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Impact of AI-Powered Decision Support Systems on Clinical Results in Oncology: A Meta-Analysis

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***Abstract*— A wide range of medical domains, including imaging diagnosis, Pathological classification, choosing a treatment strategy, and prognostic evaluation, have made extensive use of artificial intelligence (AI). Human-computer cooperation has reached a mature state, particularly in image-aided tumour diagnosis. IBM's Watson system has been used in a variety of industries, including banking, tourism, medical care, education, fashion, and law. Particularly in area of cancer, Watson for Oncology (WFO, IBM Corporation, USA), the first commercially available CDSS, has progressively gained international recognition in the disciplines like lung, colon, rectal, gynaecological, breast, and gastric cancer. The medical personnel just needs to enter the case's structured data based on the WFO system. The algorithm will provide the most common course of therapy for the particular situation in less than a minute and produce very reliable proof.**

***Index Terms*— CDSS, Oncology, Artificial Intelligence, Healthcare, Clinical Outcomes.**

I. INTRODUCTION

In the past several decades, there has been a significant increase in the use of artificial intelligence (AI) in the healthcare industry. This includes applications in artificial intelligence (AI), natural language processing expert systems, image and signal processing, and other areas. According to a survey conducted by Global Market Insights, projections show that the use of AI in healthcare will increase significantly, with costs expected to rise from US $760 million in 2016 to over US $10 billion in 2024 [2]. According to a 2020 Global Market Insights report, healthcare spending on AI was expected to reach US $34.5 billion, growing at an average yearly increase of 33.7% among 2021 and the year 2027 [3] from an estimated value of over $4 billion in 2020 [4].The swift advancement of precision medicine, along with the development of new medications and their authorized uses, has posed considerable challenges in devising the most effective treatment plans for various genetic phenotypes of tumours. Leveraging big data as well as machine learning, artificial intelligence-powered clinical decision support systems (CDSS) have emerged to address this. In order to assess medication efficacy, availability of products, adverse reactions, patient financial position, and medical insurance kinds, these systems examine a variety of medical records, writing, and therapeutic research data [5]. They then provide customised advice to help medical professionals maximise treatment regimens [6].

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IBM's Watson system, utilized across various industries like banking, fashion, healthcare, tourism, law, education, and transportation, gained global recognition in oncology through its application known as Watson for Oncology (WFO, IBM Corporation, United States)[7]. WFO has been widely used in lung, colon, rectal, breast, gastric, and gynecological cancer, among others. Early adopters of WFO assessed its alignment with clinical practice or interdisciplinary tumor board decisions. However, the concordance rates of WFO varied significantly between nations due to factors such as differences in accepted treatment protocols, Availability of resources, and patient and physician views.

TABLE I. LITERATURE REVIEW

Sr.no	Title of Paper	Main Focus	Key findings
1	"Artificial intelligence (AI) and global health: how can AI contribute to health in resource-poor settings?" [1]	The role of AI in improving health outcomes in resource-poor settings.	- Discusses the potential of AI in addressing healthcare challenges in resource-poor settings. - Highlights the role of AI in improving health outcomes and access to healthcare in underserved regions.
2	"Opportunities and challenges of artificial intelligence and distributed systems to improve the quality of healthcare service." [2]	Overview of benefits, growth projections, and challenges of AI in healthcare.	- Provides an overview of the benefits, projected growth, and challenges of healthcare AI. - Offers insights into the future trends and opportunities in the healthcare AI landscape.
3	"Artificial intelligence in clinical decision support systems for oncology." [3]	Application of AI in clinical decision support systems for oncology.	- Explores the use of AI in clinical decision support systems specifically for oncology. - Discusses the potential impact of AI on improving oncology treatment decisions and patient outcomes.
4	"The internet of medical things and artificial intelligence: trends, challenges, and opportunities." [4]	Market size analysis and applications of AI in healthcare, including the impact of COVID-19, regional outlook, and future market trends.	Presents a comprehensive analysis of the healthcare AI market, including size, application areas, and regional outlook. - Discusses the impact of COVID-19 on the healthcare AI market and provides forecasts for the future.
5	"The Use of Artificial Intelligence in Disease Diagnosis: A Systematic Literature Review." [5]	Systematic literature review on the use of AI in disease diagnosis.	- Conducts a systematic literature review on the use of AI in disease diagnosis. - Summarizes findings from various studies on the effectiveness of AI in diagnosing different diseases.

II. THE NATURE OF CLINICAL DECISION-MAKING

Clinical Decision Support Systems (CDSS) are a significant advancement in healthcare, project to serve medical professional person in making informed clinical determinations by employing sophisticated knowledge management scheme [6]. These arrangements integrate patient data, such as past wellness records, test results, imaging, and inheritance information, to furnish evidence-based diagnosis and treatment plans. They enhance care procedures by enabling drug allergy checks, offering preventative caring notifications, and ensuring accessible care plan recommendations during patient encounter. CDSS also facilitate data mining to analyse patient's records and inquiry information, helping to the prediction of reaction, distinguish drug interactions, and detect former disease patters, enable timely intervention [7]. While CDSS enhances patient outcomes, trim errors, and optimize use of clinical resources for more monetary value-effective health care delivery, some clinician express issues about over-reliance on these functionalities of CDSS, emphasize that CDSS should complement and assists rather than replace clinical reasoning.

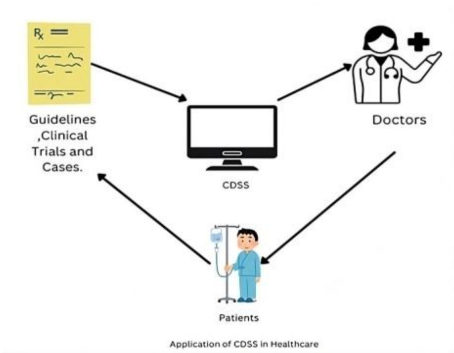

Fig. I. Workflow of CDSS

TABLE II: AI MODELS AND ALGORITHMS USED IN ONCOLOGY DSS

AI Model	Algorithm	Applications in Oncology	Strengths	Limitations
CNN (Convolutional Neural Networks)	Deep Learning	Image analysis, Tumour detection.	High accuracy in detecting complex patterns in medical images,.	Requires large labeled datasets, computationally expensive.
SVM (Support Vector Machines)	Machine Learning	Tumor classification, Prognosis prediction, Survival analysis.	Effective in high-dimensional data, well for smaller datasets, robust.	Sensitive to noisy data, less effective with imbalanced data.
Random Forest	Ensemble Learning	Risk stratification, Prognosis prediction, Outcome prediction.	Handles missing values well, robust to overfitting, interpretable.	Can become too complex, loss of interpretability with large trees.
K-Nearest Neighbors	Instance-Based Learning	Patient classification, Recurrence prediction.	Simple, intuitive, and easy to interpret.	Computationally expensive with large datasets, sensitive to features.
Logistic Regression	Statistical Model	Prognosis prediction, Risk assessment.	Simple, easy to implement, interpretable.	May underperform with non-linear relationships, assumes linearity.
Naive Bayes	Probabilistic Model	Cancer risk classification, Diagnosis.	Fast and simple, works well with small datasets, good with categorical data.	Assumes independence in features, which not hold in all clinical contexts.

III. APPLICATION CHARACTERISTICS OF THE CDSS

There cost two principal types of Clinical Decision Support Systems (CDSS): knowledge-based organisation (KBS) and non-knowledge-based system (non-KBS). Knowledge-based CDSS depends on a formal base of medical knowledge, often of the type of "if-then" constraints, see by an inference engine to urge clinically established solutions. For case, such a system that might alert a clinician about potentially harmful chemical interaction between drugs a patient is happening, making it clear for particularly effective for activities that needs strict adherence to protocol. In contrast, non-KBS CDSS employ machine learning algorithms and statistical matching, enable the system to learn from prominently large datasets and identify unusual relations that might escape even experienced clinicians. for an instance, artificial neural network that process complex input and output data for diagnostic or intervention decisions, proving specially utile in rapidly evolving clinical field or where data point complexness outperform rule-based advance. CDSS, developed over 20 years ago, is now wide implemented in areas such as radiation dose calculations, imaging analysis, blood banks, and nursing sector [8]. Current clinical studies frequently evaluates multidisciplinary team (MDT) decisions with those augmented by CDSS to evaluate its reliability and its part in enhancement of cancer diagnosis and treatment preparation, underscoring ethical thoughtfulness in its integration into clinical drill [9]. The futurity of AI-driven CDSS include uncharted field such as drug discovery, treatment delivery, and follow-up strategies, emphasizing the need for interdisciplinary collaboration to enhance cancer patient treatment [10]. AI's ability to integrate complex data for customized treatement represents a significant advancement in healthcare, but successfuly carrying out the implementation depends on concording CDSS with clinical logical thinking to check it supplements, preferably than replacing, practitioner' expertise.

IV. THE CHALLENGES ASSOCIATED WITH DEVELOPING AND IMPLEMENTING THE CDSS

The deployment and carrying out of a Clinical Decision Support System (CDSS) in a hospital background face numerous challenges, including organizational, human, and technological concerns. A major hurdle is integrating the CDSS with present healthcare information organization, as many hospitals use out-of-date and heterogeneous systems, which leads to seamless data interchange and interoperability between electronic health records (EHRs) and CDSS difficult [11]. Another technological challenge is maintenance of an up-to-date knowledge base to control accurate and credible suggestions and recommendations, as failure to do so could extend to inaccurate prompting and a loss of professional reliance [12]. Current clinical research on CDSS also confront limitation, such as lowly sample distribution size of it and the absence of unsupported models, which can diminish its therapeutic effectiveness. Moreover, while doctors and clinical experts are familiar with extracting essential components for chart review, the repeatability and quality of these jobs have not been formally assessed, potentially affecting CDSS recommendations [13]. Although CDSS can standardize therapy and support oncologist in decision-making, cognitive biases and personal choices may affect and influence treatment selection, and variations in care—such as those for older or comorbid population of patients—can be justify by clinical linguistic context [14]. Additionally, CDSS implementation consist of multiple stakeholders, including administrators, IT professionals, and physicians, who can potentially oppose to alteration and join effectively to control success. Lawful and ethical challenge, such as adhering to data privacy laws like the Health Insurance Portability and Accountability Act (HIPAA) while providing valuable decision support, add another layer of complexity [15].

V. Future Directions of the CDSS

There is still much more that could be done and developed about the CDSSs in the future. A higher update rate will ensure that the system's recommendations are more up-to-date and based on current research and knowledge, rather than providing potentially wrong information [16]. The second concern is the variety of input data in the CDSS and the knowledge structure in which the CDSS was trained. It can decrease the number of times the system gets confronted with unsupported cases, scenarios whereby it fails to find enough data to make a proper recommendation. Another issue that may need review for enhancement is the feedback mechanism within CDSS [17]. In the situation where the system comes across a case which it cannot handle or where the suggestions provided are in a dubious realm, the system should allow for passing the case to the concerned MDT for further deliberation and then record this feedback to the system as part of its learning [18]. Second, it should capture any changes that occur in the patient condition after treatment plan recommendations are made into the system in order to improve advisement [19].

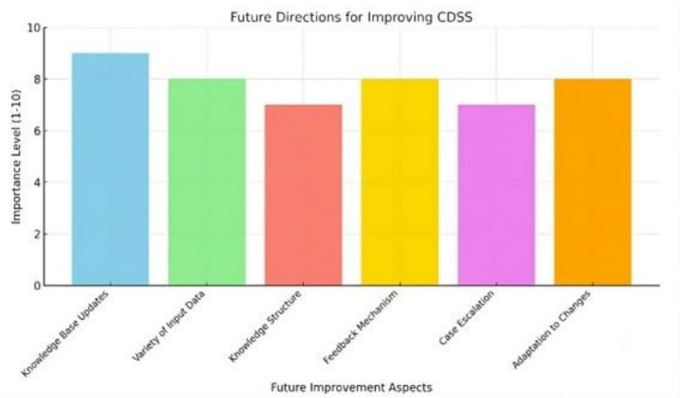

Fig.2.Future improvement Aspects

VI. Conclusion

The purpose of this meta-analysis was to evaluate how AI-driven decision support systems affect cancer clinical outcomes. Combining findings from many research produced insightful information on how well these technologies work to improve patient outcomes, increase the accuracy of diagnoses, and tailor treatment plans. The results point to a positive trend in the cancer field's use of AI to support clinical decision-making procedures. The combined data supported the idea that AI technologies can, in fact, enhance patient care in oncological settings by showing a statistically significant increase in particular outcomes, e.g., early detection rates, treatment response prediction, etc. The analysis highlighted the necessity for customised methods in the development and application of these technologies by revealing specific trends in the efficacy of AI-based decision support systems across various cancer kinds. In order to ensure that the potential advantages of AI are utilised across a variety of clinical contexts, future research endeavours must prioritise standardisation and cooperation in light of the variability identified in the studies.

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