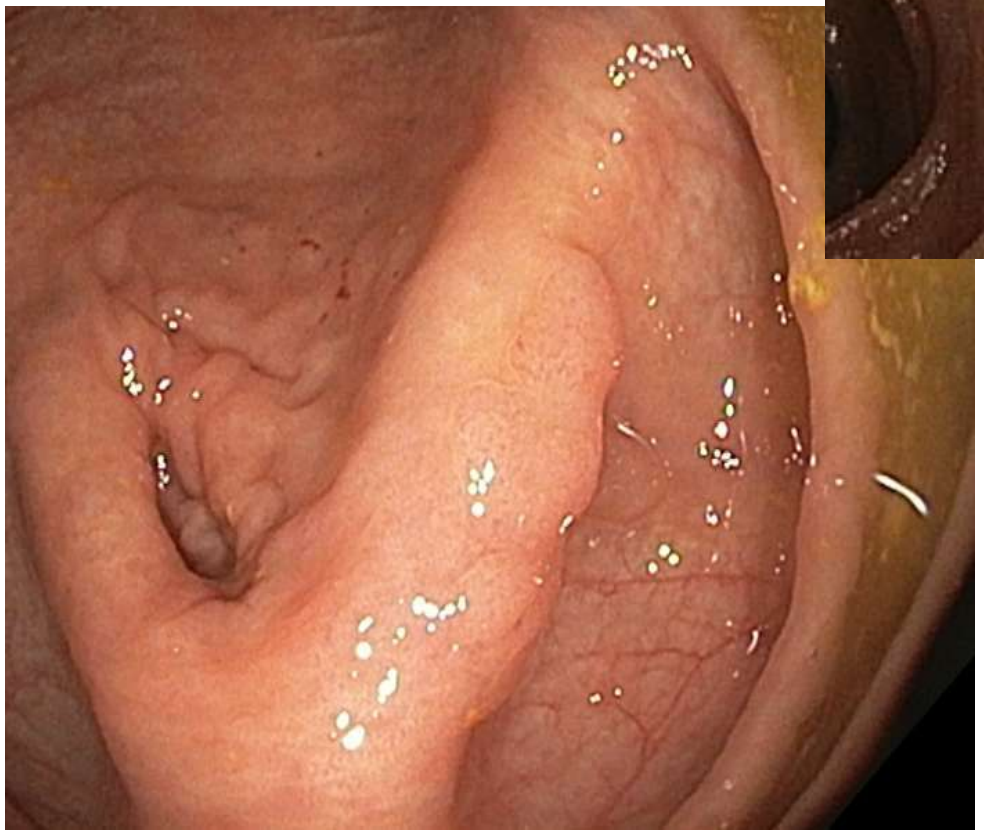
ADR as key performance measure

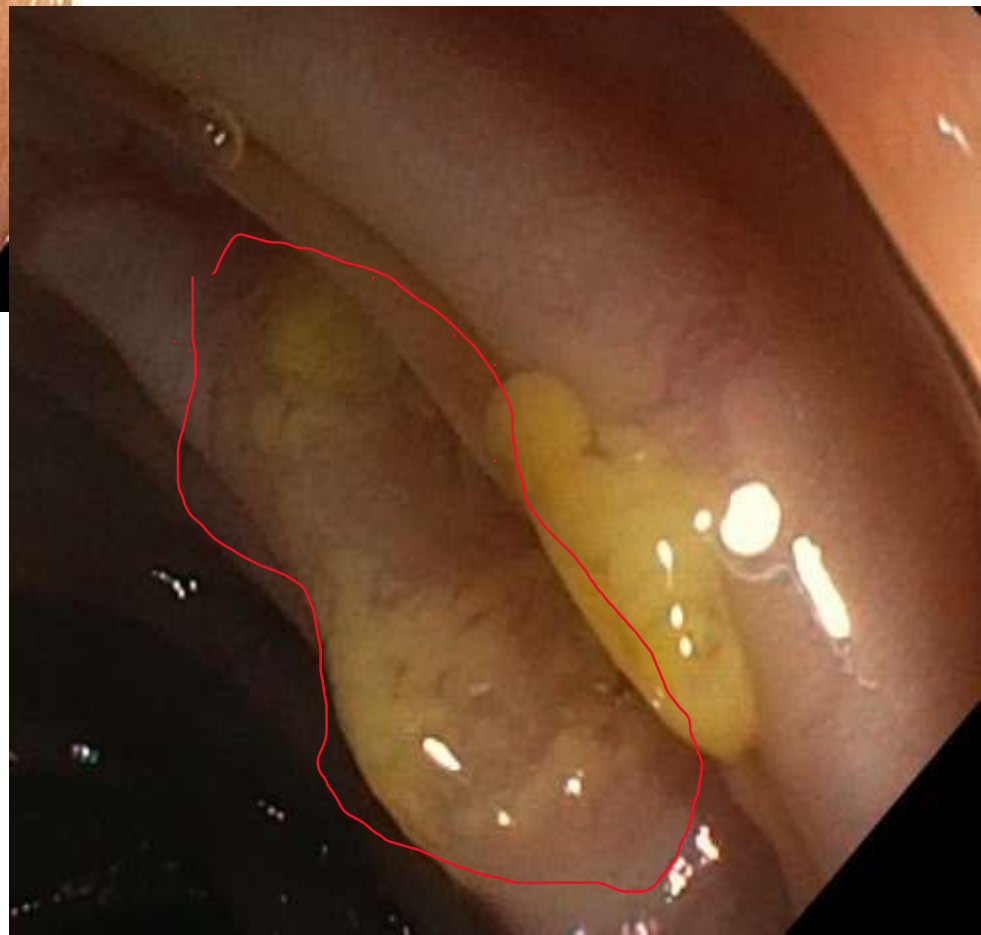
- ADR - goal is:
  - for men ≥ 30 % (40%, ASGE 2024)
  - for women ≥ 20 % (30%, ASGE 2024)
- **AMR** and AAMR (meta-analysis of ≈ 15 000 tandem colonoscopies)
  - AMR 26% and AAMR 9% and 27% serrated polyps missed rate

- **AI's AMR and AAMR significalntly reduced**

Raf Bisschops et al. ESGE Guideline on advanced imaging for detection and differentiation of colorectal neoplasia. Endoscopy 2019; 51
Zhao S et al. Gastroenterology 2019;156:1661–1674



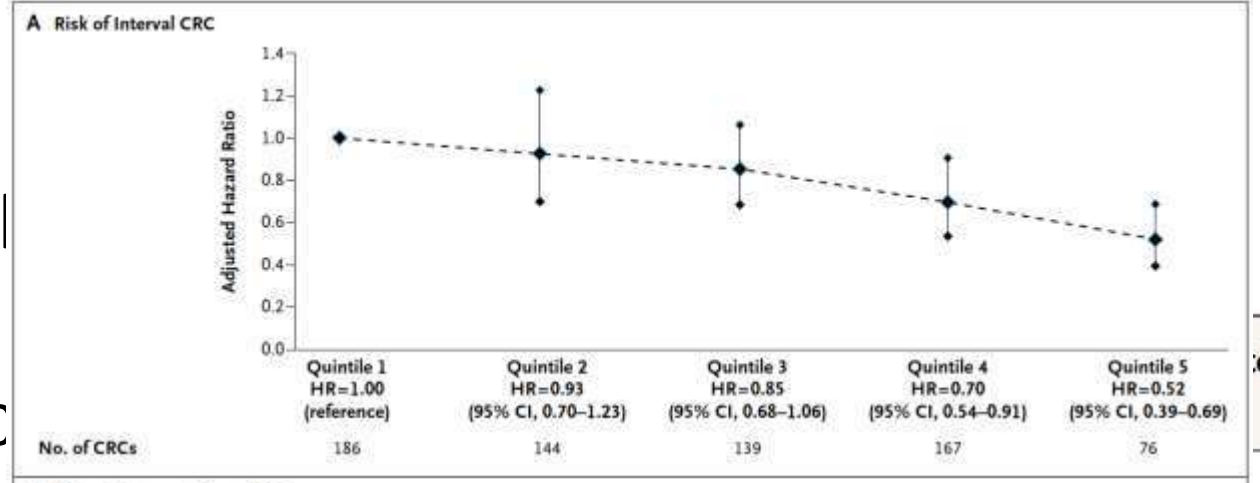


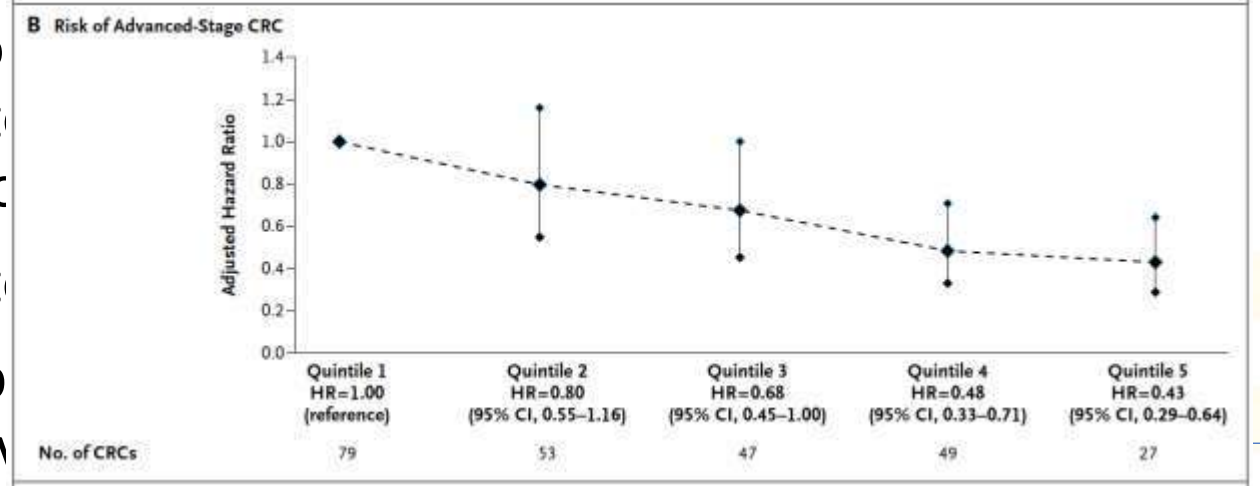


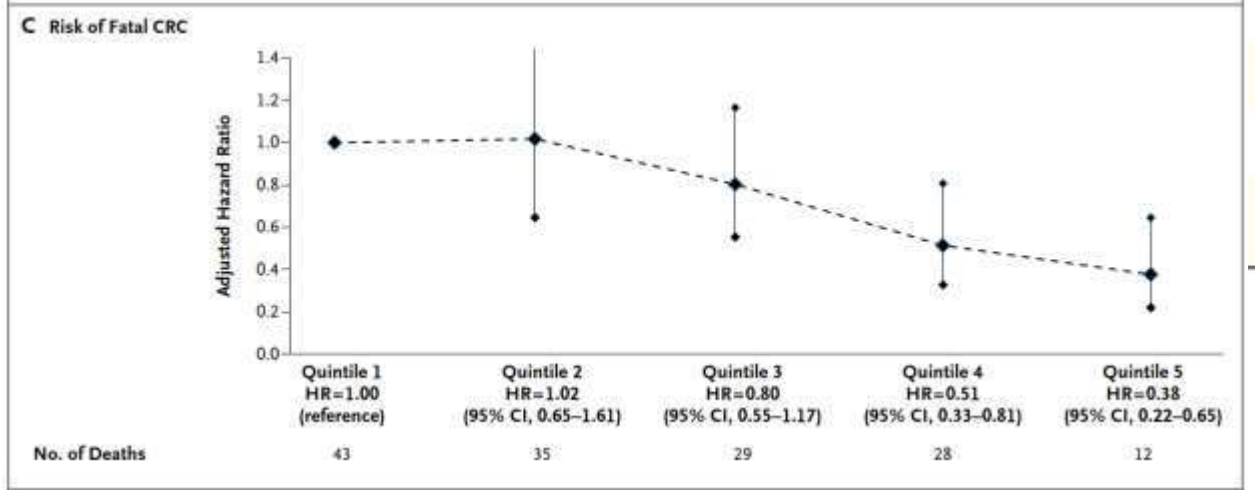
We all have AMR/AAMR

ADR a

- > 250 000
- 136 endo
  > 300 in t
  colonosc
- ADR 7.4 t
- follow-up
  712 inter







e and Risk of an Interval Colorectal Cancer

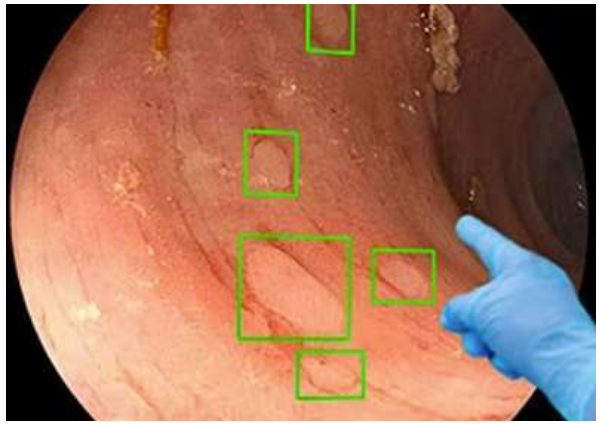
Interval Cancer	Hazard Ratio (95% CI)*	Unadjusted Risk
no. of cases		*no. of cases/ 10,000 person-yr*
712	0.97 (0.96–0.98)	7.7
186	1.00 (reference)	9.8
144	0.93 (0.70–1.23)	8.6
139	0.85 (0.68–1.06)	8.0
167	0.70 (0.54–0.91)	7.0
76	0.52 (0.39–0.69)	4.8

each 1% increase in the ADR is estimated to correspond to a 3% reduction in cancer risk

Douglas A. Corley et al. Aden

Variables in polyp search

- endoscopist experience
- bowel preparation
- withdrawal time – observation time
- rectal retroflexion
- virtual (probably marginally better for detection itself) and/or conventional chromoendoscopy
- HD scopes
- wide-angle scopes
- transparent cap
- fold-flattering device



Raf Bisschops et al. ESGE Guideline on advanced imaging for detection and differentiation of colorectal neoplasia. Endoscopy 2019; 51
Zhao S et al. Gastroenterology 2019;156:1661–1674

Critical outcomes in screening colonosocopy

- ADR (PDR)
- AMR
- CRC incidence
- CRC-related mortality
- PCCRC incidence

- how does the use of CADe reflexes to these?

COLO-DETECT trial

- a multicentre, open-label, parallel-arm, pragmatic randomised controlled trial
- CADe (GI Genius) vs routine colonoscopy practice in a real-world setting:
  - screening population (FIT positive)
  - symptomatic
  - surveillance (positive personal or family history of CRC)
  - expert and non-expert colonoscopists
  - teaching and general hospitals

COLO-DETECT trial

	Group value		CADe-assisted colonoscopy *vs* standard colonoscopy		
Mean adenomas per procedure	CADe-assisted colonoscopy: n; median [IQR]; mean (SD)	Standard colonoscopy: n; median [IQR]; mean (SD)	Adjusted MD (95% CI)	Adjusted IRR* (95% CI)	p value for adjusted IRR
Overall (n=2010)†	n=1001; 1 [0 to 2]; 1·56 (2·82)	n=1009; 0 [0 to 2]; 1·21 (1·91)	0·36 (0·14 to 0·57)	1·30 (1·15 to 1·47)	<0·0001
Screening subpopulation (n=1225)	n=608; 1 [0 to 3]; 2·08 (3·36)	n=617; 1 [0 to 2]; 1·61 (2·16)	0·47 (0·15 to 0·78)	1·29 (1·12 to 1·48)	<0·0001
Symptomatic subpopulation (n=785)	n=393; 0 [0 to 1]; 0·76 (1·33)	n=392; 0 [0 to 1]; 0·57 (1·18)	0·19 (0·02 to 0·37)	1·33 (1·03 to 1·71)	0·027
Adenoma detection rate	CADe-assisted colonoscopy: n/N; proportion	Standard colonoscopy: n/N; proportion	PD (95% CI)	Adjusted OR* (95% CI)	p value for adjusted OR
Overall (n=1966)	555/980; 56·6%	477/986; 48·4%	8·3% (3·9 to 12·7)	1·47 (1·21 to 1·78)	<0·0001
Screening subpopulation (n=1197)	404/594; 68·0%	368/603; 61·0%	7·0% (1·6 to 12·4)	1·37 (1·07 to 1·74)	0·011
Symptomatic subpopulation (n=769)	151/386; 39·1%	109/383; 28·5%	10·7% (4·0 to 17·3)	1·65 (1·20 to 2·26)	0·0018

Other secondary outcomes are presented in the appendix (pp 3–10). CADe=computer-aided detection. MD=mean difference. IRR=incidence rate ratio. PD=proportion difference. OR=odds ratio. *IRR and OR were adjusted for all randomisation stratification variables. †With imputation of missing data; data were not missing at random and thus additional modelling guided by clinical knowledge was done to simulate the missing data mechanism and impute the missing data (appendix pp 11–12, 21).

SSL detection = PD 3% [95% CI 0.4-5.5]; adjusted OR 1.46 [95% CI 1.07-1.99], p=0.017

Table 2: **The primary outcome (mean adenomas per procedure) and key secondary outcome (adenoma detection rate), overall and by subpopulation**

8.3% increase in ADR - > 25% reduction in PCCRC and 40% reduction in fatal CRC
3.0% increase in SSL detection rate could equate to a 23% reduction in PCCRC

Alexander Seager et al. COLO-DETECT trial. Lancet Gastroenterol Hepatol. 2024; 9:911-23

CADe colonoscopy vs colonoscopy without CADe - microsimulation modeling: primary CRC outcomes

Outcome Timeframe	Study results and measurements	Absolute effect estimates		Certainty of evidence (Quality of evidence)
		Routine practice colonoscopy	CADe colonoscopy	
CRC incidence 10 years	Modeling evidence	**82** per 10 000	**71** per 10 000	Very low
		Difference: **11 fewer per 10 000** (95%CI 35 fewer–17 more)		
CRC-related deaths 10 years	Modeling evidence	**15** per 10 000	**13** per 10 000	Low
		Difference: **2 fewer per 10 000** (95%CI 10 fewer–18 more)		
Post-colonoscopy CRC incidence 10 years	Modeling evidence	**34** per 10 000	**23** per 10 000	Very low
		Difference: **11 fewer per 10 000** 95%CI 22 fewer–12 more		

Michael Bretthauer et al. ESGE Position Statement on the use of CADe colonoscopy in colorectal cancer screening and surveillance. Endoscopy 2025

CADe colonoscopy vs colonoscopy without CADe - microsimulation modeling: primary CRC outcomes

Outcome Timeframe	Study results and measurements	Absolute effect estimates		Certainty of evidence (Quality of evidence)
		Routine practice colonoscopy	CADe colonoscopy	
Adenoma detection rate	Relative risk: 1.22 (95%CI 1.16–1.29) Based on data from 30 674 participants in 40 studies	**37** per 100	**45** per 100	**Low** Due to serious risk of bias Due to serious publication bias
		Difference: **8 more per 100** (95%CI 6 more–11 more)		
Adenoma miss rate	Relative risk: 0.47 (95%CI 0.36–0.6) Based on data from 2018 participants in 6 studies	**35** per 100	**16** per 100	**Moderate** Due to serious risk of bias
		Difference: **19 fewer per 100** (95%CI 22 fewer–14 fewer)		
Adenomas per colonoscopy	Based on data from participants in 39 studies	**0.65** per 1 colonoscopy Mean	**0.87** per 1 colonoscopy Mean	**Low** Due to serious risk of bias Due to serious publication bias
		Difference: **MD 0.22 more** (95%CI 0.16 more–0.28 more)		
Advanced adenomas per colonoscopy	Based on data from participants in 26 studies	**0.12** per 1 colonoscopy Mean	**0.13** per 1 colonoscopy Mean	**Moderate** Due to serious risk of bias
		Difference: **MD 0.01 more** (95%CI 0.01 fewer–0.02 more)		

CADe colonoscopy vs colonoscopy without CADe - microsimulation modeling: primary CRC outcomes

Outcome Timeframe	Study results and measure-ments	Absolute effect estimates		Certainty of evidence (Quality of evidence)
		Routine practice colonoscopy	CADe colonoscopy	
Individuals needing follow-up post index colonoscopy 10 years	Modeling evidence	**2645** per 10 000	**3280** per 10 000	Low
		Difference: **635 more per 10 000** (95%CI 582 more–688 more)		
Perforation 10 years	Modeling evidence	**1** per 10 000	**1** per 10 000	Low
		Difference: **0 fewer per 10 000** (95%CI 0 fewer–0 fewer)		
Bleeding 10 years	Modeling evidence	**19** per 10 000	**20** per 10 000	Low
		Difference: **1 more per 10 000** 95%CI 9 fewer–11 more		

Michael Bretthauer et al. ESGE Position Statement on the use of CADe colonoscopy in colorectal cancer screening and surveillance. Endoscopy 2025

Studies on CADe

- primarily focused on “performance metrics”, such as ADR, rather than patient-centered outcomes like the incidence of PCCRC or mortality rates
- the long-term impact of CADe on overall patient health has not been addresed directy, but have been projected (it is well established that a higher ADR is associated with a reduced risk of PCCRC)

Mike Tzuhen Wei et al. AI–Assisted Colonoscopy in Real-World Clinical Practice: SR & MA. Clinical and Translational Gastroenterology 2024;15:e00671.
Natalie Halvorsen et al. BMJMED 2025;4:e001446. Saeed Soleymanjahi et al. AI-Assisted Colonoscopy for Polyp Detection : SR & MA. Ann Intern Med . 2024 Dec;177(12):1652-1663.
Jonathan Makar et al. Use of AI improves colonoscopy performance in adenoma detection: SR & MA. Gastrointest Endosc 2025; 101:1

RECOMMENDATION

The panel believes that most well-informed patients who have already decided to undergo colonoscopy for screening or surveillance would favor CADe assistance during colonoscopy. This is due to the potential benefits, although limited, of reduction in colorectal cancer incidence and mortality.

This recommendation is weak, because the evidence is limited with considerable uncertainty of the evidence estimates, the absolute benefits for colorectal cancer incidence and mortality are small, and there is patient burden associated with CADe (more polyp overdiagnosis and more colonoscopy surveillance).

Michael Bretthauer et al. ESGE Position Statement on the use of CADe colonoscopy in colorectal cancer screening and surveillance. Endoscopy 2025

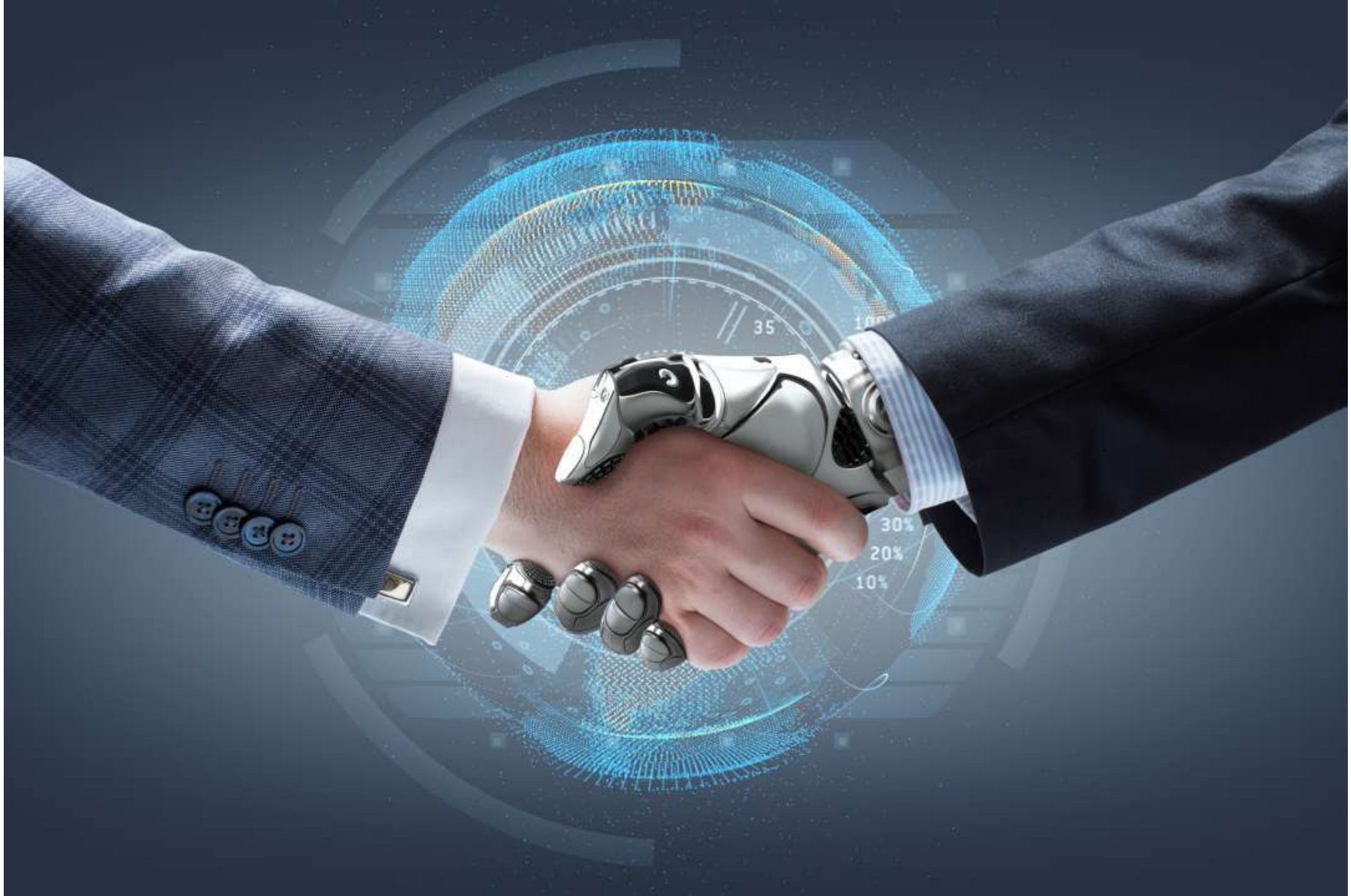
Conclusions

- CADe standardises the quality of colonoscopy, serving as ‘second observer’
- CADe facts
  - detecting more diminutive polyps / adenomas
  - significant increase of ADR for general endoscopists (MA data); significan increase in PDR
  - more resection of non-neoplastic lesions
  - more survaillance endosopies (more patients are referred to surveillance after screening with CADe as compared with screening performed without CADe)
  - prolongation of procedure < 1 minute

- CADe = operator-dependent tool with adequate mucosal exposure and meticulous endoscopic techniques beeing prerequisites for effective lesion detection
- CADe cannot compensate for suboptimal procedural quality = no potential benefit form CADe without high quality cleaning and technique with full mucosal visualisation
- CADe + fold-flattering device
- combination of CADe, CADx i CAQ will increase the overall gain for the health system

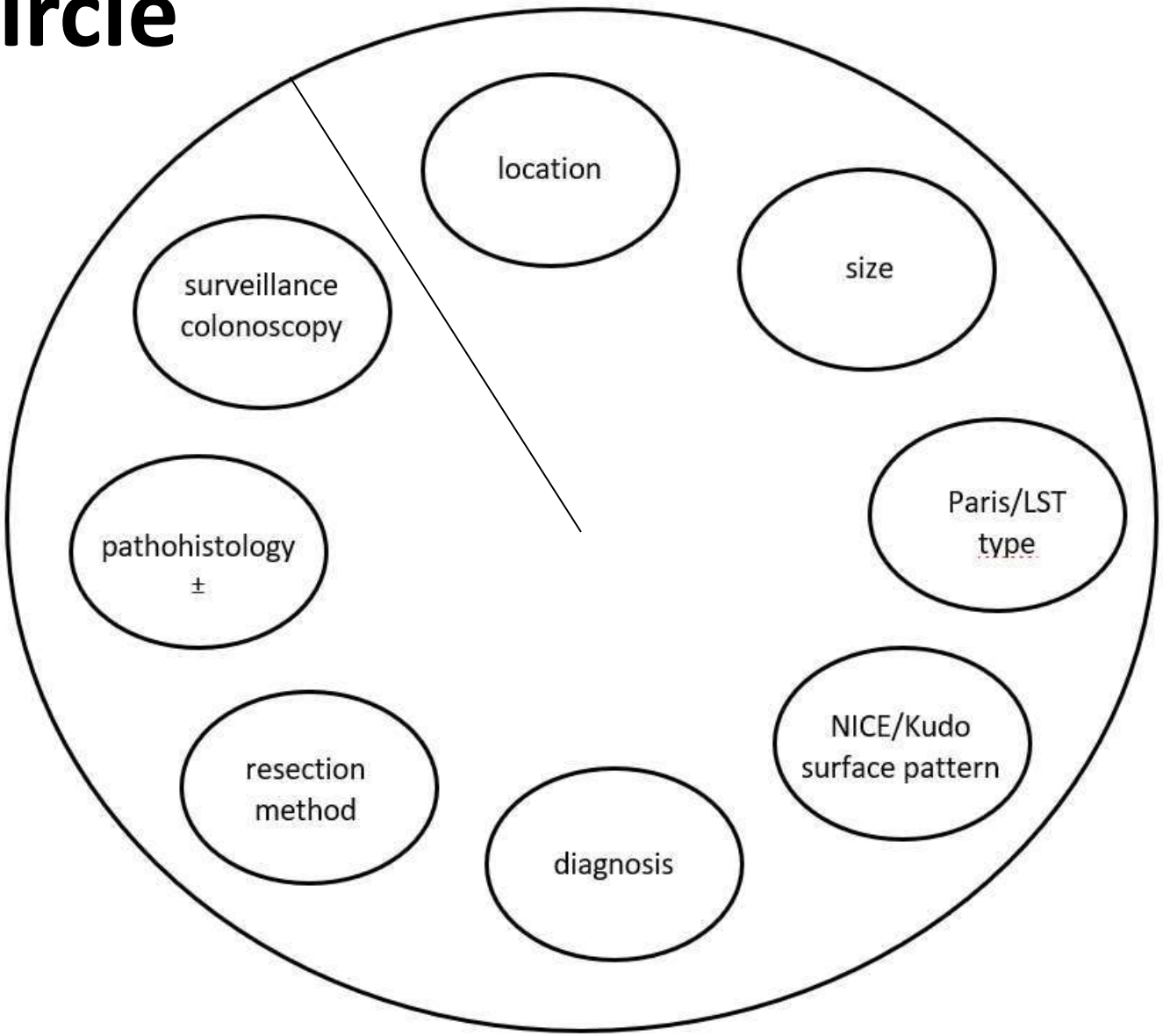
Mike Tzuhen Wei et al. AI–Assisted Colonoscopy in Real-World Clinical Practice: SR & MA. Clinical and Translational Gastroenterology 2024;15:e00671.
Natalie Halvorsen et al. BMJMED 2025;4:e001446. Saeed Soleymanjahi et al. AI-Assisted Colonoscopy for Polyp Detection : SR & MA. Ann Intern Med . 2024 Dec;177(12):1652-1663.
Jonathan Makar et al. Use of AI improves colonoscopy performance in adenoma detection: SR & MA. Gastrointest Endosc 2025; 101:1


OLYSENSE
Unlocking the Power of
Intelligent Endoscopy
Adenoma
MAYO Score: 2
OLYMPUS

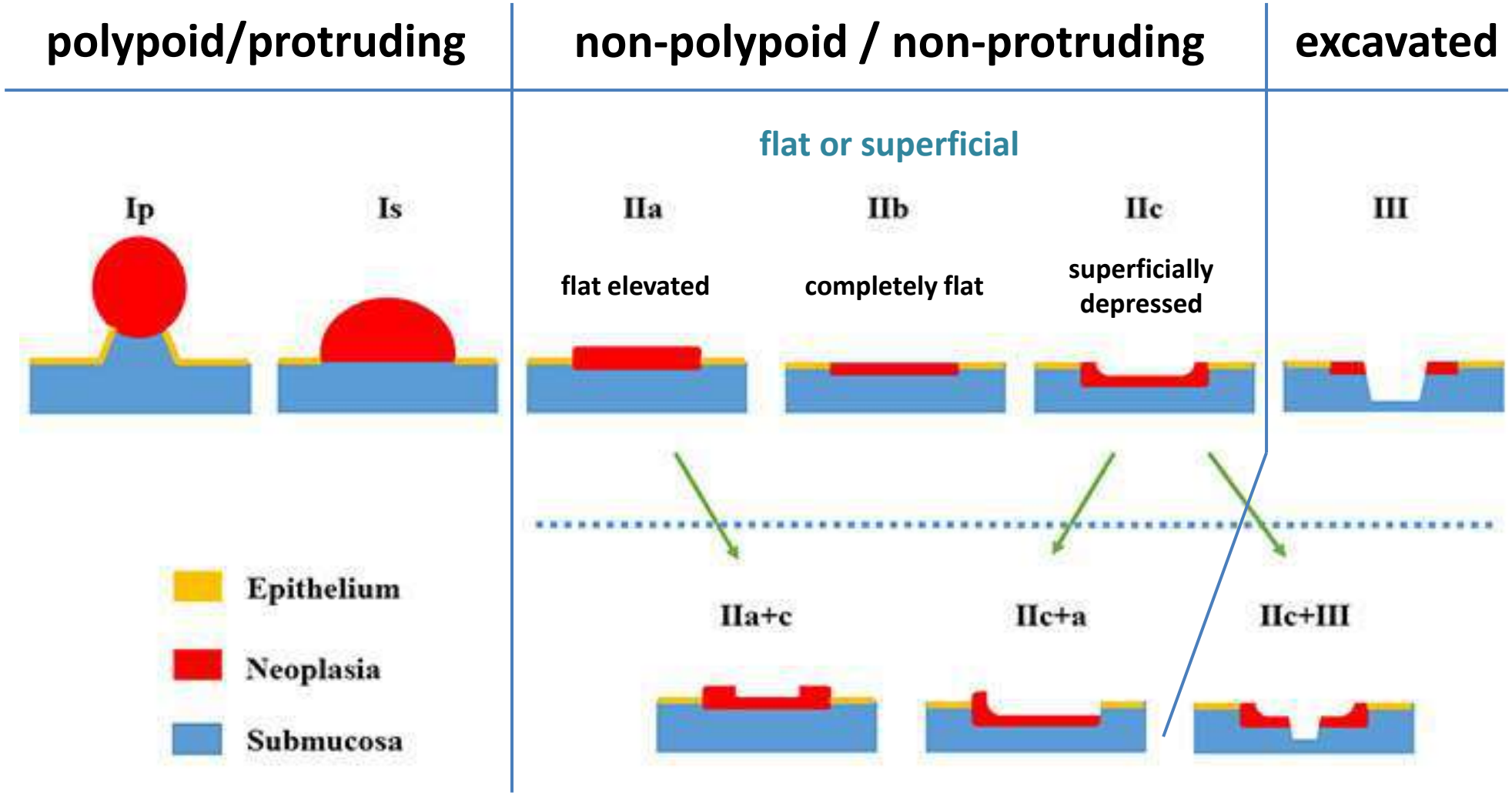

35
30%
20%
10%

Role of AI in characterisation of GI lesions

Polyp's circle



Morphology

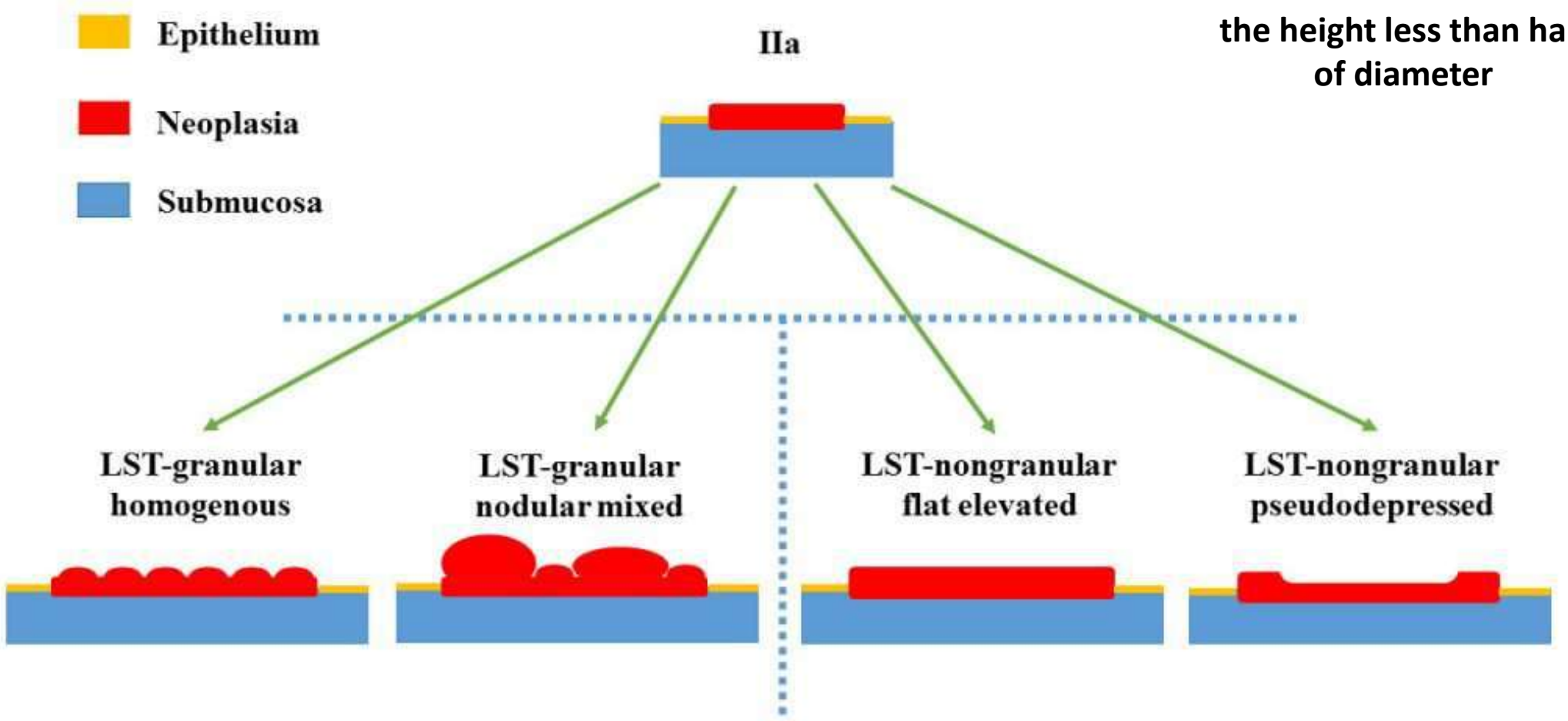


Original publications: GIE 2003;58:6 and Endoscopy 2005;37(6):570-8; downloaded from www.endoscopy-campus.com/

Morphology

> 10 (20) mm

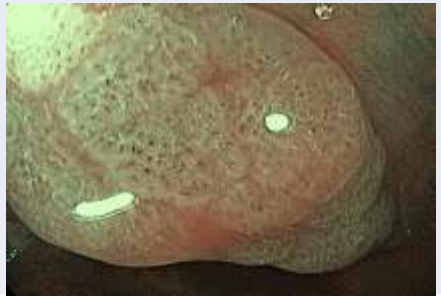
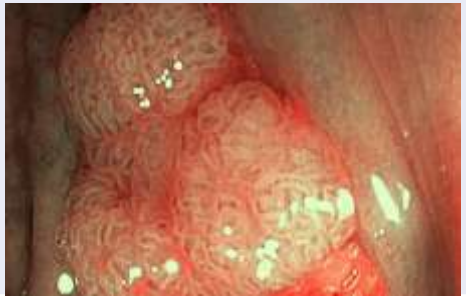
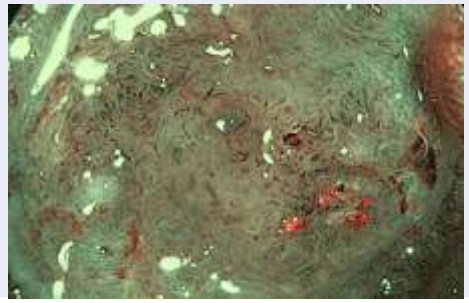
the height less than half of diameter



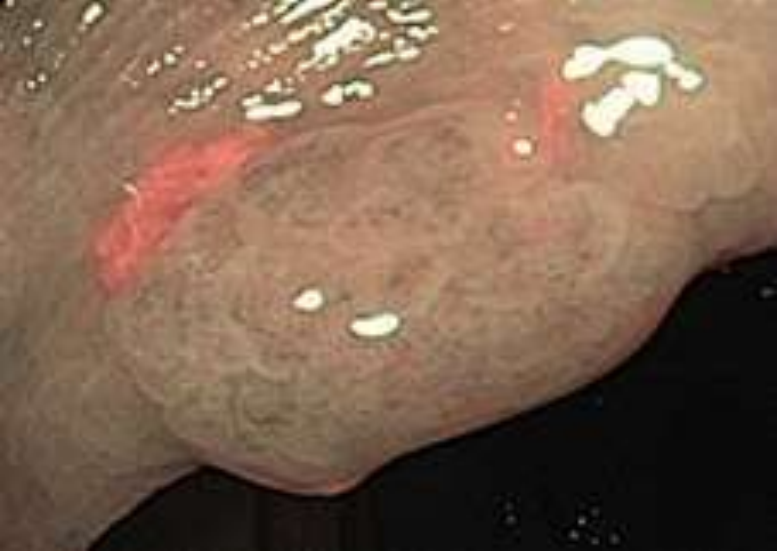
downloaded from www.endoscopy-campus.com/

Kudo SE et al. Nonpolypoid neoplastic lesions of the colorectal mucosa. Gastrointest Endosc. 2008 Oct;68(4 Suppl):S3-47.

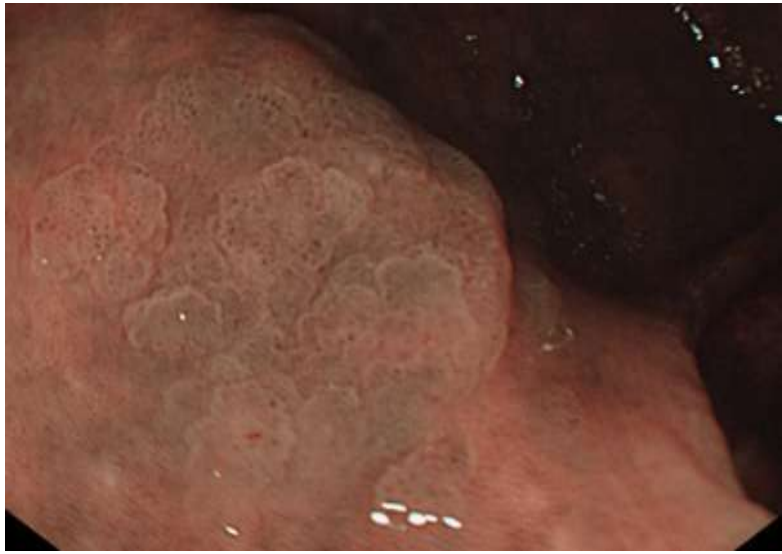
Japan NBI Expert Team (JNET) classification

	Type 1	Type 2 A	Type 2 B	Type 3
Vessels pattern	Invisible	▪ Regular caliber ▪ Regular distribution (meshed/spiral pattern)	▪ Variable caliber ▪ Irregular distribution	▪ Loose vessel areas ▪ Interuption of thick vessels
Surface pattern	▪ Regular dark or white spots ▪ Similar to surrounding normal mucosa	▪ Regular (tubular, branched, papillary)	▪ Irregular or obscure	▪ Amorphous areas
Most likely pathology	**Hyperplastic polyp/ Sessile serrated polyp**	**Low grade intramucosal neoplasia**	**High grade intramucosal neoplasia / Shallow submucosal invasive cancer**	**Deep submucosal invasive cancer**
Examples				

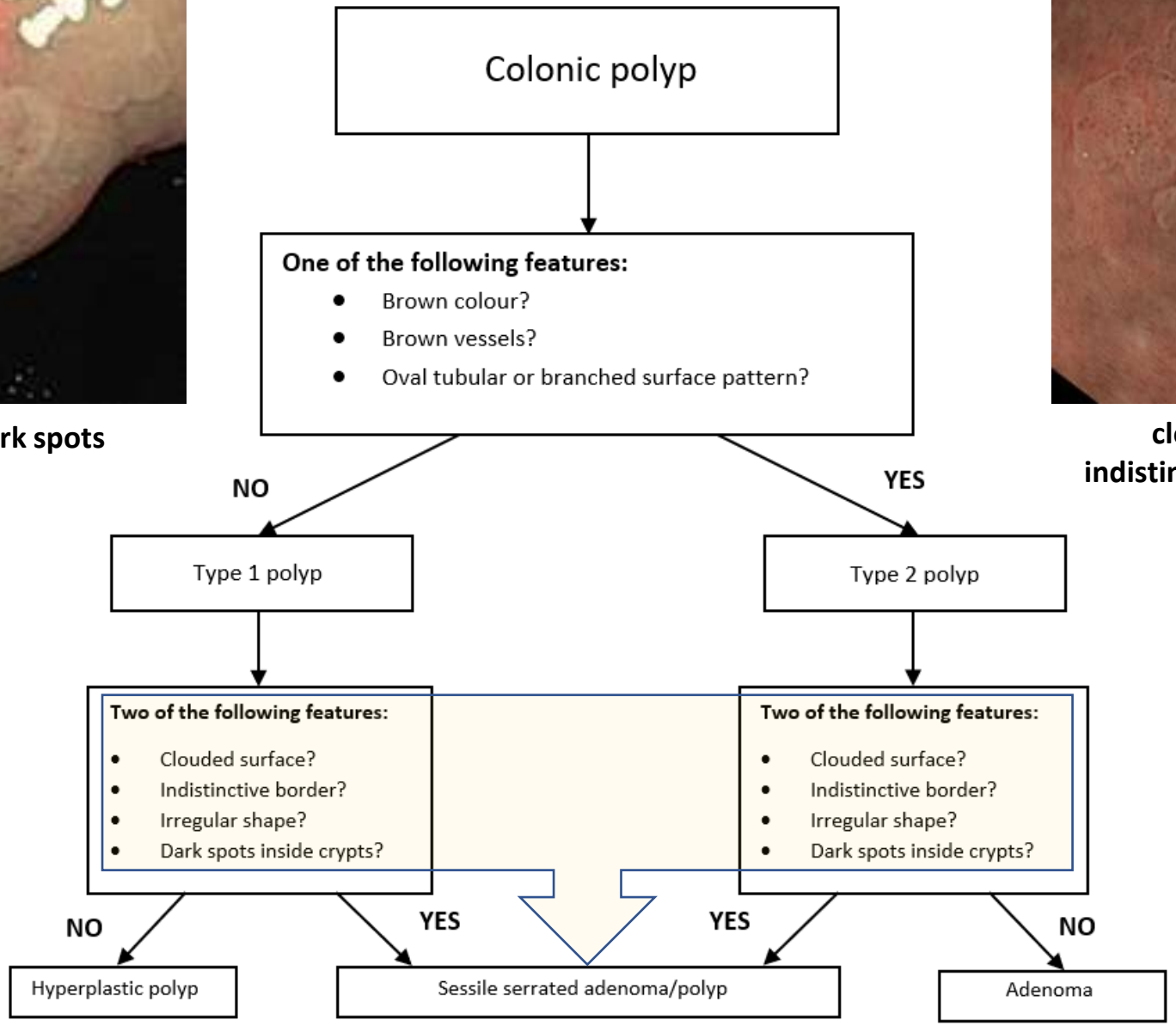
Sano Y et al. Dig Endosc. 2016;28(5):526-33.



clouded surface; crypts with dark spots



clouded surface; irregular shape; indistinctive border; crypts with dark spots



IJspeert JEG, et al. Gut 2015;0:1–8.
Images form https://www.endoscopy-campus.com/en/bildergalerie/polyp-classification-wasp-incl-ssa/

Would you like a

For your issue?

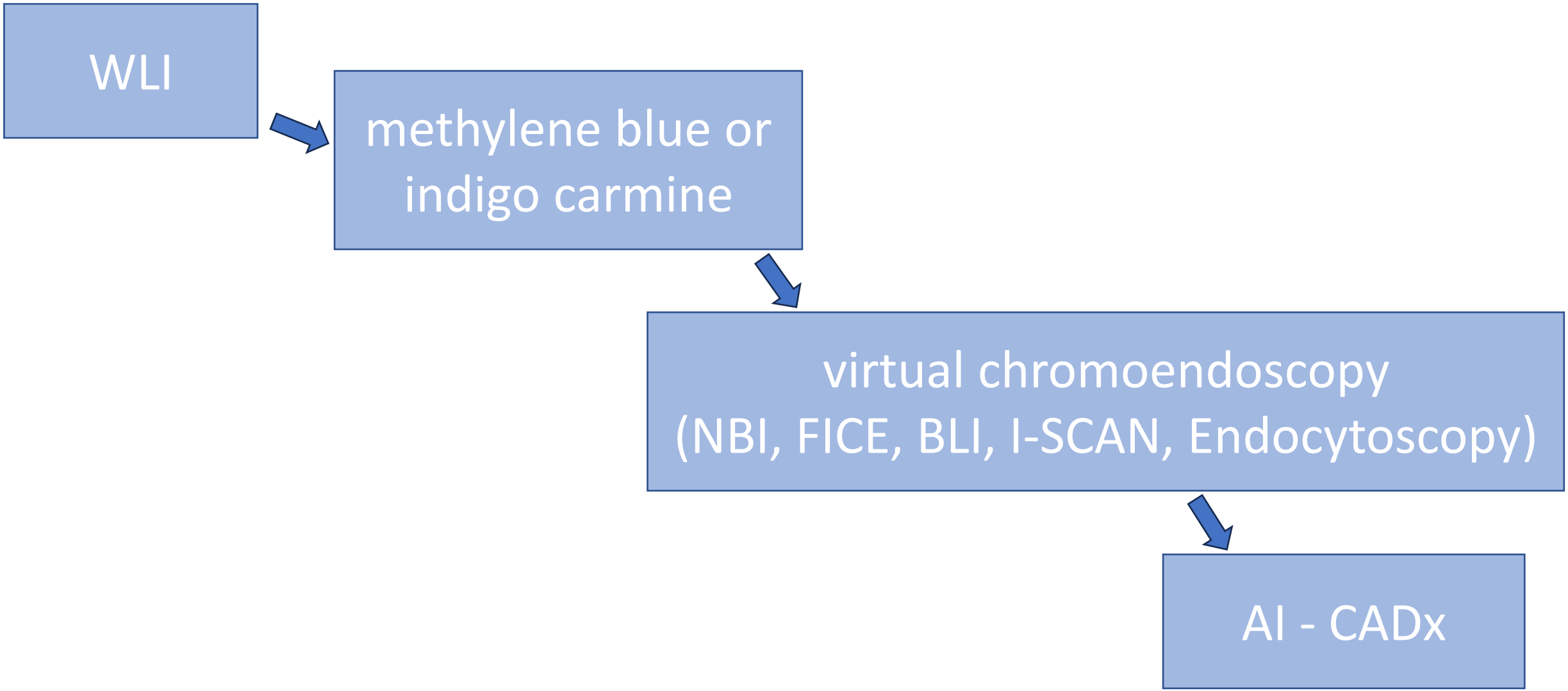
Optical diagnosis of diminutive polyps – minimum standards

Standard	Leave-*in-situ* strategy	Resect-and-discard strategy
Negative predictive value (%)	≥90[b)]	
Sensitivity (%)	≥90[c)]	≥80[d)]
Specificity (%)	≥80[c)]	≥80[d)]
Agreement with post-polypectomy surveillance intervals (%)		≥90[a)]

Histopathology assessments are used as the gold standard.
ASGE, American Society for Gastrointestinal Endoscopy; ESGE, European Society of Gastrointestinal Endoscopy; PIVI, preservation and incorporation of valuable endoscopic innovations; SODA, simple optical diagnosis accuracy.
[a)]PIVI 1, [b)]PIVI 2, [c)]SODA 1, [d)]SODA 2.

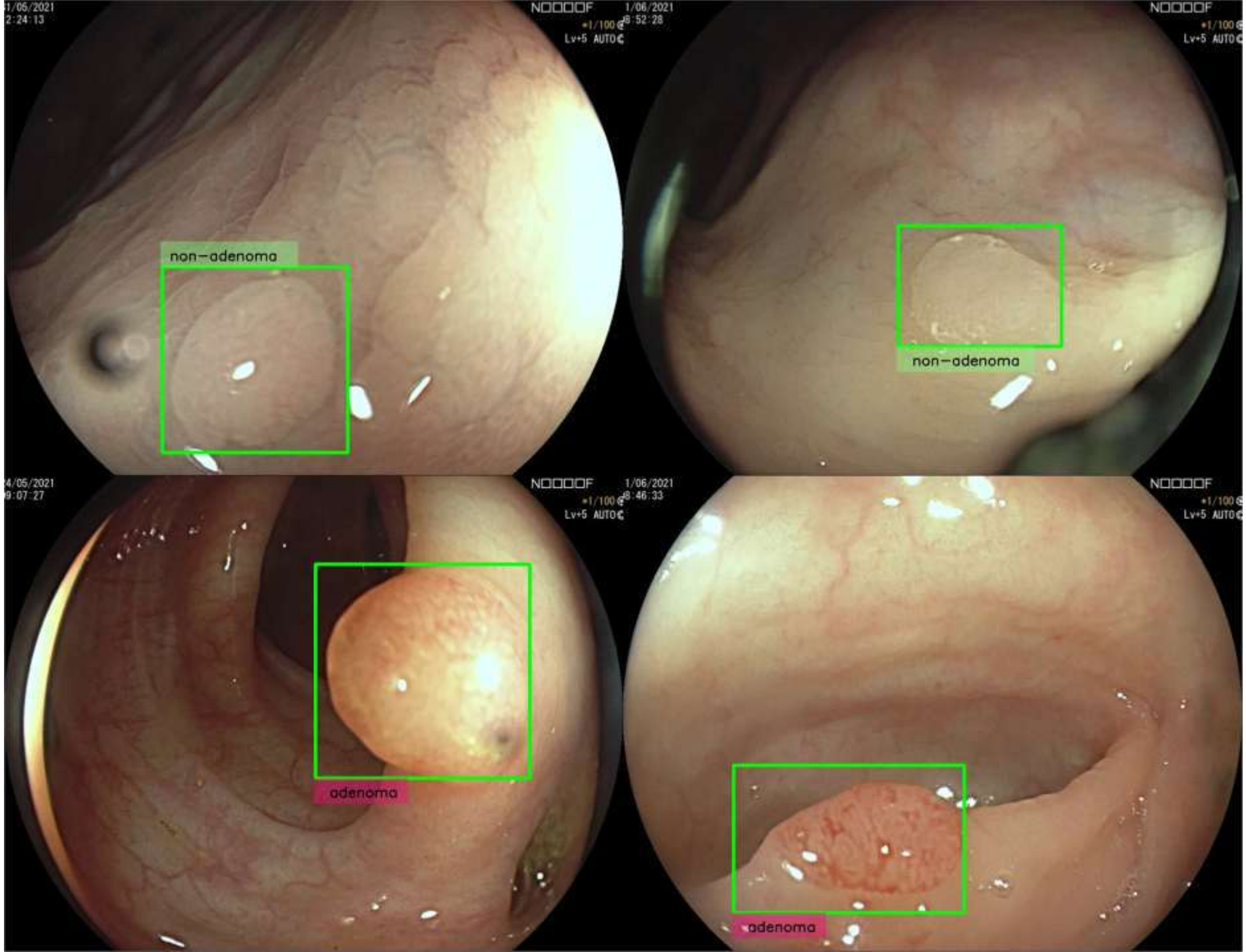
From: Natalie Halvorsen, Yuichi Mori. Computer-aided polyp characterization in colonoscopy: sufficient performance or not? Clin Endosc 2024;57:18-23.

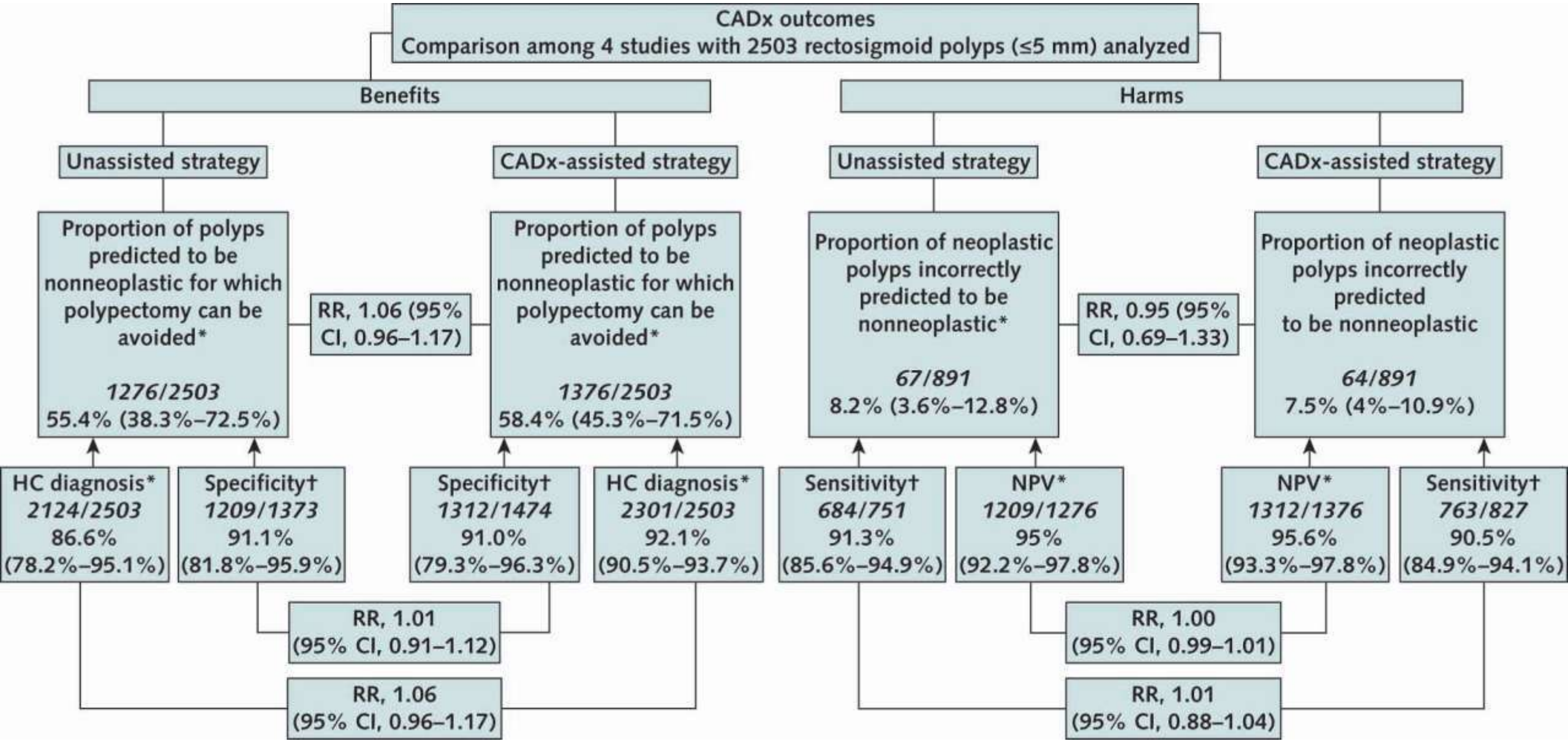
History of optical diagnosis



What does CADx currently offers?

0 or 1


non-adenoma
non-adenoma
adenoma
adenoma



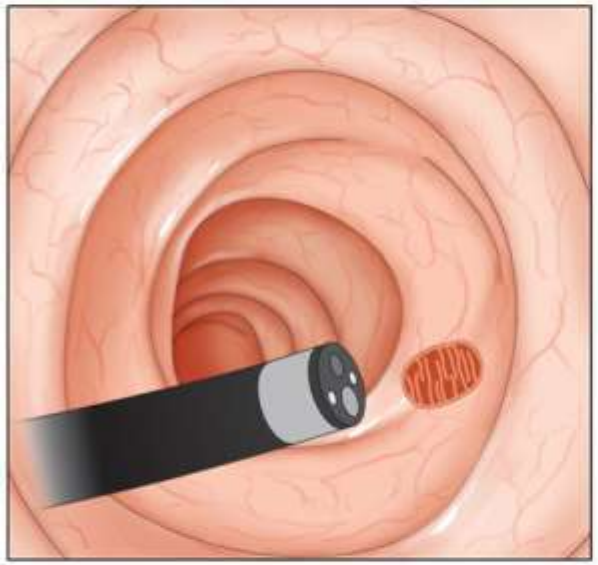
Cesare Hassan et al. CADx for Leaving Colorectal Polyps In Situ: SR & MA. Ann Intern Med.2024;177:919-928.

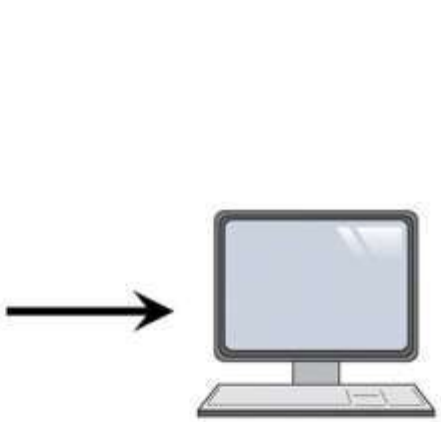
- all studies up to 2023
- all from expert centres
- optical diagnosis was performed by experts

- reflecting the CADe way to real-life

Autonomous Artificial Intelligence versus AI Assisted Human optical diagnosis of colorectal polyps: A randomized controlled trial

resect-and-discard threshold reached





CADx
optical diagnosis

Autonomous AI

77.2% Accuracy

91.5% Surveillance Interval Agreement

p = 0.016

Human decides final diagnosis

72.1% Accuracy

82.1% Surveillance Interval Agreement

Gastroenterology

Roupen Djinbachian, Claire Haumesser, et al. Autonomous AI vs AI–Assisted Human Optical Diagnosis of Colorectal Polyps: RCT. Gastroenterology 2024;167:392–399

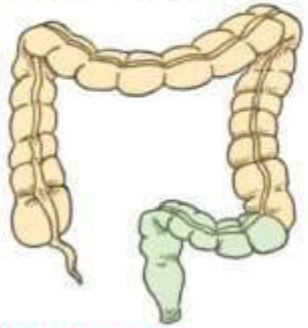
Table 2. Diagnostic Characteristics for Optical Diagnosis of 1–5-mm Adenomas

Characteristics	Autonomous AI, % (95% CI)	AI-H, % (95% CI)
All locations		
Sensitivity	84.8 (76.8–90.9)	83.6 (75.4–90.0)
Specificity	64.4 (48.8–78.1)	63.8 (51.3–75.0)
PPV	85.6 (77.6–91.5)	78.6 (70.1–85.7)
NPV	63.0 (47.5–76.8)	71.0 (58.1–81.8)
Rectosigmoid		
Sensitivity	80.0 (44.4–97.5)	100.0 (83.9–100.0)[a]
Specificity	73.1 (52.2–88.4)	71.4 (55.4–84.3)
PPV	53.3 (26.6–78.7)	63.6 (45.1–79.6)
NPV	92.6 (75.7–99.1)	100.0 (90.7–100.0)[a]

leave-in-situ threshold reached

Roupen Djinbachian, Claire Haumesser, et al. Autonomous AI vs AI–Assisted Human Optical Diagnosis of Colorectal Polyps: RCT. Gastroenterology 2024;167:392–399

Accuracy of Computer-aided Diagnosis in Colonoscopy Varies according to Polyp Location. A Systematic Review and Meta-analysis.

CADx-Alone Diagnostic performance: Data based on **7,782 ≤ 5mm polyps** from **11 diagnostic accuracy studies**. * Results based on a bivariate model ** Results based on a univariate model	**Proximal colon** *(cecum + ascending colon + transverse colon + descending colon)* **Pooled data [95% CI]**	 **Risk Ratio [95% CI]**	**Distal colon** *(Rectum + sigmoid colon)* **Pooled data [95% CI]**
Sensitivity*	**0.89 [0.83, 0.93]**	**1.00 [0.97, 1.03]**	**0.87 [0.80, 0.92]**
Specificity*	**0.62 [0.52, 0.71]**	**0.74 [0.72, 0.84]**	**0.85 [0.75, 0.92]**
Negative Predictive Value**	0.64 [0.55, 0.72]	0.71 [0.64, 0.79]	0.93 [0.90, 0.95]
Positive Predictive Value**	0.87 [0.84, 0.91]	1.11 [1.06, 1.17]	0.76 [0.70, 0.82]
Accuracy**	0.81 [0.77, 0.85]	0.95 [0.91, 0.99]	0.86 [0.83, 0.90]

Highlights

CADx alone diagnostic performance is lower in the proximal colon versus the distal colon, mainly due to lower specificity

Due to the higher prevalence of neoplastic polyps in the proximal colon, a lower negative predictive value was observed in the proximal colon.

Clinical Gastroenterology and Hepatology

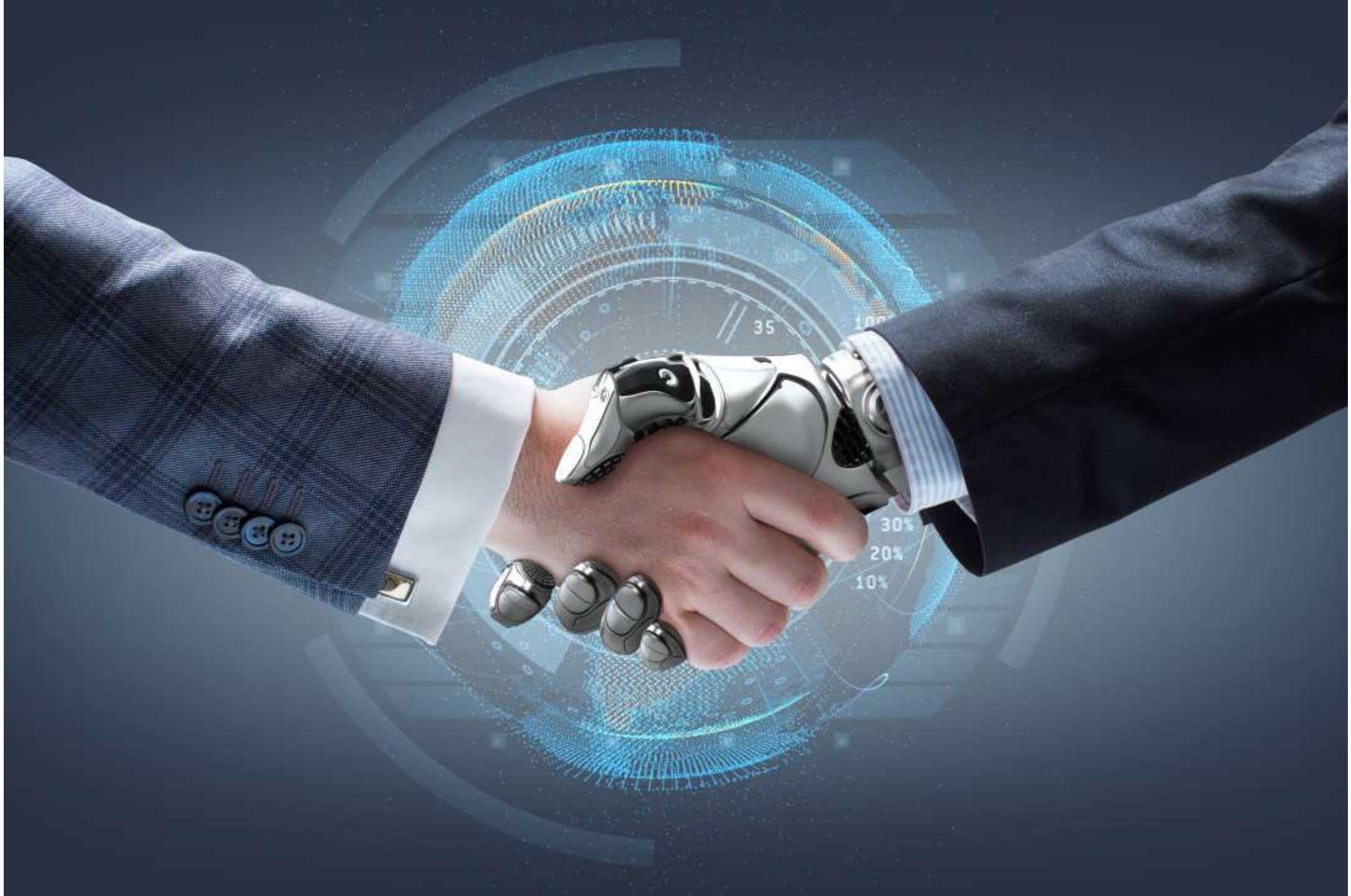
Tommy Rizkala et al. Accuracy of CADx Varies According to Polyp Location: SR & MA. Clinical Gastroenterology and Hepatology, 2025; 23:4:531-541

CADx challenges

- SSL characterization
- resistance to implemention of optical diagnosis in general as well as with the aid of CADx due to fear of:
  - providing an incorrect diagnosis - leaving malignant lesion
  - giving incorrect recommendations of surveillance intervals
  - possible liability issues caused by optical diagnosis-driven decision-making
- endoscopists' reliance on CADx may hamper the development of optical diagnostic skills of endoscopists

Conclusion

- diminutive polyps account for most of detected polys and advanced histology found only in <2% -> optical diagnosis without or with CADx is warranted
- high level of accuracy for optical diagnosis in academic centers, but not in general clinical practice
- PIVI recommendations:
  - 90% agreement with pathology-based surveillance intervals to implement “resect and discard” strategy
  - 90% negative predictive value (NPV) for rectosigmoid adenomas to implement “diagnose and leave’’ strategy
- optical diagnosis saves a lot of resources
- CADx to overcome barriers to implementation of optical diagnosis and strategies
- more studies are needed


35
30%
20%
10%


obrigado
Dank U
Merci
mahalo
Köszi
спасибо
Grazie
Thank you
mauruuru
Takk
Gracias
Dziękuję
Děkuju
danke
Kiitos