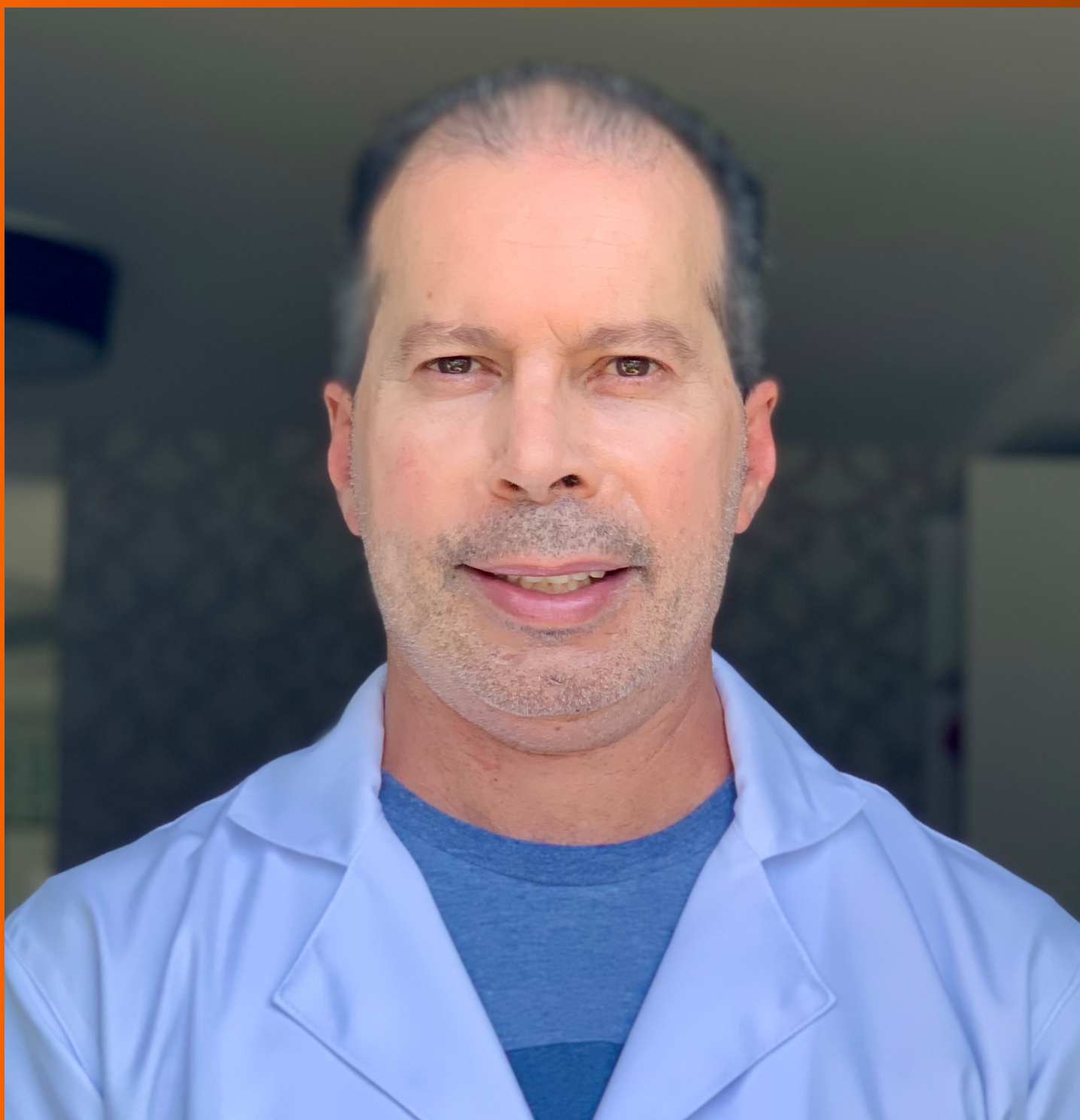


World Journal of *Gastroenterology*

World J Gastroenterol 2024 February 21; 30(7): 614-778



EDITORIAL

- 614 Pathophysiology of severe gallstone pancreatitis: A new paradigm
Isogai M
- 624 Trauma to the solid abdominal organs: The missed dark box of colonoscopy
Emara MH, Mazid U, Elshaer YA, Elkerdawy MA, Malik DF, Mahros AM
- 631 From prediction to prevention: Machine learning revolutionizes hepatocellular carcinoma recurrence monitoring
Ramírez-Mejía MM, Méndez-Sánchez N
- 636 Muscle strength and non-alcoholic fatty liver disease/metabolic-associated fatty liver disease
Hao XY, Zhang K, Huang XY, Yang F, Sun SY

MINIREVIEWS

- 644 Colon and rectal cancer: An emergent public health problem
Pinheiro M, Moreira DN, Ghidini M
- 652 Recent advances in age-related metabolic dysfunction-associated steatotic liver disease
He QJ, Li YF, Zhao LT, Lin CT, Yu CY, Wang D
- 663 Current landscape of preoperative neoadjuvant therapies for initial resectable colorectal cancer liver metastasis
Cheng XF, Zhao F, Chen D, Liu FL

ORIGINAL ARTICLE

Retrospective Study

- 673 Endoscopic features and treatments of gastric cystica profunda
Geng ZH, Zhu Y, Fu PY, Qu YF, Chen WF, Yang X, Zhou PH, Li QL

Observational Study

- 685 Red cell distribution width/platelet ratio estimates the 3-year risk of decompensation in Metabolic Dysfunction-Associated Steatotic Liver Disease-induced cirrhosis
Dallio M, Romeo M, Vaia P, Auletta S, Mammone S, Cipullo M, Sapio L, Ragone A, Niosi M, Naviglio S, Federico A

Prospective Study

- 705 Gastrointestinal contrast-enhanced ultrasonography for diagnosis and treatment of peptic ulcer in children
Zhang YH, Xu ZH, Ni SS, Luo HX

Basic Study

- 714 Erlotinib combination with a mitochondria-targeted ubiquinone effectively suppresses pancreatic cancer cell survival
Leung PY, Chen W, Sari AN, Sitaram P, Wu PK, Tsai S, Park JI
- 728 Milk fat globule epidermal growth factor 8 alleviates liver injury in severe acute pancreatitis by restoring autophagy flux and inhibiting ferroptosis in hepatocytes
Cui Q, Liu HC, Liu WM, Ma F, Lv Y, Ma JC, Wu RQ, Ren YF

SYSTEMATIC REVIEWS

- 742 Diagnostic and therapeutic role of endoscopic ultrasound in liver diseases: A systematic review and meta-analysis
Gadour E, Awad A, Hassan Z, Shrwani KJ, Miutescu B, Okasha HH

META-ANALYSIS

- 759 Metformin and pancreatic neuroendocrine tumors: A systematic review and meta-analysis
Cigrovski Berkovic M, Coppola A, Sesa V, Mrzljak A, Lai Q

LETTER TO THE EDITOR

- 770 Complementary comments on metastatic liver lesions with exceptional and rare cases
Memis KB, Aydin S
- 774 Endoscopic ultrasonography-related diagnostic accuracy and clinical significance on small rectal neuroendocrine neoplasms
Weng J, Chen YF, Li SH, Lv YH, Chen RB, Xu GL, Lin SY, Bai KH

ABOUT COVER

Editorial Board Member of *World Journal of Gastroenterology*, Júlio Maria Fonseca Chebli, MD, PhD, Associate Professor, Professor, Research Scientist, Department of Medicine, Inflammatory Bowel disease Center, University Hospital of the Federal University, Juiz de Fora 36036-247, Minas Gerais, Brazil. julio.chebli@medicina.ufjf.br

AIMS AND SCOPE

The primary aim of *World Journal of Gastroenterology* (WJG, *World J Gastroenterol*) is to provide scholars and readers from various fields of gastroenterology and hepatology with a platform to publish high-quality basic and clinical research articles and communicate their research findings online. WJG mainly publishes articles reporting research results and findings obtained in the field of gastroenterology and hepatology and covering a wide range of topics including gastroenterology, hepatology, gastrointestinal endoscopy, gastrointestinal surgery, gastrointestinal oncology, and pediatric gastroenterology.

INDEXING/ABSTRACTING

The WJG is now abstracted and indexed in Science Citation Index Expanded (SCIE), MEDLINE, PubMed, PubMed Central, Scopus, Reference Citation Analysis, China Science and Technology Journal Database, and Superstar Journals Database. The 2023 edition of Journal Citation Reports® cites the 2022 impact factor (IF) for WJG as 4.3; Quartile category: Q2. The WJG's CiteScore for 2021 is 8.3.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Yi-Xuan Cai; **Production Department Director:** Xu Guo; **Editorial Office Director:** Jia-Ru Fan.

NAME OF JOURNAL

World Journal of Gastroenterology

ISSN

ISSN 1007-9327 (print) ISSN 2219-2840 (online)

LAUNCH DATE

October 1, 1995

FREQUENCY

Weekly

EDITORS-IN-CHIEF

Andrzej S Tarnawski

EXECUTIVE ASSOCIATE EDITORS-IN-CHIEF**EDITORIAL BOARD MEMBERS**

<http://www.wjgnet.com/1007-9327/editorialboard.htm>

PUBLICATION DATE

February 21, 2024

COPYRIGHT

© 2024 Baishideng Publishing Group Inc

PUBLISHING PARTNER

Shanghai Pancreatic Cancer Institute and Pancreatic Cancer Institute, Fudan University
Biliary Tract Disease Institute, Fudan University

INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

Xian-Jun Yu (Pancreatic Oncology), Jian-Gao Fan (Chronic Liver Disease), Hou-Bao Liu (Biliary Tract Disease)

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>

PUBLISHING PARTNER'S OFFICIAL WEBSITE

<https://www.shca.org.cn>
<https://www.zs-hospital.sh.cn>



From prediction to prevention: Machine learning revolutionizes hepatocellular carcinoma recurrence monitoring

Mariana Michelle Ramírez-Mejía, Nahum Méndez-Sánchez

Specialty type: Gastroenterology and hepatology

Provenance and peer review: Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C, C
Grade D (Fair): 0
Grade E (Poor): E

P-Reviewer: Jin C, China; Yu H, China

Received: November 13, 2023

Peer-review started: November 13, 2023

First decision: December 5, 2023

Revised: December 12, 2023

Accepted: January 22, 2024

Article in press: January 22, 2024

Published online: February 21, 2024



Mariana Michelle Ramírez-Mejía, Plan of Combined Studies in Medicine, Faculty of Medicine, National Autonomous University of Mexico, Distrito Federal 04510, Mexico

Mariana Michelle Ramírez-Mejía, Nahum Méndez-Sánchez, Liver Research Unit, Medica Sur Clinic & Foundation, Distrito Federal 14050, Mexico

Nahum Méndez-Sánchez, Faculty of Medicine, National Autonomous University of Mexico, Distrito Federal 04510, Mexico

Corresponding author: Nahum Méndez-Sánchez, FAASLD, AGAF, FACG, MD, MSc, PhD, Doctor, Professor, Liver Research Unit, Medica Sur Clinic & Foundation, Puente de Piedra 150, Col. Toriello Guerra, Distrito Federal 14050, Mexico. nah@unam.mx

Abstract

In this editorial, we comment on the article by Zhang *et al* entitled Development of a machine learning-based model for predicting the risk of early postoperative recurrence of hepatocellular carcinoma. Hepatocellular carcinoma (HCC), which is characterized by high incidence and mortality rates, remains a major global health challenge primarily due to the critical issue of postoperative recurrence. Early recurrence, defined as recurrence that occurs within 2 years posttreatment, is linked to the hidden spread of the primary tumor and significantly impacts patient survival. Traditional predictive factors, including both patient- and treatment-related factors, have limited predictive ability with respect to HCC recurrence. The integration of machine learning algorithms is fueled by the exponential growth of computational power and has revolutionized HCC research. The study by Zhang *et al* demonstrated the use of a groundbreaking preoperative prediction model for early postoperative HCC recurrence. Challenges persist, including sample size constraints, issues with handling data, and the need for further validation and interpretability. This study emphasizes the need for collaborative efforts, multicenter studies and comparative analyses to validate and refine the model. Overcoming these challenges and exploring innovative approaches, such as multi-omics integration, will enhance personalized oncology care. This study marks a significant stride toward precise, efficient, and personalized oncology practices, thus offering hope for improved patient outcomes in the field of HCC treatment.

Key Words: Hepatocellular carcinoma; Early recurrence; Machine learning; XGBoost model; Predictive precision medicine; Clinical utility; Personalized interventions

Core Tip: Machine learning is an important approach for personalized oncology care, as it paves the way for precise and individualized postoperative strategies, thereby enhancing patient outcomes in the field of hepatocellular carcinoma treatment. Ongoing collaboration, larger sample sizes, and multicenter studies are crucial for validating and refining this innovative predictive model, thus ensuring its applicability and reliability in diverse clinical settings.

Citation: Ramírez-Mejía MM, Méndez-Sánchez N. From prediction to prevention: Machine learning revolutionizes hepatocellular carcinoma recurrence monitoring. *World J Gastroenterol* 2024; 30(7): 631-635

URL: <https://www.wjgnet.com/1007-9327/full/v30/i7/631.htm>

DOI: <https://dx.doi.org/10.3748/wjg.v30.i7.631>

INTRODUCTION

In this editorial, we comment on the article by Zhang *et al*[1] entitled Development of a machine learning-based model for predicting the risk of early postoperative recurrence of hepatocellular carcinoma. Hepatocellular carcinoma (HCC) is the most common form of primary liver cancer and is considered a major global health challenge due to its high incidence and mortality rates[2,3]. Despite advances in medical and surgical interventions, recurrence remains a critical problem affecting the long-term survival of patients with HCC[4,5]. Recurrence of HCC within the 2 years posttreatment is categorized as early recurrence. Early recurrence typically occurs due to the hidden spread of the primary tumor within the liver, and its incidence is correlated with the tumor's size and extent. On the other hand, recurrence after 2 years posttreatment is categorized as late recurrence. Late recurrence is associated with *de novo* HCC, indicating the development of new cancerous growth independent of the original tumor[6]. Several predictive factors associated with recurrence have been recognized. Factors contributing to early recurrence include patient-related aspects such as age, the presence of underlying health conditions, liver function, viral load, the presence and activity of hepatitis, metabolic dysfunction-associated fatty liver disease, alcoholic liver disease and other etiologies, and the existence and activity of liver cirrhosis. Additionally, treatment-related factors, including the type of treatment employed, surgical margins, and specifics of the resection, also play a crucial role in predicting early recurrence[7]. The intricate nature of liver cancer, coupled with the diverse factors influencing recurrence, makes it challenging to provide an accurate prognosis[8,9]. Due to the constantly evolving landscape of HCC research, the quest for methods for predicting early recurrence has undergone a remarkable transformation in recent decades. Initially, researchers focused on deciphering the morphological characteristics of tumors as a basis for predictions[10]. Factors such as vascular invasion, tumor multiplicity and large tumor size have emerged as fundamental, although somewhat rudimentary, indicators that establish the basis for understanding the complexities of HCC recurrence[11,12]. Nevertheless, the paradigm shifted with the arrival of molecular analysis. Elevated alpha-fetoprotein (AFP) levels emerged as one of the first markers used for HCC prediction, offering insight into the intricate molecular landscape of this aggressive cancer[13,14]. Despite these advances, the multifaceted nature of HCC recurrence requires more nuanced and sophisticated approaches. Researchers and clinicians alike recognize the limitations of relying solely on morphologic and molecular analyses[15]. The quest for increasing predictive accuracy has led the scientific community to explore uncharted territory and harness the transformative power of technology, especially in the fields of imaging, genetics and computational sciences[16].

The evolution of technology has emerged as a pivotal catalyst, propelling HCC research into an era of unprecedented possibilities. Cutting-edge imaging techniques, coupled with advancements in genetic profiling, provide researchers with a comprehensive understanding of the tumor microenvironment[17-20]. These insights, combined with the computational progress of modern data analysis, paved the way for a new generation of predictive models. These models transcended the limitations of traditional analyses, offering a more nuanced and accurate glimpse into the future course of HCC[21-24].

MACHINE LEARNING IN HCC RESEARCH

The exponential growth of computational power has heralded a new era in HCC research, where machine learning algorithms have emerged as valuable tools in handling vast datasets and deciphering complex patterns[25,26]. This convergence of computational capabilities and healthcare needs represents a significant paradigm shift, transforming the landscape of HCC research. The integration of machine learning into the study of HCC offers a multitude of benefits and promises to address long-standing challenges in this field[27,28].

In a retrospective study, Zhang *et al*[1], harnessed the potential of supervised machine learning to develop a state-of-the-art preoperative prediction model for early postoperative HCC recurrence. Leveraging readily available clinical and imaging data, the team built six different risk prediction models, using ensemble learning, linear and neural network models, each meticulously designed to identify patients at high risk of recurrence. The study methodology consisted of analyzing the demographic and clinical data of 371 patients with HCC, excluding cases with incomplete data or previous

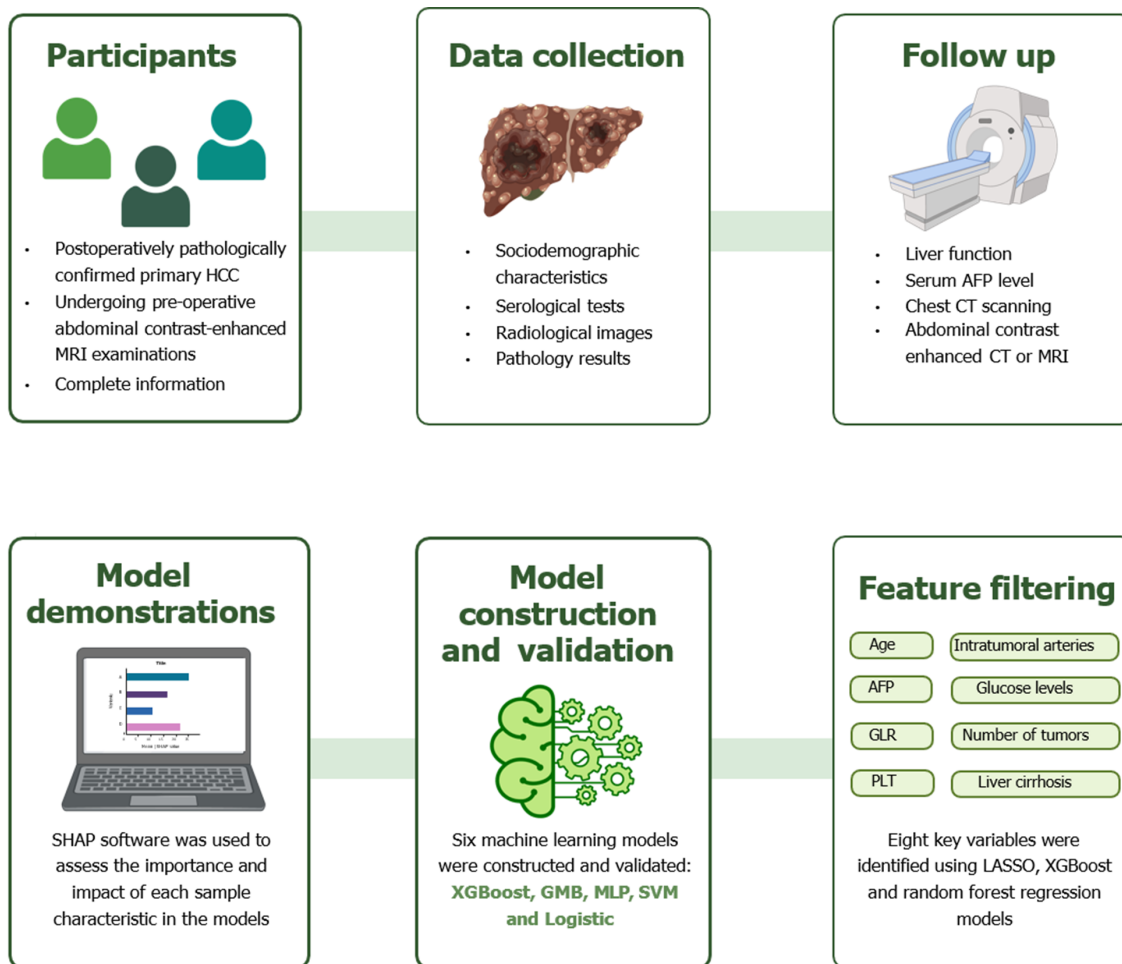


Figure 1 Summary of the study process. AFP: Alpha-fetoprotein; CT: Contrasted tomography; GLR: γ -glutamyl transferase-to-lymphocyte ratio; GMB: Complement NB; HCC: Hepatocellular carcinoma; MLP: Multilayer perceptron; MRI: Magnetic resonance imaging; PLT: Blood platelet; SVM: Support vector machine.

neoadjuvant treatments. Using machine learning algorithms, the researchers identified eight key variables to predict early HCC recurrence: Age, intra-tumoral arteries, AFP, blood glucose, number of tumors, glucose-to-lymphocyte ratio (GLR), liver cirrhosis, and platelet count. These variables formed the basis for the construction of six different prediction models, of which the XGBoost model proved to be the most robust (Figure 1). The XGBoost model, outperformed its peers, showing unmatched performance on several metrics. In the training dataset, the model achieved an impressive area under the receiver operating characteristic curve (AUROC) of 0.993, proof of its accuracy. Even in the validation and test data sets, the XGBoost model maintained its excellence, with AUROC values of 0.734 and 0.706, respectively. Calibration curve analysis underscored the reliability of the model, confirming its alignment with real-world results. Furthermore, decision curve analysis highlighted the clinical utility of the XGBoost model, highlighting its potential to guide surgical strategies and usher in an era of individualized postoperative medicine. By employing the SHAP (SHapley exPlanations) package, the study provided a detailed interpretation of the model results, unraveling the intricate relationships between variables. Preoperative glycemia emerged as a key factor, in line with previous research highlighting its role in HCC progression. The predictive power of the model was further demonstrated using an online calculator, designed to assist physicians in their daily practice. This user-friendly tool represents a major breakthrough, as it ensures the seamless integration of predictive analytics into clinical decision making.

The relevance of this study goes far beyond conventional medical research. Machine learning algorithms, used to decipher the intricate web of preoperative variables, have ushered in an era where predictive precision medicine reigns supreme. The identification of these eight key variables is a pivotal moment, providing physicians with unprecedented insight into the intricate factors that determine early postoperative recurrence.

Several research projects have been conducted to explore the use of machine learning in predicting HCC recurrence. Kucukkaya *et al*[29] developed a predictive model based on the analysis of pre-treatment magnetic resonance imaging using the VGG16 and XGBoost machine learning models. This model aimed to predict recurrence in six different time intervals, ranging from 1 year to 6 years, and demonstrated performance with AUROC values between 0.71 and 0.85. In another study, Zeng *et al*[25] compared the performance of random survival forest (RSF) models with Cox proportional hazard (CPH) models in predicting early recurrence using clinical features of the participants. In training and internal and external validation cohorts, the C-index of the RSF model was 0.725, 0.762, and 0.747, respectively. Although both studies highlighted the utility of machine learning, neither included the analysis of clinical and imaging variables, assuming a linear interaction of predictors for HCC recurrence. In this context, Zhang *et al*[1] proposed a solution in their

study, addressing the need to include clinical and imaging variables in the analysis. Their approach seeks to overcome the limitation of assuming linear interactions among predictors of HCC recurrence.

CHALLENGES AND FUTURE DIRECTIONS

This represents a significant advancement in early postoperative HCC recurrence prediction. Future research should focus on overcoming challenges related to sample size, data handling, validation, and interpretability. The authors acknowledge these limitations, emphasizing the need for future research endeavors to validate and refine the model further. These findings call for additional research, urging the scientific community to collaborate, expand sample sizes, and conduct multicenter studies. Comparative analyses with existing prediction models are crucial for ensuring the reliability and applicability of this innovative approach[30,31].

CONCLUSION

The development of accurate, interpretable, and widely applicable prediction models for early postoperative HCC recurrence represents a significant advance in personalized medicine. Addressing the challenges associated with data quality and model interpretability while exploring innovative approaches, such as multi-omics integration and continuous model refinement, will pave the way for improved patient outcomes and healthcare practices in the field of HCC treatment. Through collaborative efforts, continued research and the use of patient-centered approaches, the field of oncology can continue its journey toward more precise, efficient and personalized oncology care.

FOOTNOTES

Author contributions: Méndez-Sánchez N and Ramírez-Mejía MM contributed to this paper; Méndez-Sánchez N designed the overall concept and outline of the manuscript; Ramírez-Mejía MM contributed to the discussion and design of the manuscript; Méndez-Sánchez N and Ramírez-Mejía MM contributed to the writing and editing of the manuscript, the illustrations, and the review of the literature.

Conflict-of-interest statement: All the authors declare that they have no conflicts of interest related to the manuscript.

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: <https://creativecommons.org/licenses/by-nc/4.0/>

Country/Territory of origin: Mexico

ORCID number: Mariana Michelle Ramírez-Mejía 0009-0005-6279-1527; Nahum Méndez-Sánchez 0000-0001-5257-8048.

S-Editor: Lin C

L-Editor: Filipodia

P-Editor: Chen YX

REFERENCES

- 1 **Zhang YB**, Yang G, Bu Y, Lei P, Zhang W, Zhang DY. Development of a machine learning-based model for predicting risk of early postoperative recurrence of hepatocellular carcinoma. *World J Gastroenterol* 2023; **29**: 5804-5817 [PMID: 38074914 DOI: 10.3748/wjg.v29.i43.5804]
- 2 **Singal AG**, Lampertico P, Nahon P. Epidemiology and surveillance for hepatocellular carcinoma: New trends. *J Hepatol* 2020; **72**: 250-261 [PMID: 31954490 DOI: 10.1016/j.jhep.2019.08.025]
- 3 **Llovet JM**, Kelley RK, Villanueva A, Singal AG, Pikarsky E, Roayaie S, Lencioni R, Koike K, Zucman-Rossi J, Finn RS. Hepatocellular carcinoma. *Nat Rev Dis Primers* 2021; **7**: 6 [PMID: 33479224 DOI: 10.1038/s41572-020-00240-3]
- 4 **Papaconstantinou D**, Tsimimigras DI, Pawlik TM. Recurrent Hepatocellular Carcinoma: Patterns, Detection, Staging and Treatment. *J Hepatocell Carcinoma* 2022; **9**: 947-957 [PMID: 36090786 DOI: 10.2147/JHC.S342266]
- 5 **Tabrizian P**, Jibara G, Shrager B, Schwartz M, Roayaie S. Recurrence of hepatocellular cancer after resection: patterns, treatments, and prognosis. *Ann Surg* 2015; **261**: 947-955 [PMID: 25010665 DOI: 10.1097/SLA.0000000000000710]
- 6 **Pagano D**, Mamone G, Petridis I, Gruttadauria S. Hepatocellular Carcinoma Recurrence: How to Manage. In: Hepatocellular Carcinoma. Ettore GM, editor. Cham: Springer International Publishing, 2023: 191-197 [DOI: 10.1007/978-3-031-09371-5_23]
- 7 **Nevola R**, Ruocco R, Criscuolo L, Villani A, Alfano M, Beccia D, Imbriani S, Claar E, Cozzolino D, Sasso FC, Marrone A, Adinolfi LE, Rinaldi L. Predictors of early and late hepatocellular carcinoma recurrence. *World J Gastroenterol* 2023; **29**: 1243-1260 [PMID: 36925456 DOI: 10.3748/wjg.v29.i8.1243]
- 8 **Zhu Y**, Gu L, Chen T, Zheng G, Ye C, Jia W. Factors influencing early recurrence of hepatocellular carcinoma after curative resection. *J Int*

- Med Res* 2020; **48**: 300060520945552 [PMID: 33106072 DOI: 10.1177/0300060520945552]
- 9 **Jung SM**, Kim JM, Choi GS, Kwon CHD, Yi NJ, Lee KW, Suh KS, Joh JW. Characteristics of Early Recurrence After Curative Liver Resection for Solitary Hepatocellular Carcinoma. *J Gastrointest Surg* 2019; **23**: 304-311 [PMID: 30215196 DOI: 10.1007/s11605-018-3927-2]
 - 10 **Izumi R**, Shimizu K, Ii T, Yagi M, Matsui O, Nonomura A, Miyazaki I. Prognostic factors of hepatocellular carcinoma in patients undergoing hepatic resection. *Gastroenterology* 1994; **106**: 720-727 [PMID: 8119543 DOI: 10.1016/0016-5085(94)90707-2]
 - 11 **Arii S**, Tanaka J, Yamazoe Y, Minematsu S, Morino T, Fujita K, Maetani S, Tobe T. Predictive factors for intrahepatic recurrence of hepatocellular carcinoma after partial hepatectomy. *Cancer* 1992; **69**: 913-919 [PMID: 1310434 DOI: 10.1002/1097-0142(19920215)69:4<913::aid-cnrcr2820690413>3.0.co;2-t]
 - 12 **Tung-Ping Poon R**, Fan ST, Wong J. Risk factors, prevention, and management of postoperative recurrence after resection of hepatocellular carcinoma. *Ann Surg* 2000; **232**: 10-24 [PMID: 10862190 DOI: 10.1097/0000658-200007000-00003]
 - 13 **Notarapalo A**, Layese R, Magistri P, Gambato M, Colledan M, Magini G, Miglioiresi L, Vitale A, Vennarecci G, Ambrosio CD, Burra P, Di Benedetto F, Fagioli S, Colasanti M, Maria Ettorre G, Andreoli A, Cillo U, Laurent A, Katsahian S, Audureau E, Roudot-Thoraval F, Duvoux C. Validation of the AFP model as a predictor of HCC recurrence in patients with viral hepatitis-related cirrhosis who had received a liver transplant for HCC. *J Hepatol* 2017; **66**: 552-559 [PMID: 27899297 DOI: 10.1016/j.jhep.2016.10.038]
 - 14 **Shirabe K**, Takenaka K, Gion T, Shimada M, Fujiwara Y, Sugimachi K. Significance of alpha-fetoprotein levels for detection of early recurrence of hepatocellular carcinoma after hepatic resection. *J Surg Oncol* 1997; **64**: 143-146 [PMID: 9047252 DOI: 10.1002/(sici)1096-9098(199702)64:2<143::aid-jso10>3.0.co;2-7]
 - 15 **Kim SJ**, Kim JM. Prediction models of hepatocellular carcinoma recurrence after liver transplantation: A comprehensive review. *Clin Mol Hepatol* 2022; **28**: 739-753 [PMID: 35468711 DOI: 10.3350/cmh.2022.0060]
 - 16 **Degroote H**, Geerts A, Verhelst X, Van Vlierberghe H. Different Models to Predict the Risk of Recurrent Hepatocellular Carcinoma in the Setting of Liver Transplantation. *Cancers (Basel)* 2022; **14** [PMID: 35740638 DOI: 10.3390/cancers14122973]
 - 17 **Al-Ameri AAM**, Wei X, Wen X, Wei Q, Guo H, Zheng S, Xu X. Systematic review: risk prediction models for recurrence of hepatocellular carcinoma after liver transplantation. *Transpl Int* 2020; **33**: 697-712 [PMID: 31985857 DOI: 10.1111/tri.13585]
 - 18 **Guo D**, Gu D, Wang H, Wei J, Wang Z, Hao X, Ji Q, Cao S, Song Z, Jiang J, Shen Z, Tian J, Zheng H. Radiomics analysis enables recurrence prediction for hepatocellular carcinoma after liver transplantation. *Eur J Radiol* 2019; **117**: 33-40 [PMID: 31307650 DOI: 10.1016/j.ejrad.2019.05.010]
 - 19 **Zhao JW**, Shu X, Chen XX, Liu JX, Liu MQ, Ye J, Jiang HJ, Wang GS. Prediction of early recurrence of hepatocellular carcinoma after liver transplantation based on computed tomography radiomics nomogram. *Hepatobiliary Pancreat Dis Int* 2022; **21**: 543-550 [PMID: 35705443 DOI: 10.1016/j.hbpd.2022.05.013]
 - 20 **Son JA**, Ahn HR, You D, Baek GO, Yoon MG, Yoon JH, Cho HJ, Kim SS, Nam SW, Eun JW, Cheong JY. Novel Gene Signatures as Prognostic Biomarkers for Predicting the Recurrence of Hepatocellular Carcinoma. *Cancers (Basel)* 2022; **14** [PMID: 35205612 DOI: 10.3390/cancers14040865]
 - 21 **Wang W**, Wang F, Chen Q, Ouyang S, Iwamoto Y, Han X, Lin L, Hu H, Tong R, Chen YW. Phase Attention Model for Prediction of Early Recurrence of Hepatocellular Carcinoma With Multi-Phase CT Images and Clinical Data. *Front Radiol* 2022; **2**: 856460 [PMID: 37492657 DOI: 10.3389/fradi.2022.856460]
 - 22 **An C**, Kim DW, Park YN, Chung YE, Rhee H, Kim MJ. Single Hepatocellular Carcinoma: Preoperative MR Imaging to Predict Early Recurrence after Curative Resection. *Radiology* 2015; **276**: 433-443 [PMID: 25751229 DOI: 10.1148/radiol.15142394]
 - 23 **Cho HJ**, Kim B, Kim HJ, Huh J, Kim JK, Lee JH, Seo CW, Ahn HR, Eun JW, Kim SS, Cho SW, Cheong JY. Liver stiffness measured by MR elastography is a predictor of early HCC recurrence after treatment. *Eur Radiol* 2020; **30**: 4182-4192 [PMID: 32189053 DOI: 10.1007/s00330-020-06792-y]
 - 24 **Chan AWH**, Zhong J, Berhane S, Toyoda H, Cucchetti A, Shi K, Tada T, Chong CCN, Xiang BD, Li LQ, Lai PBS, Mazzaferro V, García-Fiñana M, Kudo M, Kumada T, Roayaie S, Johnson PJ. Development of pre and post-operative models to predict early recurrence of hepatocellular carcinoma after surgical resection. *J Hepatol* 2018; **69**: 1284-1293 [PMID: 30236834 DOI: 10.1016/j.jhep.2018.08.027]
 - 25 **Zeng J**, Zeng J, Lin K, Lin H, Wu Q, Guo P, Zhou W, Liu J. Development of a machine learning model to predict early recurrence for hepatocellular carcinoma after curative resection. *Hepatobiliary Surg Nutr* 2022; **11**: 176-187 [PMID: 35464276 DOI: 10.21037/hbsn-20-466]
 - 26 **Saito A**, Toyoda H, Kobayashi M, Koiwa Y, Fujii H, Fujita K, Maeda A, Kaneoka Y, Hazama S, Nagano H, Mirza AH, Graf HP, Cosatto E, Murakami Y, Kuroda M. Prediction of early recurrence of hepatocellular carcinoma after resection using digital pathology images assessed by machine learning. *Mod Pathol* 2021; **34**: 417-425 [PMID: 32948835 DOI: 10.1038/s41379-020-00671-z]
 - 27 **Feng S**, Wang J, Wang L, Qiu Q, Chen D, Su H, Li X, Xiao Y, Lin C. Current Status and Analysis of Machine Learning in Hepatocellular Carcinoma. *J Clin Transl Hepatol* 2023; **11**: 1184-1191 [PMID: 37577233 DOI: 10.14218/JCTH.2022.00077S]
 - 28 **Zou ZM**, Chang DH, Liu H, Xiao YD. Current updates in machine learning in the prediction of therapeutic outcome of hepatocellular carcinoma: what should we know? *Insights Imaging* 2021; **12**: 31 [PMID: 33675433 DOI: 10.1186/s13244-021-00977-9]
 - 29 **Kucukkaya AS**, Zeevi T, Chai NX, Raju R, Haider SP, Elbanan M, Petukhova-Greenstein A, Lin M, Onofrey J, Nowak M, Cooper K, Thomas E, Santana J, Gebauer B, Mulligan D, Staib L, Batra R, Chapiro J. Predicting tumor recurrence on baseline MR imaging in patients with early-stage hepatocellular carcinoma using deep machine learning. *Sci Rep* 2023; **13**: 7579 [PMID: 37165035 DOI: 10.1038/s41598-023-34439-7]
 - 30 **Ahn JC**, Qureshi TA, Singal AG, Li D, Yang JD. Deep learning in hepatocellular carcinoma: Current status and future perspectives. *World J Hepatol* 2021; **13**: 2039-2051 [PMID: 35070007 DOI: 10.4254/wjh.v13.i12.2039]
 - 31 **Calderaro J**, Seraphin TP, Luedde T, Simon TG. Artificial intelligence for the prevention and clinical management of hepatocellular carcinoma. *J Hepatol* 2022; **76**: 1348-1361 [PMID: 35589255 DOI: 10.1016/j.jhep.2022.01.014]



Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA

Telephone: +1-925-3991568

E-mail: office@baishideng.com

Help Desk: <https://www.f6publishing.com/helpdesk>

<https://www.wjgnet.com>

