**EDITORIAL**

7  Artificial intelligence and colorectal cancer: How far can you go?

*Alloro R, Sinagra E*

---

**MINIREVIEWS**

12  Advances in the application of artificial intelligence in solid tumor imaging

*Shao Y, Zhang YX, Chen HH, Lu SS, Zhang SC, Zhang JX*
ABOUT COVER

Editorial Board Member of Artificial Intelligence in Cancer, Ravi P Sahu, PhD, Assistant Professor, Department of Pharmacology and Toxicology, Boonshoft School of Medicine Wright State University, Dayton, OH 45345, United States. ravi.sahu@wright.edu

AIMS AND SCOPE

The primary aim of Artificial Intelligence in Cancer (AIC, Artif Intell Cancer) is to provide scholars and readers from various fields of artificial intelligence in cancer with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

AIC mainly publishes articles reporting research results obtained in the field of artificial intelligence in cancer and covering a wide range of topics, including artificial intelligence in bone oncology, breast cancer, gastrointestinal cancer, genitourinary cancer, gynecological cancer, head and neck cancer, hematologic malignancy, lung cancer, lymphoma and myeloma, pediatric oncology, and urologic oncology.

INDEXING/ABSTRACTING

There is currently no indexing.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Ying-Yi Yuan; Production Department Director: Yu-Jie Ma; Editorial Office Director: Jin-Lei Wang.
Artificial intelligence and colorectal cancer: How far can you go?

Rita Alloro, Emanuele Sinagra

ORCID number: Rita Alloro 0000-0003-1237-3878; Emanuele Sinagra 0000-0002-8528-0384.

Author contributions: Sinagra E and Alloro R designed the study and wrote the manuscript.

Conflict-of-interest statement: All the authors declare that this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors, and thus there is no conflict of interest regarding this paper.

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/Licenses/by-nc/4.0/

Manuscript source: Invited manuscript

Specialty type: Gastroenterology and hepatology

Country/Territory of origin: Italy

Rita Alloro, Department of Surgical, Oncological and Oral Sciences (Di.Chir.On.S.), Unit of General and Oncological Surgery, Paolo Giaccone University Hospital, University of Palermo, Palermo 90127, Italy

Emanuele Sinagra, Gastroenterology and Endoscopy Unit, Fondazione Istituto G. Giglio, Palermo 90015, Italy

Corresponding author: Emanuele Sinagra, PhD, Attending Doctor, Gastroenterology and Endoscopy Unit, Fondazione Istituto G. Giglio, Contrada Pietrapollastra Pisciotto, Cefalù, Palermo 90015, Italy. emanuesinagra83@googlemail.com

Abstract

Artificial intelligence is an emerging technology whose application is rapidly increasing in several medical fields. The numerous applications of artificial intelligence in gastroenterology have shown promising results, especially in the setting of gastrointestinal oncology. Therefore, we would like to highlight and summarize the research progress and clinical application value of artificial intelligence in the diagnosis, treatment, and prognosis of colorectal cancer to provide evidence for its use as a promising diagnostic and therapeutic tool in this setting.

Key Words: Artificial intelligence; Colorectal cancer; Diagnosis; Treatment; Prognosis

©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

Core Tip: In this editorial, we would like to highlight and summarize the research progress and clinical application value of artificial intelligence in the diagnosis, treatment, and prognosis of colorectal cancer to provide evidence for its use as a promising diagnostic and therapeutic tool in this setting.

Citation: Alloro R, Sinagra E. Artificial intelligence and colorectal cancer: How far can you go? Artif Intell Cancer 2021; 2(2): 7-11
URL: https://www.wjgnet.com/2644-3228/full/v2/i2/7.htm
DOI: https://dx.doi.org/10.35713/aic.v2.i2.7
INTRODUCTION

Colorectal cancer (CRC) is a major healthcare concern worldwide. It is the third most common cancer in males, the second most common cancer in females and the fourth leading cause of cancer death worldwide[1-3]. Furthermore, up to 60%-70% of recognized cases in symptomatic patients are diagnosed at an advanced stage[4-6].

Artificial intelligence (AI) is a form of machine technology in which intelligent agents perform functions associated with the human mind, such as learning and problem solving[7-9]; AI algorithms are primarily used for disease diagnosis, treatment and prognosis[10,11].

In the setting of endoscopic diagnosis, AI has been primarily evaluated in 3 clinical scenarios: Polyp detection, polyp characterization (adenomatous vs nonadenomatous), and the prediction of invasive cancer within a polypoid lesion[12].

With regard to polyp detection, the adenoma detection rate (ADR) defines the proportion of patients with at least one colorectal adenoma detected at the first screening colonoscopy among all the patients examined by an endoscopist, represents a pivotal quality measure for colonoscopy[6,13]. In fact, it has been reported that a 1% increase in the ADR is associated with a 3% decrease in interval CRC incidence[6,14,15].

The outcomes reported by different mono- and multicenter randomized clinical trials are highly promising; the overall ADR of these studies was significantly higher when computer-aided diagnosis (CAD) systems were incorporated (up to 80%)[16-20].

With regard to polyp characterization, CAD systems can achieve thresholds of preservation and incorporate valuable endoscopic innovations for diminutive, nonneoplastic rectosigmoid polyps according to various studies[6,21-25].

With regard to differentiation between invasive cancer and nonmalignant adenomatous polyps, an accuracy of 94.1% and 81.2%, respectively, was achieved in two recent studies[26,27].

AI has also been evaluated in the classification and diagnosis of biopsy samples. In a recent systematic review performed by Thakur and coworkers, the authors concluded that artificial intelligence showed promising results in terms of accuracy in diagnosing CRC with regard to tumor classification, tumor microenvironment analysis, and prognosis prediction. However, the scale and quality of the training and validation datasets of most of these studies are insufficiently adequate, limiting the applicability of this technique in clinical practice[28].

With regard to surgical approaches, robot-assisted colorectal surgery has shown better performance than human-alone surgery, in terms of short- and long-term outcomes[10,29].

Additionally, with regard to the pharmacological approach, some studies evaluated targeted drug delivery[30], drug pharmacokinetics[31] and prediction of the rate of drug toxicity[32].

Furthermore, the personalization and precision of cancer treatments have become major themes in oncology research. For example, “Watson for Oncology” is an AI system that can assist in the precision medicine-based treatment of tumors[10,33]. It can automatically extract medical language from doctors’ records and translate them into a practical language for learning[10]. This model can be used to identify new cancer sub-populations, analyze their genetic biomarkers, and find effective drug combinations[10].

Finally, the emergence of AI has allowed clinicians to predict the prognoses of CRC patients more easily and precisely by using several approaches. For example, in one study, genetic markers of CRC were used to train a model based on different algorithms[34]. In another study, a computer-aided analysis method for tissue sections based on multifractal analyses of cytokeratin-stained tumor sections was proposed to evaluate the complexity of tumor-stroma interfaces[35]. Other studies have evaluated cytokeratin immunohistochemical images to predict lymph node metastasis[36,37] and the infiltration of immune cells in influencing CRC prognosis[38].

In the near future, AI technology will help doctors diagnose and treat their patients and provide CRC patients with personalized and accurate prognosis evaluations.

CONCLUSION

In conclusion, AI could play a pivotal role in gastrointestinal oncology, especially in the setting of CRC, for tailoring patient treatments and predicting their clinical outcomes[9].
Table 1 Application of artificial intelligence in colorectal cancer

| Setting  | Application                                                   | Ref.   |
|----------|---------------------------------------------------------------|--------|
| Diagnosis| Polyp identification                                          | [16-20]|
|          | Polyp characterization                                        | [21-25]|
|          | Prediction of invasive cancer within a polyoid lesion         | [26,27]|
|          | Search for new diagnostic biomarkers                         | [10]   |
|          | Pathologic biopsy                                             | [28]   |
| Treatment| Preoperative evaluation                                       | [10]   |
|          | Robot-assisted surgery                                        | [29]   |
|          | Drug delivering in a targeted manner                          | [30]   |
|          | Evaluation of drugs pharmacokinetic                          | [31]   |
|          | Prediction of the rate of toxicity                            | [32]   |
|          | Watson for Oncology project                                   | [33]   |
| Prognosis| Search for new prognostic biomarkers                          | [38]   |
|          | Evaluation of tumour-stroma ratio                             | [35]   |
|          | Prediction of lymph-node metastasis                           | [36,37]|

Future randomized studies could directly increase the overall value (quality and costs) of AI by examining its effects not only in diagnosis (by evaluating colonoscopy findings, endoscopy durations, polyps and ADRs) but also in prognosis and therapy.

Since AI science continues to grow and evolve, the current limitations must be considered as a future challenge; these limitations are also inherited by the medicine applications of AI, including the difficult predictability of situations characterized by some degree of uncertainty[6]. Table 1 shows the applications of AI in CRC.

Future applications of AI could be implemented in all the settings of CRC management, such as the determination of the potential role of noncoding RNAs in tumor diagnosis and treatment[10].

Finally, the integration of AI in human-based medicine has to considered. AI has never been nor will ever be considered a substitute for the physician; on the contrary, it seems to be an extremely helpful tool to be used by the physician who, given his or her ability and skills, is the only one able to process and interpret all the information extracted by the AI to make decisions on patient management.

REFERENCES

1 Global Burden of Disease Cancer Collaboration, Fitzmaurice C, Dicker D, Pain A, Hamavid H, Moradi-Lakeh M, MacIntyre MF, Allen C, Hansen G, Woodbrook R, Wolfe C, Hamadeh RR, Moore A, Werdecker A, Gessner BD, Te Ao B, McMahon B, Karimkhani C, Yu C, Cooke GS, Schwebel DC, Carpenter DO, Pereira DM, Nash D, Kazi DS, De Leo D, Plass D, Ukwaja KN, Thurston GD, Yun Jin K, Simard EP, Mills E, Park EK, Catala-López F, deVéber G, Gotay C, Khan G, Hosgood HD 3rd, Santos IS, Leasher JL, Singh J, Leigh J, Jonas JB, Sanabria J, Beardsley J, Jacobsen KH, Takahashi K, Franklin RC, Ronfani L, Montico M, Naldi L, Tonelli M, Geleijnse J, Petzold M, Shrimie MG, Younis M, Yonemoto N, Breithorde N, Yip P, Pournmalek F, Lotufo PA, Esteghamati A, Hankey GJ, Ali R, Lunecvicius R, Malekzadeh R, Dellavalle R, Weintraub R, Lucas R, Hay R, Rojas-Rueda D, Westerman R, Sepanlou SG, Nolte S, Patten S, Weichenthal S, Aher SF, Fereshtehnejad SM, Shiee I, Driscoll T, Vasankari T, Alsharif U, Rahimi-Movaghar V, Vlassov VV, Marcenes WS, Meekonnen W, Melaku YA, Yano Y, Artaman A, Campos I, MacLachlan J, Mueller U, Kim D, Trillini M, Eshtari B, Williams HC, Shibuya K, Dandona R, Murthy K, Cowie B, Amare AT, Antonio CA, Castañeda-Orijuela C, van Gool CH, Violante F, Oh IH, Derihe K, Soreide K, Knibbs L, Kereselidze M, Green M, Cardenas R, Roy N, Tillmann T, Li Y, Krueger H, Monasta L, Dey S, Sheikhbahaei S, Hafezi-Nejad N, Kumar GA, Sreeramareddy CT, Dandona L, Wang H, Vollset SE, Mokdad A, Salomon JA, Lozano R, Vos T, Forouzanfar M, Lopez A, Murray C, Naghavi M. The Global Burden of Cancer 2013. JAMA Oncol 2015; 1: 505-527 [PMID: 26181261 DOI: 10.1001/jamaoncol.2015.0735]

2 Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. CA Cancer J Clin 2015; 65: 87-108 [PMID: 25651787 DOI: 10.3322/caac.21262]
Maida M, Morreale G, Sinagra E, Ianigo G, Margherita V, Cirrone Cipolla A, Camilleri S. Quality measures improving endoscopic Screening of colorectal cancer: a review of the literature. *Expert Rev Anticancer Ther* 2019; 19: 223-235 [PMID: 30614284 DOI: 10.1080/14737140.2019.1565999]

Mandel JS, Bond JH, Church TR, Snover DC, Bradley GM, Schuman LM, Ederer F. Reducing mortality from colorectal cancer by screening for fecal occult blood. Minnesota Colon Cancer Control Study. *N Engl J Med* 1993; 328: 1365-1371 [PMID: 8474513 DOI: 10.1056/NEJM1993051333281901]

Maida M, Macaluso FS, Ianigo G, Mangiola F, Sinagra E, Hold G, Maida C, Cammarota G, Gasbarrini A, Scarpulla G. Screening of colorectal cancer: present and future. *Expert Rev Anticancer Ther* 2017; 17: 1131-1146 [PMID: 29022408 DOI: 10.1080/14737140.2017.1392243]

Sinagra E, Badalamenti M, Maida M, Spadaccini M, Maselli R, Rossi F, Conoscenti G, Raimondo D, Pallio S, Repici A, Anderloni A. Use of artificial intelligence in improving adenoma detection rate during colonoscopy: Might both endoscopists and pathologists be further helped. *World J Gastroenterol* 2020; 26: 5911-5918 [PMID: 33132644 DOI: 10.3748/wjg.v26.i39.5911]

Russell S, Norvig P. Artificial intelligence: A Modern Approach. Global Edition. 3rd edition. London: Pearson, 2016

Colom R, Karana S, Jung RE, Haier RJ. Human intelligence and brain networks. *Dialogues Clin Neurosci* 2010; 12: 489-501 [PMID: 21319494 DOI: 10.31887/DCNS.2010.12.4/colom]

Morreale GC, Sinagra E, Vitello A, Shahini E, Maida M. Emerging artificial intelligence applications in gastroenterology: A review of the literature. *Artif Intell Gastrointest Endosc* 2020; 1: 6-18 [DOI: 10.37126/aige.v1.i1.6]

Wang Y, He X, Nie H, Zhou J, Cao P, Ou C. Application of artificial intelligence to the diagnosis and therapy of colorectal cancer. *Am J Cancer Res* 2020, 10: 3575-3598 [PMID: 33040269 DOI: 10.7150/thno.49168]

Hamet P, Tremblay J. Artificial intelligence in medicine. *Metabolism* 2017; 69S: S36-S40 [PMID: 28126242 DOI: 10.1016/j.metabol.2017.01.011]

Pannala R, Krishnan K, Melson J, Parsi MA, Schulman AR, Sullivan S, Trikudanathan G, Trinidad AJ, Watson RR, Maple JT, Lichtenstein DR. Artificial intelligence in gastrointestinal endoscopy. *VideoGIE* 2020; 5: 598-613 [PMID: 33319126 DOI: 10.1016/j.vgie.2020.08.013]

Zhao S, Wang S, Pan P, Xia T, Chang X, Yang X, Guo L, Meng Q, Yang F, Qian W, Xu Z, Wang Y, Wang Z, Gu L, Wang R, Jia F, Yao J, Li Z, Bai Y. Magnitude, Risk Factors, and Factors Associated With Adenoma Miss Rate of Tandem Colonoscopy: A Systematic Review and Meta-analysis. *Gastroenterology* 2019; 156: 1661-1674. e11 [PMID: 30738046 DOI: 10.1053/j.gastro.2019.01.260]

Rex DK, Cutler CS, Lemmel GT, Rahmani EY, Clark DW, Helper DJ, Lehrman GA, Mark DG. Colonicoscopic miss rates of adenomas determined by back-to-back colonoscopies. *Gastroenterology* 1997; 112: 24-28 [PMID: 8973385 DOI: 10.1016/s0016-5085(97)70214-2]

Corley DA, Jensen CD, Marks AR, Zhao WK, Lee JK, Doubeni CA, Zauber AG, de Boer JF, Fireman BH, Schottinger JE, Quinn VP, Ghai NR, Levin TR, Quesenberry CP. Adenoma detection rate and risk of colorectal cancer and death. *N Engl J Med* 2014; 370: 1298-1306 [PMID: 24693890 DOI: 10.1056/NEJMoa1309086]

Repici A, Badalamenti M, Maselli R, Morreale L, Radaelli F, Rondonotti E, Ferrara E, Spadaccini M, Alkandari A, Bugazza A, Anderloni A, Galtieri PA, Pellegatta G, Carrara S, Di Leo M, Craviotto V, Lamonaca L, Lorenzetti R, Andrealli A, Antonelli G, Wallace M, Sharma P, Rosch T, Hassan C. Efficacy of Real-Time Computer-Aided Detection of Colorectal Neoplasia in a Randomized trial. *Gastroenterology* 2020; 159: 512-520. e7 [PMID: 32371116 DOI: 10.1053/j.gastro.2020.04.062]

Wang P, Berzin TM, Glissen Brown JR, Bharadwaj S, Becq A, Xiao X, Liu P, Li C, Song Y, Zhang D, Li Y, Xu G, Tu M, Liu X. Real-time automatic detection system increases colonoscopic polyp and adenoma detection rates: a prospective randomised controlled study. *Gut* 2019; 68: 1813-1819 [PMID: 30814121 DOI: 10.1136/gutjnl-2018-317500]

Wang P, Liu X, Berzin TM, Glissen Brown JR, Liu P, Zhou C, Lei L, Li L, Guo Z, Lei S, Xiong F, Wang H, Song Y, Pan Y, Zhou Z. G. Efficacy of a deep-learning computer-aided detection system on adenoma detection during colonoscopy (CADe-DB trial): a double-blind randomised study. *Lancet Gastroenterol Hepatol* 2020; 5: 343-351 [PMID: 31981517 DOI: 10.1016/S2468-1253(19)30411-X]

Gong D, Wu L, Zhang J, Mu G, Shen L, Liu J, Wang Z, Zhou W, An P, Huang X, Jiang X, Li Y, Wan X, Hu S, Chen Y, Hu X, Xu Y, Zha X, Li S, Yao L, He X, Chen D, Huang L, Wei X, Wang X, Yu H. Detection of colorectal adenomas with a real-time computer-aided system (ENDOANGEL): a randomised controlled study. *Lancet Gastroenterol Hepatol* 2020; 5: 352-361 [PMID: 31981518 DOI: 10.1016/S2468-1253(19)30413-3]

Liu WN, Zhang YY, Biao XQ, Wang LJ, Yang Q, Zhang XD, Huang J. Study on detection rate of polyps and adenomas in artificial-intelligence-aided colonoscopy. *Saudj J Gastroenterol* 2020; 26: 13-19 [PMID: 31898644 DOI: 10.4103/sjg.SJG.377 19]

Alhara H, Saito S, Inomata H, Ide D, Tamai N, Ohya TR, Kato T, Amimiti S, Tajiri H. Computer-aided diagnosis of neoplastic colorectal lesions using 'real-time' numerical color analysis during autofluorescence endoscopy. *Eur J Gastroenterol Hepatol* 2013; 25: 488-494 [PMID: 23496064 DOI: 10.1097/MEG.0b013e32835c6d6b]

Kuiper T, Alderliesten YA, Tytgat KM, Vlug MS, Nabhuaus JA, Bastiaansen BA, Löwenberg M, Fockens P, Dekker E. Automatic optical diagnosis of small colorectal lesions by laser-induced autofluorescence. *Endoscopy* 2015; 47: 56-62 [PMID: 25264765 DOI: 10.1055/s-0034-1378112]

Rath T, Tontini GE, Vieth M, Nägel A, Neurath MF, Neumann H. In vivo real-time assessment of
colorectal polyp histology using an optical biopsy forceps system based on laser-induced fluorescence spectroscopy. *Endoscopy* 2016; 48: 557-562 [PMID: 27009081 DOI: 10.1055/s-0042-170251]

24 **Kominami Y**, Yoshida S, Tanaka S, Sanomura Y, Hirakawa T, Raytchev B, Tamaki T, Koide T, Kaneda K, Chayama K. Computer-aided diagnosis of colorectal polyp histology by using a real-time image recognition system and narrow-band imaging magnifying colonoscopy. *Gastrointest Endosc* 2016; 83: 643-649 [PMID: 26264431 DOI: 10.1016/j.gie.2015.08.004]

25 **Mori Y**, Kudo SE, Misawa M, Saito Y, Ikematsu H, Hotta K, Ohtsuka K, Urushibara F, Kataoka S, Ogawa Y, Maeda Y, Takeda K, Nakamura H, Ichimasa K, Kudo T, Hayashi T, Wakamura K, Ishida F, Inoue H, Itoh H, Oda M, Mori K. Real-Time Use of Artificial Intelligence in Identification of Diminutive Polyps During Colonoscopy: A Prospective Study. *Ann Intern Med* 2018; 169: 357-366 [PMID: 30105375 DOI: 10.7326/M18-0249]

26 **Takeda K**, Kudo SE, Mori Y, Misawa M, Kudo T, Wakamura K, Katagiri A, Baba T, Hidaka E, Ishida F, Inoue H, Oda M, Mori K. Accuracy of diagnosing invasive colorectal cancer using computer-aided endocytoscopy. *Endoscopy* 2017; 49: 798-802 [PMID: 28472832 DOI: 10.1055/s-0043-174245]

27 **Ito N**, Kawahira H, Nakashima H, Uesato M, Miyauchi H, Matsubara H. Endoscopic Diagnostic Support System for cT1b Colorectal Cancer Using Deep Learning. *Oncoology* 2019; 96: 44-50 [PMID: 30130758 DOI: 10.1159/0004091636]

28 **Thakur N**, Yoon H, Chong Y. Current Trends of Artificial Intelligence for Colorectal Cancer Pathology Image Analysis: A Systematic Review. *Cancers* (Basel) 2020; 12 [PMID: 32668721 DOI: 10.3390/cancers12011864]

29 **Yoon SN**, Kim KY, Kim JW, Lee SC, Kwon YJ, Cho JW, Jung SY, Kim BC. Comparison of short- and long-term outcomes of an early experience with robotic and laparoscopic-assisted resection for rectal cancer. *Hepatogastroenterology* 2015; 62: 34-39 [PMID: 25911863]

30 **Felfoul O**, Mohammadi M, Taherkhani S, de Lanauze D, Zhong Xu Y, Loghin D, Essa S, Jancik S, Houle D, Lafleur M, Gaboury L, Tabrizian M, Kaou N, Atkin M, Vuong T, Batist G, Beauchemin N, Radzieo D, Martel S. Magneto-aerotactic bacteria deliver drug-containing nanoliposomes to tumour hypoxic regions. *Nat Nanotechnol* 2016; 11: 941-947 [PMID: 27525475 DOI: 10.1038/nnano.2016.137]

31 **Cruz S**, Gomes SE, Borrhalo PM, Rodrigues CMP, Gaudêncio SP, Pereira F. In Silico HCT116 Human Colon Cancer Cell-Based Models En Route to the Discovery of Lead-Like Anticancer Drugs. *Biomolecules* 2018; 8 [PMID: 30018273 DOI: 10.3390/biom08030056]

32 **Oyaga-Iriarte E**, Insauti A, Sayar O, Aldaz A. Prediction of irinotecan toxicity in metastatic colorectal cancer patients based on machine learning models with pharmacokinetic parameters. *J Pharmacol Sci* 2019; 140: 20-25 [PMID: 31105026 DOI: 10.1016/j.jphs.2019.03.004]

33 **Schmidt C**. M. D. Anderson Breaks With IBM Watson, Raising Questions About Artificial Intelligence in Oncology. *J Natl Cancer Inst* 2017; 109 [PMID: 30053147 DOI: 10.1093/jnci/djx113]

34 **Gründner J**, Prokosch HU, Stürzl M, Croner R, Christoph J, Toddenroth D. Predicting Clinical Outcomes in Colorectal Cancer Using Machine Learning. *Stud Health Technol Inform* 2018; 247: 101-105 [PMID: 29677931]

35 **Mecheyevski A**, Hrynychyk I, Karlberg M, Portyanko A, Egevad L, Ragnhammar P, Edler D, Glimelius B, Östman A. Image analysis-derived metrics of histomorphological complexity predicts prognosis and treatment response in stage II-III colon cancer. *Sci Rep* 2016; 6: 36149 [PMID: 27805003 DOI: 10.1038/srep36149]

36 **Zhou YP**, Li S, Zhang XX, Zhang ZD, Gao YX, Ding L, Lu Y. [High definition MRI rectal lymph node aided diagnostic system based on deep neural network]. *Zhonghua Wai Ke Za Zhi* 2019; 57: 108-113 [PMID: 30704213 DOI: 10.7360/cma.j.issn.0529-5815.2019.02.007]

37 **Lu Y**, Yu Q, Gao Y, Zhou Y, Liu G, Dong Q, Ma J, Ding L, Yao H, Zhang Z, Xiao G, An Q, Wang G, Xi J, Yuan W, Lian Y, Zhang D, Zhao C, Yao Q, Liu W, Zhou X, Liu S, Wu Q, Xu W, Zhang J, Wang D, Sun Z, Zhang X, Hu J, Zhang M, Zheng C, Wang L, Zhao J, Yang S. Identification of Metastatic Lymph Nodes in MR Imaging with Faster Region-Based Convolutional Neural Networks. *Cancer Res* 2018; 78: 5135-5143 [PMID: 30026330 DOI: 10.1158/0008-5472.CAN-18-0494]

38 **Eyraud D**, Granger B, Bardier A, Loncar Y, Gottrand G, Le Naour G, Siksik JM, Vaillant JC, Klatzmann D, Paybasset L, Charlotte F, Augustin J. Immunological environment in colorectal cancer: a computer-aided morphometric study of whole slide digital images derived from tissue microarray. *Pathology* 2018; 50: 607-612 [PMID: 30166125 DOI: 10.1016/j.pathol.2018.04.006]
