Artificial Intelligence in Gastroenterology

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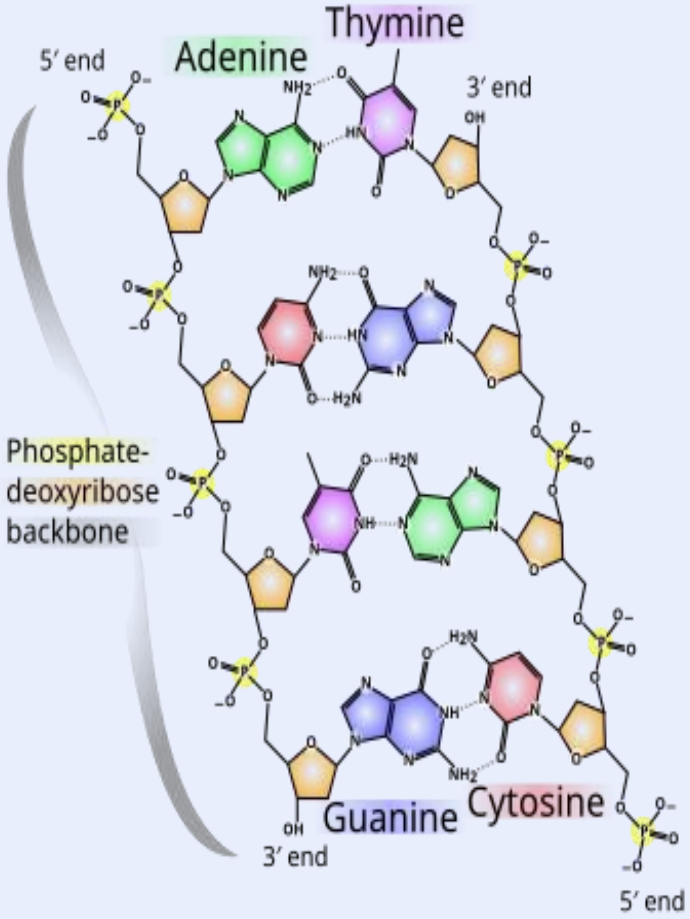
What is Artificial intelligence (AI) ?

- AI can be understood as studying the principle of human intelligence activities, constructing an artificial system with ***certain intelligence*** , to let computers to do the works that required human intelligence in the past.
- AI applications in medicine are now divided into virtual and physical branches .



Human Intelligence

Nucleobases (nitrogenous bases or simply bases) are nitrogen-containing biological compounds that form nucleosides, which, in turn, are components of nucleotides, with all of these monomers constituting the basic building blocks of nucleic acids. The ability of nucleobases to form base pairs and to stack one upon another leads directly to long-chain helical structures such as ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). Five nucleobases—adenine (A), cytosine (C), guanine (G), thymine (T), and uracil (U)—are called primary or canonical. They function as the fundamental units of the genetic code, with the bases A, G, C, and T being found in DNA while A, G, C, and U are found in RNA.



. Machine learning (ML) is an essential sub branch of AI which includes deep learning (DL), supervised learning (SL), semi-supervised learning (SSL), support vector machine (SVM), random forest (RF), and convolutional neural network (CNN) .

. Among them, DL and CNN are representatives of the most successful algorithms used in medicine.



AI History

- Although Robots backed to ancient Greek and Roman or compulsory work. myths but the word “robot” first appeared in the works of the Czech dramatist Karel Capek in the early 20th century, referring to forced labor.



AI History

- In 1950, Alan Turing experimentally detected some machines that showed intelligent behavior like human and in 1956, John McCarthy and his team officially proposed the concept of AI .

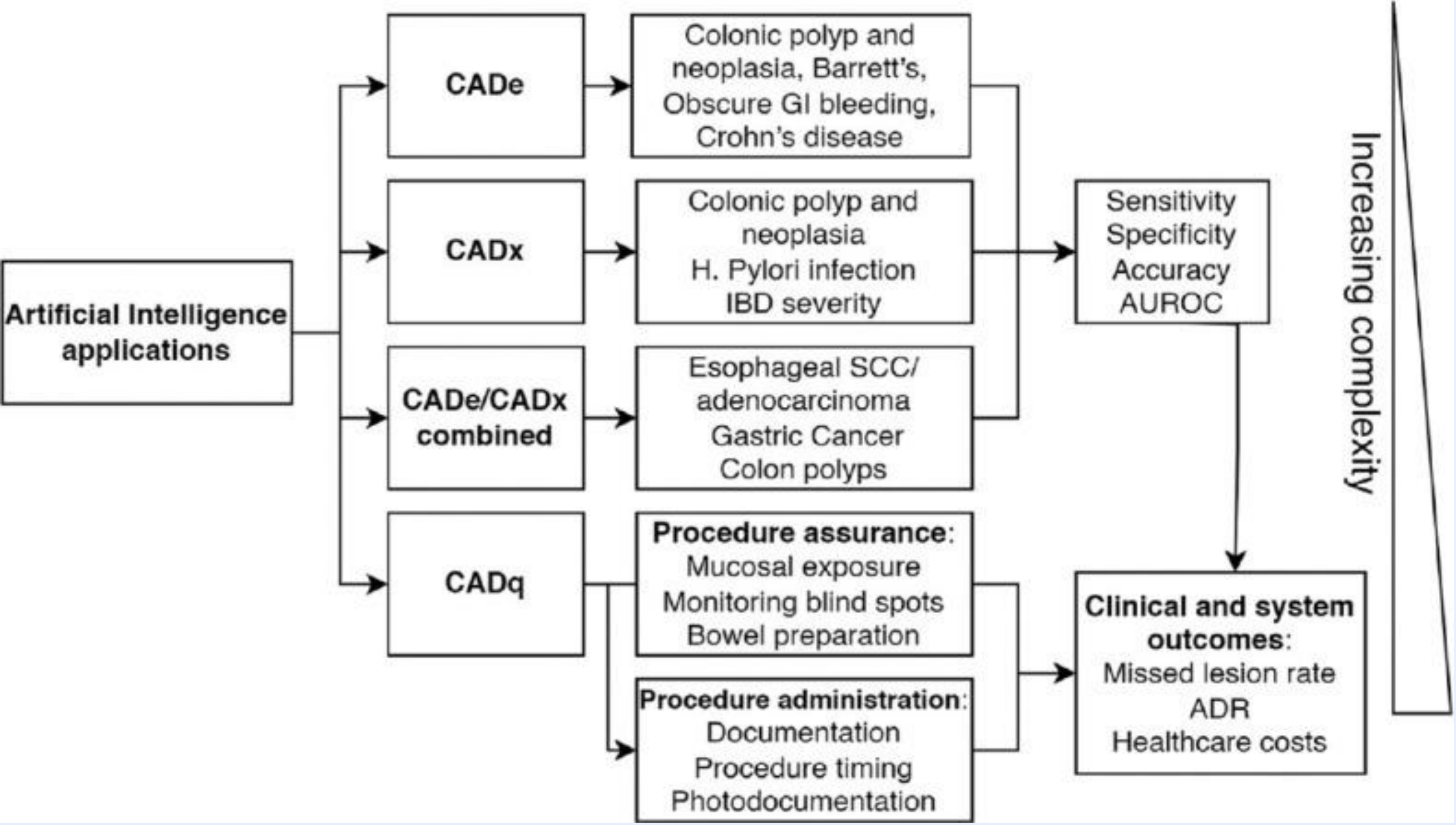
- Over the past 60 years, AI has made great progress in all walks of life.

- AI has apparent advantages in solving complex nonlinear parameter problems.

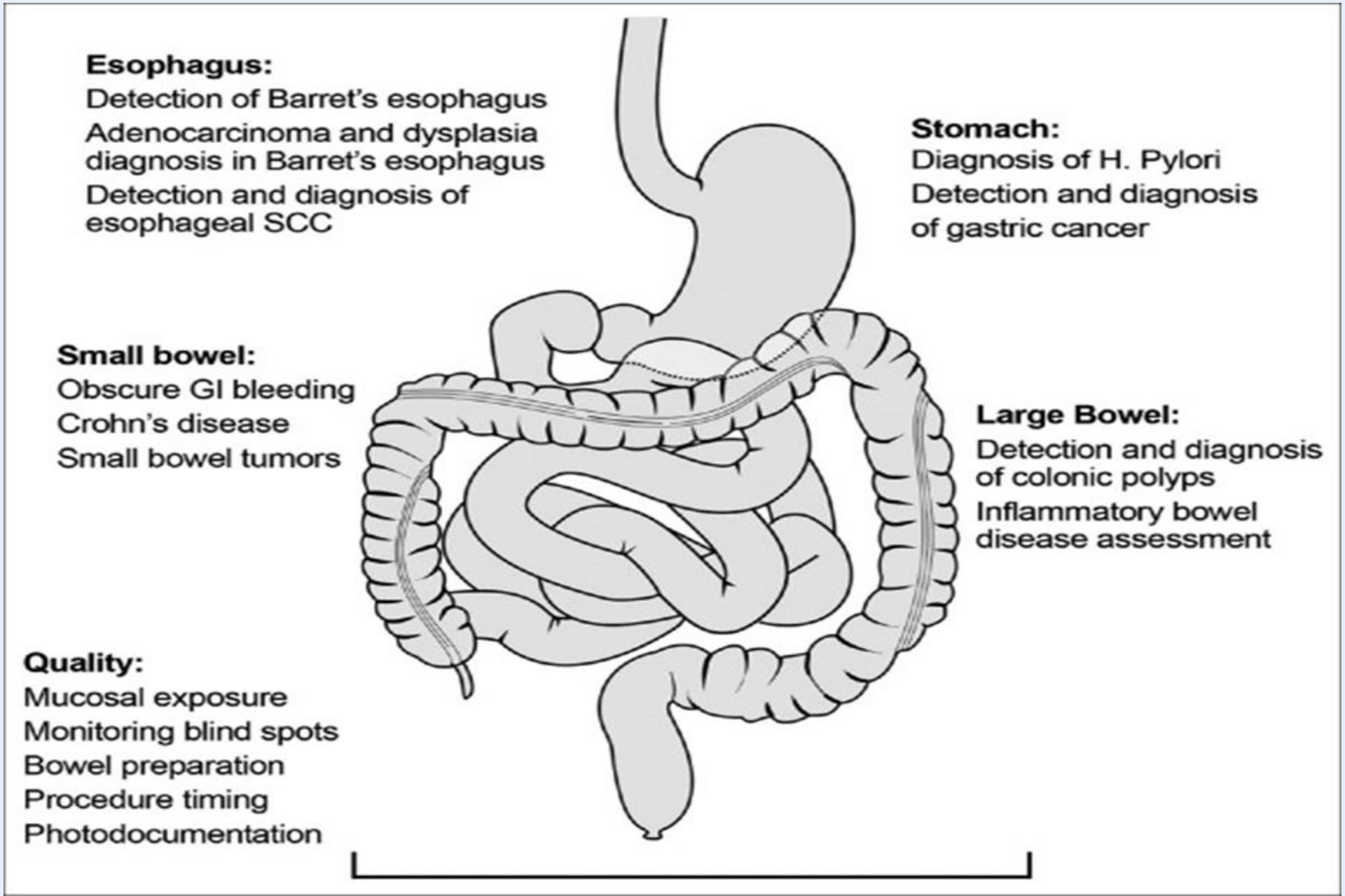


Artificial Intelligence (AI)

- Since the emergence of AI in medicine, endoscopy applications in gastroenterology have been at the forefront of innovations.
- *AI capabilities by computer aided detection (CADe), diagnosis (CADx), and quality assessment (CADq).*
- CADe : accurate detection of esophageal, gastric and colonic neoplasia as well as identifying sources of bleeding and Crohn's disease in the small bowel.
- CADx :optical biopsies to give further information to characterize neoplasia and grade inflammatory disease.
- CADq : quality and increase the efficiency of procedures.
- Future : multimodal capabilities , clinical decision making and performance of endoscopy.


Artificial Intelligence applications
CADe
CADx
CADe/CADx combined
CADq
Colonic polyp and neoplasia, Barrett's, Obscure GI bleeding, Crohn's disease
Colonic polyp and neoplasia
H. Pylori infection
IBD severity
Esophageal SCC/ adenocarcinoma
Gastric Cancer
Colon polyps
Procedure assurance:
Mucosal exposure
Monitoring blind spots
Bowel preparation
Procedure administration:
Documentation
Procedure timing
Photodocumentation
Sensitivity
Specificity
Accuracy
AUROC
Clinical and system outcomes:
Missed lesion rate
ADR
Healthcare costs
Increasing complexity

Speech Subjects !



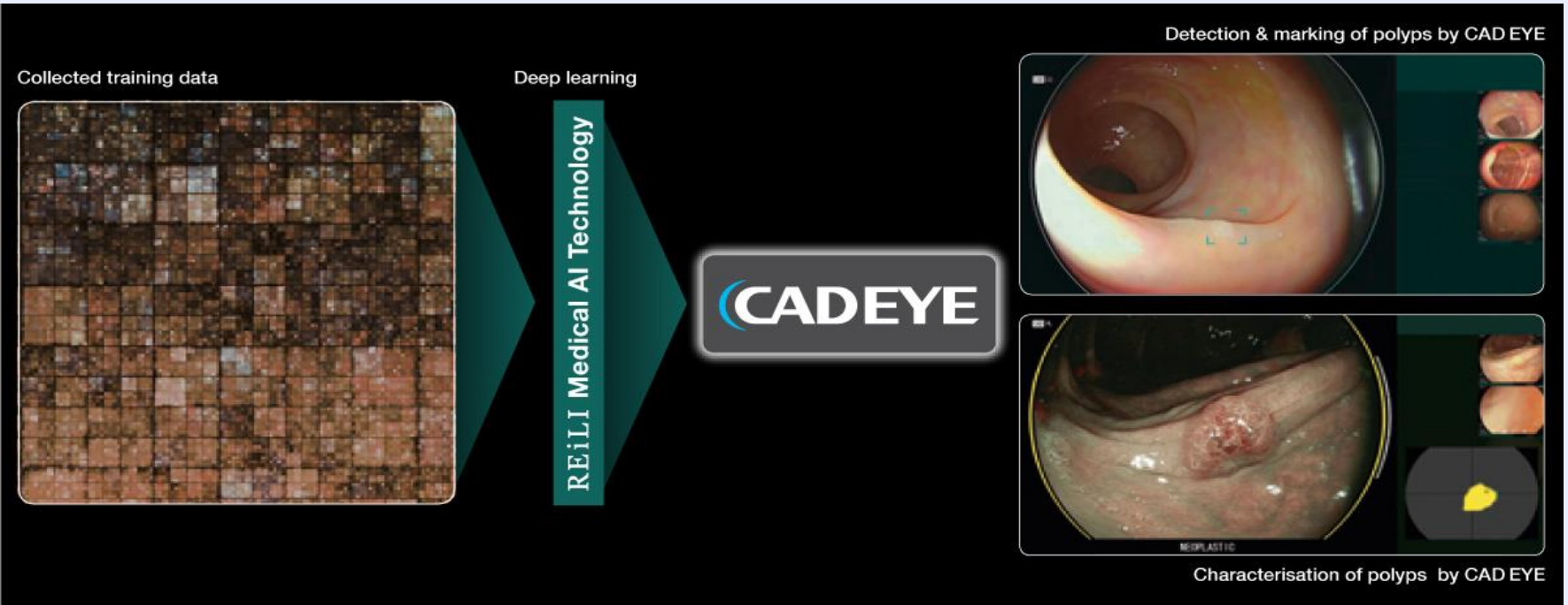
Endocuff Vision



How it Works

ENDOCUFF VISION™ is a device attached to the distal end of a colonoscope, designed to maintain and maximize the viewable mucosa during endoscopic therapy by manipulating colonic folds.

A single row of flexible arms evert and flatten folds to provide an enhanced view of the entire colon and to decrease the polyp miss rate. [8]



Esophagus

- 89% accuracy in detecting Barrett's , dysplasia , and Adeno-Carcinoma .
- 90-95% sensitivity in detecting Barrett's , dysplasia , and Adeno-Carcinoma.
- 88% -94% true negative range in detecting Barrett's.
- 95% sensitivity , and 85%-90% specificity in detecting ESCC.

Stomach

- AI detection of HP status : accuracy = 92% , sensitivity =87%-95% , specificity =83%-94%.

- AI endoscopy intestinal metaplasia diagnosis has sensitivity of 94% , and specificity of 93% .
  The AI exhibited a higher diagnostic capacity than endoscopists (sensitivity: 95% vs. 79%).

- The pooled sensitivity and specificity of AI for early gastric cancer diagnosis were 0.86 , and 0.90 respectively. The area under the curve was 0.94.

Colon : polyps and tumors

Indicadores Preprocedimiento	Indicadores Intraprocedimiento	Indicadores Postprocedimiento
Obtención de consentimiento informado (100 %)	Documentación de preparación intestinal (100 %)	Incidencia de perforación < 1:500 en procedimientos terapéuticos y < 1:1000 en detección
Documentación apropiada de indicación de colonoscopia (100 %)	Tasa de intubación cecal (> 95 %)	Porcentaje de sangrado postpolipectomía < 1 %
Cumplimiento de plazos e intervalos de endoscopias (100 %)	Tasa de detección de adenomas (>25 %)	Sangrado postpolipectomía debe ser manejado endoscópicamente (> 90 %)
Realización de endoscopia por especialistas con entrenamiento formal (100 %)	Medición de tiempo de inspección y salida mayor a 6 minutos (100 %) Resección endoscópica de pólipos pediculados y sésiles < 2 cm en el mismo tiempo endoscópico	Seguimiento con colonoscopias control según resultados de acuerdo con guías internacionales

- Most CRCs transform from polyp mutations.
- The colonoscopy assisted by AI can significantly improve the ADR and more importantly reduce AMR , thereby lowering the possibility of CRC incidence.

TABLE 1 The summary of the application of AI in the diagnosis of CRC.

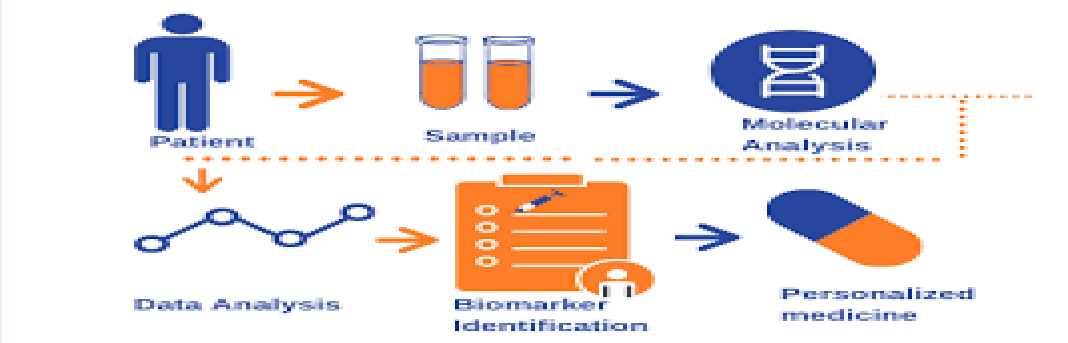
https://doi.org/10.3389/fmed.2023.1128084

Theme	Year	Subject	Model	Sample	Result
Endoscopic diagnosis	2018	Polyp detection	CNN	155 videos	AUC = 0.87
	2019	Neoplasia detection	CNN	685 subjects	ADR = 54.8%
	2020	Adenoma detection	DL	386 patients	AMR = 13.89%
	2022	Neoplasia detection	CNN	230 subjects	AMR = 15.5%
	2020	Polyp and adenoma detection	CNN	308 patients	ADR = 0.289;0.367(polyp; adenoma)
	2020	Polyp detection	YOLO	150 patients	PDR = 38.7%
	2022	Polyp and adenoma detection	CNN	1,434 patients	PDR = 40.8% ADR = 20.1%
	2021	Adenoma detection	CADe	1,076 patients	ADR = 21.27%
	2021	Polyp	DL	2,352 patients detection	PDR = 38.8%
	2019	Polyp and adenoma detection	DL	522 patients	ADR = 29.1% PDR = 64.93%
	2021	Adenoma detection	CNN	358 patients	AMR = 13.8%

AI role in personalized medicine for CRC

- The treatments for CRC include surgical therapy, chemotherapy, targeted therapy, and other combined therapies.

- Application of AI in the treatment of CRC can design appropriate therapeutic plans for patients, providing patients with more personalized and precise medical decisions, and improving the prognosis.



Robotic Surgery for CRC

- Leonardo da Vinci made a major contributor to medical physics ,in 1495.
- The 1 g da Vinci surgical system was manufactured and put on the market in 1999.

- So far, robot-assisted surgery has been widely used for patients and has advantages, such as shorter hospital stay, less perioperative bleeding, fewer complications, and improved postoperative quality of life in comparison with open and laparoscopic surgery .

- The robotic surgery’s recurrence and mortality rates are comparable to that of laparoscopic surgery.



IBD

- The accuracy of AI models (25 studies) to assess ulcerative colitis (UC) endoscopic activity ranged between 86.54% and 94.5%.

- AI-assisted analysis of colonoscopic images can help differentiate IBD from non-IBD, UC from non-UC and UC from Crohn's disease (CD) (three studies) with 72.1%, 98.3% and > 90% accuracy, respectively.

- AI-assisted virtual chromoendoscopy (4 studies) could predict histologic remission and long-term outcomes.

- Computer-assisted detection (CADe) of dysplasia (2 studies) is feasible along with AI-based differentiation of high from low-grade IBD neoplasia (79% accuracy).

Small Intestine

- AI-assisted capsule endoscopy reading (12 studies) substantially reduced analyzable images and reading time with excellent accuracy (90.5% to 99.9%) for source of bleeding .

- Applications of artificial intelligence in celiac disease.
- AI in small intestinal Crohn’s disease.
- AI in primary small intestinal tumor.
- Small intestinal ischemia injury .The detection accuracy of irreversible damage may be close to 100% by bio-impedance sensor .
- Small intestinal motor dysfunction.

- All of the mentioned things about AI ,has a promising prospect in the era of cancer screening and management .

- Application of AI in medicine is in its infancy and has a lot of limitation .
- There is a need to strengthen cooperation between clinicians and computer because “No one knows everything, But with AI, we know a whole lot” .

- Combining AI and Human Intelligence is more sophisticated for medical practice , research and education.




Thank You !