To the Editor: Bladder cancer is the most common malignant tumor of the urinary system in the Asian population. In China, it is reported 80,000 new cases each year with an increasing incidence every year. Among these cases, 75% are of non-muscle invasive bladder cancer (NMIBC). In muscular invasive bladder cancer (MIBC) and NMIBC patients, radical cystectomy is considered as a primary approach of treatment due to the higher risk of tumor progression. Furthermore, cystoscopy and traditional transurethral resection are the main approaches for diagnosing and staging of bladder cancer. However, these approaches are relatively risky because of their complications and high peri-operative mortality. Moreover, the most critical limitation of cystoscopy is its inefficient ability to differentiate between malignant tumors and healthy urothelium considering the multifocal aspect of the disease and inconspicuous but significant lesions (such as carcinoma in situ).

Utilizing artificial intelligence (AI), we can accurately identify the distribution of heterogeneous tumors with the aid of a noninvasive, 3D image-based feature of computed tomography, or magnetic resonance imaging (MRI). Machine learning (ML), when incorporated with 3D image-based MRI, can help differentiate low- and high-grade tumors. Furthermore, it enables physicians to perform less invasive surgical procedures, reduce intraoperative blood loss, shorten hospital stays, accelerate gastrointestinal function recovery, and reduce overall complications. The ML-based approach has been implemented in patients with MIBC to accurately quantify the tumor buds in immunofluorescence-labeled slides. Tumor budding is correlated to the tumor-node-metastasis staging system. All MIBC patients were classified into three novel staging standards based on their disease-specific survival rate. Moreover, quantitative analysis of tumor buds using automated slide analysis can provide an alternative staging model with prognostic value for MIBC patients. The ML algorithm has been adopted to build predictive models of recurrence rate and survival time from imaging and surgical data. Both the sensitivity and specificity of predicting patients’ recurrence rate and survival rate after 1, 3, and 5 years of cystectomy are found to be >70%. By optimizing surgical data acquisition, these predictive models can help physicians develop patient follow-up plans, provide assistance in treatment, and deliver improved care possibilities. Moreover, to generate the mathematical model classifier for outcome prediction, we can integrate the genome-wide atlas of frozen NMIBC specimens into the genetic programming algorithm.

Although multiple ML and deep learning (DL) studies have been conducted to predict the prognosis of patients with bladder cancer, these models are rarely used in clinical practice. The main challenges in adopting these models in a clinical environment are incorporating standardized parameters, adjusting device differences, and collecting data from multiple institutions to ensure the models’ universality. Furthermore, the formulation and recommendations of diagnosis and treatment plans are based on numerous evidence-based scientific papers and physicians’ clinical experience. Unfortunately, the development of these guidelines for diagnosing and treating most diseases in many countries has significantly poor data research considering their population for reference. In contrast, differences in ethnicity and other factors that reduce reference value are
often found in various relevant foreign studies. Furthermore, ML and DL predictions should be further incorporated as data and model retraining while providing personalized patient care. After resolving these issues, ML and DL models can be trained using the bladder cancer dataset along with pre-operative, intra-operative, and post-operative data to accurately predict each patient’s prognosis. For understanding various disease processes, extensive patient data sets and electronic medical records can be semiautomated, thus providing real-time predictive analysis. However, the prediction accuracy depends mainly on the effective data integration acquired from different sources. Although these models will not replace shared decision-making, they can complement the information that patients obtain from traditional methods. Moreover, each country should encourage healthcare organizations for collecting the data, enabling physicians to provide more reliable clinical and evidence-based treatment for their patients. Furthermore, organizations should take the initiative for collaborating with technology companies for executing a variety of AI-based research.

The application of AI is still in the initial phase in the healthcare system, but it has tremendous potential in treatment measurements and has various applications in the diagnosis of bladder cancer. Similar to all the medical interventions, the application of ML for cancer diagnosis has both advantages and disadvantages. AI can improve the speed and consistency of diagnosis; however, it may also exacerbate overdiagnosis. ML cannot solve the gold standard problem, but it can further expose the predicament. Ultimately, what matters to patients and physicians is whether the diagnosis of bladder cancer is related to the length and quality of life. Before this technology is widely adopted, serious consideration should be given to the possibility of training ML algorithms for identifying the intermediate category between “cancer” and “noncancer.” The application of AI in the clinical field will develop and modify the diagnosis and decision-making process. Undoubtedly, physicians’ experience and evidence-based scientific papers will continue to play a vital role in AI future development to ensure that these systems operate as expected.

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**Conflicts of interest**

None.

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