INTELLIGENT WHOLE-COURSE CASE MANAGEMENT AND COMPLICATION EARLY WARNING CLOUD PLATFORM FOR UROLOGICAL TUMOR PATIENTS

Field of the Invention

The present invention relates to the field of medical informatization technology, and particularly relates to an intelligent whole-course case management and complication early warning cloud platform for urological tumor patients.

Background to the Invention

Urological tumors (such as prostate cancer, renal cancer, bladder cancer, etc.) are common malignant tumors. Their treatment process is complex, involving multiple means including surgery, radiotherapy, chemotherapy, and endocrine therapy, and the treatment cycle is long, requiring patients to undergo long-term follow-up and health management. Current technologies for the treatment of urological tumors have the following defects.

1. The current diagnosis and treatment process for urological tumors (such as prostate cancer, renal cancer, bladder cancer) relies on decentralized hospital information systems. Patient data is stored in different departments (such as hospital information system (HIS), laboratory information system (LIS), picture archiving and communication system (PACS)) and lacks an integration mechanism. Doctors need to manually access data from multiple systems, leading to:

information fragmentation: incomplete medical history (such as medication responses and surgical complications) is available during clinical decision-making, resulting in a high misdiagnosis rate;

duplicate examinations: when patients transfer hospitals, they need to repeat imaging or laboratory tests, increasing medical costs; and

delayed response to complications: postoperative infections, renal failure, and other complications rely on manual monitoring, leading to delayed early warning.

2. Existing systems lack the ability for in-depth analysis of patients' genetic data and metabolomics:

standardized treatment plans: most patients do not receive gene-detection-based targeted therapy;

coarse rehabilitation plans: factors including patients' age and comorbidities are not

considered, resulting in rehabilitation effects falling short of expectations; and

medication safety risks: inability to monitor drug interactions in real time, leading to severe adverse reactions in patients.

3. Inefficient doctor-patient communication, and the traditional outpatient model fails to meet the needs of long-term follow-up: patients have low participation, fail to complete rehabilitation training as prescribed, and have insufficient awareness of early warning signs of postoperative complications.

Aiming at the above problems, the present invention provides an intelligent whole-course case management and complication early warning cloud platform for urological tumor patients.

Statement of Invention

A main objective of the present invention is to provide an intelligent whole-course case management and complication early warning cloud platform for urological tumor patients, which may effectively solve the problems in the background art.

To achieve the above objectives, the technical solutions adopted in the present invention are as follows.

An intelligent whole-course case management and complication early warning cloud platform for urological tumor patients includes:

a data collection module: configured to collect multi-source heterogeneous data of patients, including basic information, clinical data, examination reports, treatment records, and transmit the data to a data storage module;

a data storage module: configured to store the multi-source heterogeneous data of patients and establish electronic health records for patients;

a data analysis module: configured to clean, integrate, mine, and analyze the multi-source heterogeneous data of patients to extract valuable information and knowledge;

a personalized management module: configured to generate personalized treatment plans and health management plans based on factors including conditions, physical status, and treatment responses of patients;

a complication early warning module: configured to monitor real-time condition changes of patients, predict the risk of complications, and issue early warnings promptly;

a doctor-patient interaction module: configured to enable online communication and interaction between doctors and patients;

a decision support module: configured to provide decision-making support for doctors; and

a system management module: configured to manage and maintain users, permissions, data, system parameters, and other elements of the cloud platform.

Preferably, the data collection module includes:

an HIS interface: configured to acquire basic information, hospitalization records, surgical records, and other data of patients;

an LIS interface: configured to acquire test reports, pathological results, and other data of patients;

a PACS interface: configured to acquire imaging examination results of patients;

an electronic medical record (EMR) system interface: configured to acquire electronic medical records of patients;

a wearable device interface: configured to acquire physiological parameters of patients; and

a patient mobile application: configured to allow patients to input information including symptoms and medication usage.

Preferably, the data analysis module employs deep learning algorithms and machine learning algorithms to analyze patient data, including:

a convolutional neural network (CNN): configured to analyze medical imaging data;

a recurrent neural network (RNN): configured to analyze time-series data;

a random forest: configured to construct a complication prediction model; and

a support vector machine (SVM): configured to perform classification and prediction analysis.

Preferably, the personalized management module generates personalized treatment plans and health management plans based on genetic testing results, immunohistochemistry results, metabolomics data, and other data of patients, in combination with clinical guidelines and expert experience.

Preferably, the complication early warning module implements complication early warning through the following steps:

A. setting thresholds and change trends for complication-related indicators;

B. monitoring real-time indicator data of patients and comparing the data with the thresholds;

C. triggering an early warning mechanism when the indicator data exceeds the thresholds or exhibits abnormal change trends; and

D. notifying doctors and patients via short message service (SMS), mobile APP push notifications, emails, and other means, according to an early warning level.

Preferably, the doctor-patient interaction module includes:

an online consultation platform: allowing patients to consult doctors via text, voice, video, and other means;

a health consultation community: allowing patients to exchange treatment experiences and share health knowledge in the community;

a health education system: regularly publishing content including prevention and treatment knowledge of urological tumors and treatment progress, and other contents; and

a medication reminder function: reminding patients to take medications on time and undergo regular reexaminations.

Preferably, the decision support module constructs a knowledge base for urological tumor treatment, including:

disease diagnosis criteria;

treatment guidelines and expert consensus;

drug information and treatment regimens;

prevention and treatment measures for complications; and

clinical research results and latest advancements.

Preferably, the system management module employs a multi-layer security protection mechanism, including:

user identity authentication and authorization;

encrypted data transmission and storage;

access log recording and auditing;

data backup and recovery; and

system security vulnerability detection and repair.

Preferably, the cloud platform further includes:

a clinical research module: automatically screening patients meeting enrollment criteria and generating research reports and data visualizations;

a pharmaceutical logistics management system: interfacing with medical e-commerce platforms to enable intelligent delivery of targeted drugs and medication reminders; and

a cost management module: automatically calculating medical expenses and generating medical insurance reimbursement suggestions based on diagnosis related groups (DRG) grouping rules.

Compared with the prior art, the present invention has the following advantages.

1. Full-process data integration and intelligent analysis

The present invention realizes the following through the multi-source data collection module and deep learning analysis engine:

improved diagnosis and treatment efficiency: doctors may obtain complete medical records more quickly;

higher accuracy in complication prediction: early warning of risks including infection and bleeding 72 hours in advance; and

assisted imaging diagnosis: the CNN model performs Gleason scoring on prostate cancer magnetic resonance imaging (MRI) images to reduce errors.

2. Implementation of personalized medicine

based on gene-metabolomics analysis, the system may:

precise treatment recommendation: matching targeted drugs for patients;

dynamic plan adjustment: automatically optimizing the treatment cycle according to real-time physiological data (such as prostate-specific antigen (PSA) fluctuations); and

quantified rehabilitation effect: monitoring exercise data through wearable devices to improve the completion rate of rehabilitation plans.

3. Optimization of doctor-patient collaboration

The interaction module improves communication efficiency. Through video tutorials and artificial intelligence (AI)-based Q&A, patients' awareness of complications is enhanced, medication compliance is improved, and the intelligent reminder function reduces the

missed dose rate.

Brief Description of the Drawings

FIG. 1 is an overall flow chart of an intelligent whole-course case management and complication early warning cloud platform for urological tumor patients of the present invention.

Detailed Description

To make the technical means, creative features, objectives and effects of the present invention easy to understand, the present invention is further described below in conjunction with the accompanying figure and specific implementation manners.

An intelligent whole-course case management and complication early warning cloud platform for urological tumor patients includes:

a data collection module: configured to collect multi-source heterogeneous data of patients, including basic information, clinical data, examination reports, treatment records, and transmit the data to a data storage module; the data collection module including:

an HIS interface: configured to acquire basic information, hospitalization records, surgical records, and other data of patients;

an LIS interface: configured to acquire test reports, pathological results, and other data of patients;

a PACS interface: configured to acquire imaging examination results of patients;

an EMR system interface: configured to acquire electronic medical records of patients;

a wearable device interface: configured to acquire physiological parameters of patients; and

a patient mobile application: configured to allow patients to input information including symptoms and medication usage;

a data storage module: configured to store the multi-source heterogeneous data of patients and establish electronic health records for patients;

a data analysis module: configured to clean, integrate, mine, and analyze the multi-source heterogeneous data of patients to extract valuable information and knowledge; the data

analysis module employing deep learning algorithms and machine learning algorithms to analyze patient data, including:

a CNN: configured to analyze medical imaging data;

an RNN: configured to analyze time-series data;

a random forest: configured to construct a complication prediction model; and

an SVM: configured to perform classification and prediction analysis;

a personalized management module: configured to generate personalized treatment plans and health management plans based on factors including conditions, physical status, and treatment responses of patients; the personalized management module generating personalized treatment plans and health management plans based on genetic testing results, immunohistochemistry results, metabolomics data, and other data of patients, in combination with clinical guidelines and expert experience;

a complication early warning module: configured to monitor real-time condition changes of patients, predict the risk of complications, and issue early warnings promptly;

the complication early warning module implementing complication early warning through the following steps:

A. setting thresholds and change trends for complication-related indicators;

B. monitoring real-time indicator data of patients and comparing the data with the thresholds;

C. triggering an early warning mechanism when the indicator data exceeds the thresholds or exhibits abnormal change trends; and

D. notifying doctors and patients via short message service (SMS), mobile APP push notifications, emails, and other means, according to an early warning level;

a doctor-patient interaction module: configured to enable online communication and interaction between doctors and patients; the doctor-patient interaction module including:

an online consultation platform: allowing patients to consult doctors via text, voice, video, and other means;

a health consultation community: allowing patients to exchange treatment experiences and share health knowledge in the community;

a health education system: regularly publishing content including prevention and treatment knowledge of urological tumors and treatment progress, and other contents; and

a medication reminder function: reminding patients to take medications on time and undergo regular reexaminations;

a decision support module: configured to provide decision-making support for doctors;

the decision support module constructing a knowledge base for urological tumor treatment, including:

disease diagnosis criteria;

treatment guidelines and expert consensus;

drug information and treatment regimens;

prevention and treatment measures for complications; and

clinical research results and latest advancements; and

a system management module: configured to manage and maintain users, permissions, data, system parameters, and other elements of the cloud platform; the system management module employing a multi-layer security protection mechanism, including:

user identity authentication and authorization;

encrypted data transmission and storage;

access log recording and auditing;

data backup and recovery; and

system security vulnerability detection and repair.

The cloud platform further includes:

a clinical research module: automatically screening patients meeting enrollment criteria and generating research reports and data visualizations;

a pharmaceutical logistics management system: interfacing with medical e-commerce platforms to enable intelligent delivery of targeted drugs and medication reminders; and

a cost management module: automatically calculating medical expenses and generating medical insurance reimbursement suggestions based on DRG grouping rules.

Example

I. Clinical scenario example

Scenario: multidisciplinary diagnosis and treatment (MDT) for advanced renal cell carcinoma patients

Data collection and integration

HIS/LIS/PACS interfaces: patient pathological reports (clear cell carcinoma), genetic testing results (von Hippel-Lindau (VHL) mutation), and 3 computed tomography (CT) images (baseline, after 2 treatment cycles, after 4 treatment cycles) are acquired;

Wearable devices: heart rate variability (HRV) and activity index (ActiGraph GT3X+) are continuously monitored;

Patient mobile terminal: daily pain score (numerical rating scale (NRS) 11-point scale) and fatigue level (functional assessment of cancer therapy-fatigue (FACIT-F) scale) are recorded;

Generation of personalized treatment plans

Decision support module:

based on genetic testing results, 3 targeted drugs (pazopanib, sunitinib, axitinib) are matched from the knowledge base;

a random forest model is invoked to predict drug response probability:

pazopanib: 72% (hazard ratio (HR) 0.68, 95% confidence interval (CI) 0.51-0.92)

sunitinib: 65% (HR 0.75, 95% CI 0.58-0.97)

A personalized plan is generated: pazopanib 800 mg once daily (qd) + traditional Chinese medicine adjuvant therapy (syndromic differentiation based on constitution);

Complication early warning and intervention

Real-time monitoring:

Day 12: HRV decreases by 25% (threshold 15%), NRS score increases from 2 to 6;

Day 14: serum creatinine increases by 35% (threshold 20%), urine output decreases by 40%;

Early warning triggering:

the risk of acute kidney injury is determined by the system (SHapley Additive exPlanations (SHAP) value analysis shows a creatinine contribution rate of 62%); and

a level III warning is automatically pushed to the nephrology consultation;

Intervention results:

tubular injury is detected 48 hours in advance;

the dosage is adjusted to 600 mg qd, combined with hydration therapy; and

progression to acute renal failure (ARF) is avoided;

Doctor-patient collaborative management

Online consultation: diarrhea management plans are consulted by patients via video;

Medication reminder: “Today’s dosage adjusted to 600 mg” + medication guidance animation is pushed by the APP; and

Health education: a series of courses on “Management of Common Side Effects of Targeted Therapy” is automatically pushed;

II. Technical effect verification data

1. System performance indicators

Test item	Measured data	Compared with traditional systems
Concurrent processing capacity	5000TPS (peak)	500TPS
Data query response time	≤1.2 seconds (95% of requests)	≥8 seconds
System availability	99.992% (annual downtime <7 hours)	99.5% (annual downtime 44 hours)
Complication early warning delay	≤15 minutes	≥24 hours

2. Clinical effect evaluation

Pilot data from the urology department of a tertiary first-class hospital (n=200 cases):

accuracy of complication early warning:

urinary tract infection: 93.7% (traditional method 68.2%)

bleeding risk: 89.5% (traditional method 42.1%)

treatment decision efficiency:

MDT meeting time is shortened from 120 minutes to 45 minutes;

consistency in plan formulation is increased from 65% to 92%; and

improvement in patient experience:

satisfaction score: 9.2/10 (traditional group 7.6/10)

follow-up completion rate: 97% (traditional group 63%)

III. Detailed explanation of typical cases

Patient information: 67-year-old male, right renal clear cell carcinoma with lung metastasis (cT3bN0M1)

Process of system application:

data collection:

genetic testing: programmed cell death ligand 1 (PD-L1) positive expression (tumor proportion score (TPS) 45%), CD274 amplification

wearable devices: resting heart rate (68→82 beats/min), activity level decreases by 30%

plan formulation:

a combination regimen of pembrolizumab + axitinib is recommended (national comprehensive cancer network (NCCN) category 1 recommendation)

personalized adjustment: considering the patient's history of diabetes, a blood glucose monitoring plan is formulated

early warning events:

after the 3rd treatment cycle:

serum creatinine increases from 89 μmol/L to 135 μmol/L (threshold 120 μmol/L);

urine protein (++), HRV decreases by 28%;

system warning: risk of immune-related nephritis (SHAP value contribution: creatinine 45% + urine protein 32%);

intervention measures:

treatment is suspended, and methylprednisolone 1 mg/kg/d is initiated;

renal biopsy confirms mild interstitial nephritis;

adjustment to pembrolizumab monotherapy is made;

results:

progression of renal failure is avoided;

lung metastasis lesions shrink by 35% (response evaluation criteria in solid tumors (RECIST) v1.1); and

patient survival is extended to 18 months (median overall survival (OS) for similar patients is 12 months);

IV. Verification of system innovations

1. Multimodal data analysis

Prostate cancer radiomics analysis:

accuracy of the CNN model for Gleason grading of biopsy specimens: 87.3% (pathologist consistency 82.5%)

area under the curve (AUC) for predicting biochemical recurrence risk: 0.89 (traditional Kattan nomogram 0.76)

2. Intelligent early warning mechanism

Patients after radical cystectomy (n=150 cases):

Early warning provided by the system ≥48 hours in advance:

Intestinal obstruction: 8 cases (3 cases missed by traditional methods)

Urinary fistula: 5 cases (all not predicted by traditional methods)

Early warning accuracy: 92% (traditional monitoring 43%)

3. Knowledge base update

The latest literature from PubMed is automatically retrieved (weekly update).

In summary, the intelligent whole-course case management and complication early warning cloud platform for urological tumor patients of the present invention, through the collaborative innovation of multiple modules, breaks through the limitations of traditional diagnosis and treatment. Multi-source data including HIS/LIS/PACS are systematically integrated by the system, subsecond medical record retrieval is achieved, high processing capacity is featured, the AI analysis module ensures an error ≤0.5 points for prostate cancer MRI scoring, 72-hour advance complication early warning with high accuracy is provided. Targeted drugs are matched based on genetic testing by the personalized management module, which prolongs progression-free survival (PFS) of advanced renal

cell carcinoma patients by 2.4 months and reduces the incidence of adverse reactions. The early warning system advances the intervention for postoperative acute kidney injury by 48 hours, reducing the need for dialysis. The clinical research module accelerates the enrollment process of drug trials, with the enrollment time shortened by 64%. The entire system platform promotes the transformation of urological tumor diagnosis and treatment towards precision and intelligence.

The above has shown and described the basic principles, main features, and advantages of the present invention. Those skilled in the art will understand that the present invention is not limited by the above examples. The above examples and descriptions only illustrate the principles of the present invention. Without departing from the spirit and scope of the present invention, various changes and improvements may be made to the present invention, and these changes and improvements fall within the scope of the present invention as claimed. The protection scope of the present invention is defined by the appended claims and equivalents.