Methodologies of Legacy Clinical Decision Support System -A Review

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***Abstract*— Information technology playing a prominent role in the field of medical by incorporating the Clinical Decision Support System(CDSS) in their routine practices. CDSS is a computer based interactive program to assist the physician to make the right decision at the right time. Now a day's Clinical decision support system is a dynamic research area in the field of computer, but the lack of the knowledge of the understanding as well as the functioning of the system ,make the adoption slow by the physician and patient. The literature review of this paper will focus on the overview of legacy CDSS, the kind of methodologies and classifier employed to prepare such decision support system using a non-technical approach to the physician and the strategy- makers . This study will provide the scope of understanding the clinical decision support along with the gateway to physician ,policy-makers to develop and deploy the decision support system as a healthcare service to make the quick, agile and right decision. Future direction to handle the uncertainties along with the challenges of clinical decision support system are also enlightened in this study.**

***Index Terms*— Classifier; Clinical Decision Support System (CDSS); Knowledge Representation Techniques; Machine Learning; NLP Techniques; Text Mining; Uncertainty Handling; Visualization Method.**

I. INTRODUCTION

With the advancement of the technology, the information technology plays a vital role in the field of healthcare sector [1], [2]. Now a days, with the progression of the technology in the domain of healthcare, the medical services become diversify for handling the patients more effectively and efficiently with improvement in the patient outcomes [3] by diagnose of disease attributes at the early stage [4] In earlier years the decision support systems(DSS) were usually utilized for the retrospective analysis of administrative and financial databases [5] With the advent of data mining and NLP techniques in domain of medical, incorporates the DSS for the prediction of diseases, medical test and for prescription of medicine, etc. Clinical decision support system (CDSS) is a computer based interactive program to assist the physician to make the appropriate decision at appropriate time. Physicians are familiar with HER (electronic-health-records),e-prescription DICOM (Digital Imaging and Communications in Medicine) images and it has been implemented at some extent of success [6], [7]. Normally CDSS operate as the milieu appliance and assist the physicians by providing the information relevant to patient state through alert message and e-mail's.

Normally, the operational characteristics of CDSS are classified into four foremost divisions:

1. Input information: Information provided for the functionality of CDSS for diagnose about the patient, vary from system to system. Preferably in form of controlled vocabulary (e.g. attributes like age, gender, lab reports).
2. Knowledge Base: Can include compiled information in form of rules (e.g if-then rules) or probabilistic alliance of a disease in form of signs and symptoms(e.g. drug–food interactions).
3. Inference Engine: It associate the input patient data and knowledge base by using some rules and schemes to provide output.
4. Presented choices: After the utilizing the functionality of CDSS the physician can provide the recommendation, alerts or diagnosis report.

On the basis of above mentioned operational exclusivity the CDSS can be implemented in form of:

1. Active system: these system are triggered automatically by taking the input from EHR/CPOE (computerized physician order entry), KB(knowledge base) include the drug database and provide the decision in form of output like alert (e.g. drug interaction) without the involvement of physician.
2. Passive system: Also known as stand-alone system, in which the user personally entered the data and make the request for the support. These kinds of system are mainly prevalent.

The patient outcomes [8] and quality of care can be improved with the adoption of CDSS however, in spite of this CDSS's have been not widely adopted within the medical practice. In medical journals the methodology, detail discussion along with a simulation of CDSS is missing that can be the one cause of slow adoption. Mostly the journals are published either in the form of systematic review (summarized the earlier publish CDSS), randomized trials (discuss the testing phase result) [9] or in the form of editorial comments (In future the impact of technology in the medical field) but the technical aspects to evaluate the decisions are absent [10]. Conversely, in the field of computer- science and Healthcare journals the CDSS are extensively published . With the expansion the of Artificial Intelligent(AI), analysis techniques and computing algorithm, the CDSS's are providing the best diagnosis results as compared to earlier CDSS [11]. During the design and development phase of CDSS, the involvement of physicians and staff is required for the proper adoption of the CDSS. In the rest of the sections, we have discussed the non-technical overview of popular methodologies used in the CDSS to make the effective decision. The main focus of this paper is to provide the assistance to physician and staff to understand the CDSS

so that they can play a active role during the design and development phase of CDSS. In this paper we have covered the methodologies of CDSS only, the PO's(patient outcomes) are outside the scope of this paper. Medical informatics, academic research and development which be relevant of these methodologies are provided and forecasted in this paper

II. Methods of Literature Review

With the existence of the information technology in the field of medical, a massive information about clinic and institution can be gathered in digital form. Literature analysis suggest considerable aid in accepting the CDSS in medical field and present a initiate apex in the emergent of advance methodologies for decision making. In the literature survey, every kind of CDSS are incorporated. Comprehensive explore conducted by several search engines included Scopus, Science direct, Inderscience, Google scholar, Pub Med, EM base and MEDLINE. In addition to that the bibliographies of the relevant study were also referred. The time period from 1990 to 2015 was applied with the language restricted to English only. The explore provisions which are used like CDSS, DSS, Clinical decision, support system, prediction system, expert system, diagnosis assistance and decision making. This paper is about the review of methodologies used in CDSS, due to this reason the applicable Healthcare journals are included (Journal of Biomedical Informatics, Inter-national Journal of Medical Informatics, Artificial Intelligence in Medicine, Computer Methods Programs in Biomedicine, Decision Making, Studies in Health Technology and Informatics, BMC Medical Informatics and Decision Making, Medical Decision Making and Methods of Information in Medicine etc.) along the articles considered on the basis of keyword, abstract and the papers having high impact factor. After making the analysis of intact content, we have painstaking only those articles which were judged by a team of healthcare physician and DSS professional.

III. Sample and Selection of Methodologies Review

The total number of 1700 papers retrieved with the help of Scopus search from the range of 1990 to 2015 as shown in Figure 1. The peak period of the study publication was from the year of 2006 to 2015 and least publication published from the year 1990 - 1999. Only 95 samples were considered for further review on the basis of abstract, title and methodology. Among 98 samples only 25 samples (full sample analysis) were considered for the review which had been judged more relevant to our study. After analysis the subset of 98 selected papers, we prepare the different clusters of prime methodologies of CDSS as present in Figure 2. In the rest of the section we have discussed about the different methodologies, which are used to develop and design of legacy clinical decision support system. Some CDSS used more than one cluster methodology and on the other end some CDSS used the same methodology in more than the one category prediction. With the help of these methodologies any type of CDSS (active and passive) can be designed. Category of CDSS is independent of the methodology and perform the implementation on the basis of task to be accomplished in the clinic.

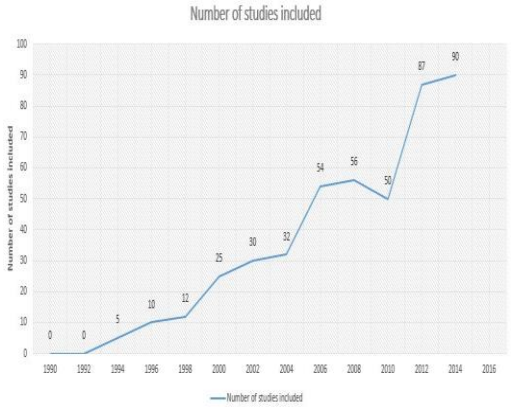

Figure 1: Study of published research papers

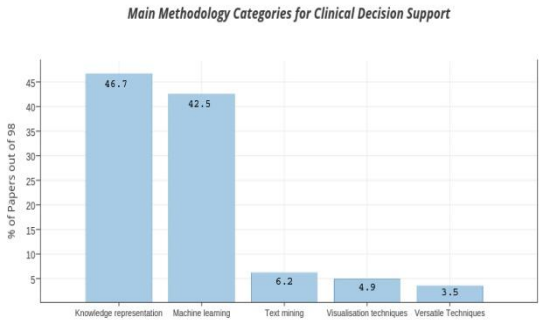

Figure 2: Major Methodology's Categories of CDSS acknowledged for literature analysis.

A. *Expert system (ES)*

Expert systems are focused on the CDSS which acquire the data from the knowledge base (KB) of specialist subject to make the prediction and provide the solution about that. ES probably used the KB and the inference mechanism to provide the elucidation to the information questioned in the form of query [12], [13]. In most of expert systems (Fuzzy based system, knowledge base system), the knowledge source takes the input from domain experts and literature evidence. MYCIN is a knowledge based (KB) expert system which uses the rules as knowledge source and expert assistance for diagnosis of any infection [14]. In these CDSS, the knowledge acquisition (process to translate human based to machine based knowledge) is a major bottleneck and time-consuming process. Maintenance of the KB is another challenge. To handle these challenges for CDSS, many acquisition tools [15]-[20] have been developed among them few were utilized to acquire medical specific knowledge domain and the rest were used for the acquiring of clinical guidelines.

The key shortcoming of acquisition tools is in handling the uncertainties and conflict that occurred in rules.

B. *Fuzzy logic system*

Fuzzy logic is multi valued probabilistic method employ to emulate the real word approximate (not in fixed form) reasoning problems for human being analysis. Reason of absence of data values or imprecise in the database, the approximate reasoning method preferred. In the fuzzy logic system the weighted fuzzy rules are applied rather than binary logic variables (output in the form of 'true' or 'false') which distinguish it from the rest of the methods. Major components of fuzzy logic system are fuzzifier, rules, inference engine and defuzzifier. This method utilized for diagnosis of the

various diseases like tuberculosis, cancer, aphasia, heart disease, arthritis, hypothyroidism etc. But this method better appropriate in the field of image processing for analysis of the specific shape or abnormalities present in the digital images. Also utilized in the medical dataset to categorization of a like clusters.

Esposito et al. [21] developed the Fuzzy logic based CDSS to evaluate the status of people, which are affected by the disease Multiple Sclerosis. The system has analyzed the normal shape of the brain white tissues along magnetic resonance, also form the clusters of the abnormal shapes of matter lesions which exist due to Multiple Sclerosis. Authors diverse characteristics of images with attributes like volume (can be small, medium or large), contrast of tissue(great, little) and on the basis of frequent attributes form IF-THEN-ELSE rules to identify the normality/abnormality of tissues.

Fuzzy logic based system, too utilized for diagnosis of the disease at a premature stage. Anooj [22] proposed a weighted rule based clinical system for the diagnosis of the heart disease. Author utilized the automatic rules generation procedure and then apply the weights to rules. Selection of attributes systematizes by the use of data mining techniques. Number of input's are 'm' and one output related to the risk-level class. For depicting the perception of human being fuzzy logic as well can be exercised.

For meningitis diagnosis, Mago VK et. al. [23], developed a Fuzzy Cognitive Mapping (Fuzzy logic) system. Patient data analysis (number of variants used) made with the help of a graphical model to depict the existence/nonexistence of disease. Meningitis domain used as input knowledge by domain expert to present the associated concepts. Nodes of graphical model are states, variables, input and output. For a given system fuzzy relationship can be used for concepts and fuzzy logic for predicting human discernment.

C. Knowledge reasoning-representation

Every policy and association of the domain that present in the KB of the system, unite with the patient data with the aid of inference engine to provide communication (input/output) to the user's. KDL (Knowledge descriptive language) chosen to represent the facts and vocabulary from health domain that can be focused via knowledge, reasoning and representation, which in return be capable of intelligible and usable as a result of workstation system's [24]. To retrieve the data from knowledge domain, automated query system can be constructed. Muhammad Afzal et. al. [25] proposed a Knowledge-Based Query Construction CDSS system,which automate edifice of knowledge based query to minimize the search time process. The authors used the Arden Syntax and control structure to accomplish this task. In return, there was a significant improvement in the performance of the system.

D. Clinical guideline-based

CPG's(Clinical Practice Guide- lines) can be primed automatically with the aid of KRR (knowledge reasoning and representation) methods. Guideline community eagerly facilitates the well-structured of CPG's to enhance the patient outcomes [26]. By adopting these CPG's, the system after accepting the input data can guide the further cure initiative and alerts about immoral verdict.

Jeeyae J et.al. [27] proposed a CPG based CDSS to provide the assistance to staff in diagnosing and managing the depression. The authors prepared CIG's (computer-interpretable guidelines) from the CPG's of patient data and used the evaluation tool GLEE for preparing the clinic CPG for implementing in CDSS. This method is a useful initiative in preparing nursing CPGs for the CDSS. It facilitates the communication between the expert and the informatician to prepare CIG for the staff.

Martínez-García et. al., [28] developed a Clinical practice guideline's based system integrated with the EHR(electronic health record) of patient data to achieve the safety counter-measure. It is a web based platform to provide the ease of communication like treatments, visits \ndstrategies among the physician and patient, which in return make the improvement in supervision of patients exaggerated due to numerous pathologies.

E. Ontology-based system

In information discipline, Ontology is a prescribed depiction of the knowledge in a domain in the form of types, relationship and properties that can be executable and interpretable by computer. In medical field the ontology elucidates the concepts like patient data, diseases, therapies and association among these concepts to form the knowledge base, which in return utilize for analysis. The major benefit of ontology based system's is easily knowledge sharing, reusability(same domain) and ease of maintenance [29].

Wang et. al. [30] proposed an ontology based CDSS to support the chronically ill patients. The authors used different ontology for the personalization process and decision tool. Personalization process prepared in two phases which in turn used as a knowledge base for nineteen diseases. During the first phase, an ontology is prepared by utilizing the concepts and association of concerned domain. In the second phase, the sub-ontology automate transform the intervention plain of an individual to a specific subject intervention-plan. Semi-automatic plans are combined into a solitary personalized plan for co-morbid subjects. Sherimon [31] developed an Ontology CDSS system to appraise the risk factors and provide the cure to the diabetic.The relationship among the concepts in CPG's are implemented by using the rules of the Web Ontology Language (OWL2) and reasoning process of diabetic. The system utilized two key ontology's for the system are clinical analysis based ontology for diabetic patient and evaluation based semantic outline. These major ontologies further classified into sub ontologies like Patient, Adaptive Questionnaire, Answered Questionnaire, Domain ontology and Process ontology. The authors utilize the forward chaining inference for framed the Rules that employ to the facts to provide the conclusion. This method is ineffective if limit of rules has been increased. The system uses the attributes like smoking, physical activity, drinking habits to predict the risk level of diabetes. The ontology based system provide the alerts in aberrant circumstances.

Few rules form in OWL are as :

1. Rule 1
   Patient(?x) ˆ Cardiac History(?x, false) ˆ age(?x,? p Val) ˆ
   less Than (?;p_val,40) ˆ HDL (?x, ?HDL value) ˆ greater than
   (?HDLvalue,2.4)→ High_HDL(?x)
   In the rule ,onward reasoning based inference chaining is applied. For class names Patient instance is 'x', input values for age, Cardiac History and HDL are verified. If the age is more than forty, Cardiac value is false and HDL parameter is more than 2.6 then the instance has

high HDL. KB is equipped with these kind of statements.

2. Rule 2
   High_HDL(x) ˆ Patient on Statins(?x, false) ˆ GFR(?x,? GFR value) ˆ greater Than(?GFRvalue,60) → Normal_GFR (?x)
   This rule is employed to evaluate the status of eGFR of the patient along with the contingent fact of Rule 1. As per rule, if value of GFR is more than 60 and taking the medicine Statins then the report is normal. This resulted information is added on in KB.

F. Machine learning based system

Machine learning [32] provide the analysis of data to automate the diagnostic model by applying the various algorithms. It can provide the hidden insights without involuntary it discretely for complex data along with effective and efficient results. At the initial stage the Machine learning performs the training phase to perform a explicit task like prediction or classification on the available patient data parameters (laboratory reports, the existence or nonexistence of the disease). Classification plays a major role in the CDSS for mapping the statistics data into predefined classes. Critical step in the CDSS to choose the right classifier for prediction or making the analysis After training phase it performs the data analysis of similar group parameters to perform the prediction(state of the disease).In the subsequent sub-section, we discussed about the multiple well known Machine learning algorithm that used in the legacy CDSS.

G. Logistic regression

This method seeks to find out the persuade of independent variables for prediction on the basis of dependant variables in the form of binary(0or1) and interaction among the independent variables [33]. LR estimates the probability of the dependant variables for the given value. This method generally preferable where the many input attributes (discriminative variables) in a dataset are present and the output variables are predefined (positive or negative, presence of disease or absent).

Smith et al. [34] developed a CDSS for prediction of the traumatic injuries with the use of logistic regression method. Authors/experts consider a number of aspects of study. In the initial phase the logistic regression , used to simplify the training dataset on the basis of predictive variables(age, thorax, injury scale etc.). In the second phase the simplified set used with other supervising learning to make the prediction. Gibss [35] proposed the system in which applied analysis (texture) to the images of breast tissues. MRI (magnetic resonance imaging) used to differentiate the malignant lesions and benign, By applying the LR the accuracy matrix for diagnosis obtained was $0.8 +/- 0.07$.

H. Neural Network(NN)

Artificial neural network (ANN) is computational and mathematical model of interconnected layers of networks which simulates the biological brain (human) patterns called neurons for classification and pattern reorganization[36]. Mostly ANN ideal for non-linear modeling, where the complex association between input and output.

Horn et. al. [37] proposed a ANN based inference CDSS to make the outcome prediction of kidney transplantation. The input attributes (age, gender, cv disease, hypertension, family history and diabetes etc.) of the beneficiary, attributes of the benefactor (e.g: cvd, living style and physical activity) and attributes of transplantation (procedure ,cold storage time and matched HLA antigens) used to provide the analysis and prediction of survival time of recipient and donor. Jorge[38] used the various machine learning algorithm to make the automatic diagnosis of smoking -induced abnormalities in the patient using the FOT (forced oscillation technique).

Neural network techniques preferred due to its simplicity, lesser statistical training requirement, find the complex association between dependent and independent variables along with providing possible prediction. The primary drawback of the technique is that highly reliant on the training data set and always provide the solution for any kind of data set.

I. SVM (Support Vector Machines)

SVM's are well known statistical based supervised learning classifiers, with high computational performance, good generalization and minimum structural risk for the prediction of vastly dimensional problems. SVM considers the input sample map that sample into n-dimensional space for the value of positive and negative samples. The optimal hyper-plane is construed in that space to make the maximum margin among the samples. An SVM classifier widely used by number of researchers in a range of areas like: text reorganization, gene production and medical diagnosis. Researchers used the SVM along with classifier for selection of features along with GMean to diagnose disease. This method used the kernel function to set its parameter with a subset of optimal input attributes to improve the performance of classifier.

Figure 3 depicts the different classifier (ANN and SVM), where white and black hole points to different attributes. In Figure 3(a) for simple samples linear classifier works well, but the performance degrade for complex samples attributes in Figure 3(b) .While in Figure 3(c), the SVM map the samples into large dimensional scale with kernel trick, classification became much more easier.

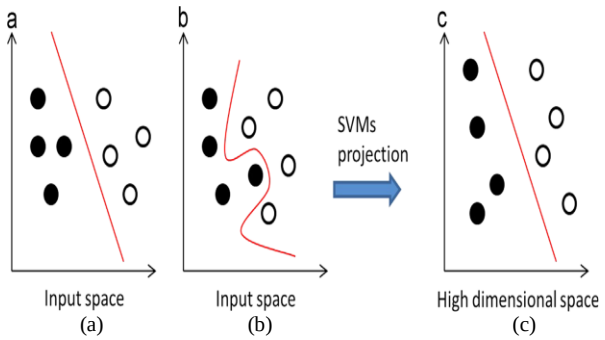

Figure 3: Linear (ANN) vs. non- linear (SVM) classifier.

Sali [39] proposed a SVM based CDSS for cardiovascular disease diagnosis . The authors combine the SVM and BPO for dataset for preparing and classifying the dataset. Attributes like gender, age, physical activity , hyper-tension and family for analysis performance matrix. Comparison with other classifier and conclude SVZ more efficient classifier for study in the field of pattern reorganization [40], one of most elegant and simple classification technique is KNN. It's the extension of the ANN, based on lazy or instance learning which evaluate the k nearest instances of the new classified

query using Euclidean distance similarity functions. Performance of K-nn classifier fluctuate on the basis of k-selected value. K-NN keep on predicting continuous value on the basis of the dependent variable k -nearest neighbour's average value.

Burroni et al.[41] apply the k-NN classifier to develop a CDSS for diagnosis of melanoma appeared due to skin lesions. The authors used the digitized images for analysis obtained from epilumi-nescence microscopy. On th basis of accuracy (98%), sensitivity (97%) matrix conclude that avoid the surgery with early diagnosis K-nn also used by Ziming [42] for a CDSS to diagnosis of probable migraine and probable tension-type headache based on CBR. The physician confuses to isolate the overlap between PM and PTTH headaches. The authors used their study to resolve this problem. Results proven that high degree of accuracy achieved to recognize these diseases.

Major shortcoming of K-NN is that the observation for the trained data set exponentially increased with respect to the dimensions.

J. NLP (Natural language processing) techniques

NLP is computationally efficient technique to interpret the human natural language to retrieve the information. These techniques automatically retrieve the information and categorize the textual information which is relevant to the field of the medical (e.g reports, clinical notes) for the performing the prediction. MedLEE is NLP based CDSS[43] used the structured information for preparing the vocabulary. For the formal illustration of the sentences it utilize the lexicon. This system has been effectively implemented for the diagnosis of disease using the pathology, radiology, echocardiogram reports.

Speroff [44] used the NLP based CDSS to diagnosis the unidentified infections, its symptoms with the help of automated surveillance .On the basis of biomedical ontology's (e.g: Systemized Nomenclature of Medicine Clinical Terms) author primed the rules. These rules are processed through the medical text to identify the symptoms for influenza, acute- hepatitis and tuberculosis which can provide a previous infection diagnosis.

Dina et al. [45] used the NLP techniques to evaluate the CDSS 's performance as compared to the existing system. In the study used the different models along the axis, to depict the association between NLP and CDS. The NLP system can be one of the following states:

1. supervised the CDS using knowledge for making the predication.
2. incorporated within the CDS itself.
3. has been developed for specific tasks.

By applying these associations the model can be made as per the requirement. The authors conclude that NLP based CDSS can provide the better result in the diagnoses.

K. IR (Information Retrieval) process

IR technique is used to extract the relevant text (e.g: report, document) from the semi-structure data as per the specific requirement of the user [46]. For the retrieval of the information from the semi-structure data the IR techniques perform the indexing phase for pre-processing of text to arrange them in some order. Statistical methods with the accompany of search algorithm used to retrieve the information (frequency of present of words) from the pre-processed outcomes.

Dympna M [47] proposed an automatic indexing and retrieval of encounter-specific evidence for assistance of physician for paediatric asthma domain. The authors use the Cochrane Library [48] align with EHR database for systematic clinically validated reviews of the patients in a specific clinical domain. They propose a framework by including the three implementation phases. In the initial phase primed a repository of names using the expert domain, In the second phase the core concepts are expanded by utilizing UMLS based ontology and TF–IDF (term frequency–inverse document frequency) schema. In the final phase the association achieves between names and the core concepts by using VSM. With help of systematic indexing the documents are retrieved and provide the review to clinicians after applying the search algorithm on retrieved documents.

Pierre et.al. [49] proposed a clinical information retrieval tools to gather the systematically information in daily practice. Authors integrated the Inforetiever tool along with educational cohort scale the impact of assessment for each computer hit. On the basis of hit categorized the impact as CDSS and CIRT (clinical information-retrieval technology). Authors claim that their novel system permits the relative and logical evaluation.

IV. VERSATILE TECHNIQUES BASED SYSTEM:

In the field of the medical ,the versatile methodologies unite the characteristics along with attributes of the above mention techniques and can be provide multiple solution for CDSS.

A. Decision Tree (DT)

DT's are the one of the most effective and powerful tool in the area of knowledge discovery, data mining, text mining, pattern reorganization ,machine learning to explore the giant and complex data to discover the new constructive pattern to that system became more effective, efficient and accurate. Decision Tree's are preferred in Knowledge representation to represent the potential decision and associated consequences in graphical format. In the CDSS they are appropriate elucidation to plan the CPG's(clinical practice guidelines) and all detail about the action-plans to a specific medical domain.

Chiou et al. [50] employ the DT (decision tree) to formulate the syntax based decision rule to examine the HBsAg ,liver enzymes and alpha-fetoprotein is abnormal for the assistance of physician. Lior, Smith et al. [51], [52] also utilized the DT along logistic regression to diagnose traumatic injuries. In the study, the attributes like age, gender, various scores of trauma, severity supplied as the input parameters for the diagnosis and prediction. The decision rules (transparent) are created by employing the DT, which in return provide the assistance to the physicians. Decision tree based CDSS system to represent the knowledge and representation proposed by Gerald et al. [53] to predict the positive tuberculin test to assist the physician. Authors performed testing on number of cases, evaluate the sensitivity and specificity for positive cases 94%, 38% with the false negative rate about 7% and conclude that the DT can minimize the number of investigations.

Decision Tree's are used with Machine learning techniques to provide the classification and prediction. They are useful in the field of medical because provide the classification rules in human readable form. Initially by using the training dataset the DT decompose the domain into a number of regions

nodes known as 'leaves', input attributes and on the basis of their values the rules flow from the branches of tree to make the classification or prediction. Decision tree techniques are not very effective where the amount of missing value are enormous in the database.

B. Naive Bayes (NB)

For classification of the high dimensional data the NB classifier is considered the most probabilistic technique. In this method the input attributes independent to each other which, along the Bayes' law apply the Bayesian theorem for evaluating the probability of the anonymous evidence based instance [54] and have a preference of graph posterior probabilities. On the basis of the symptoms and disease, it can calculate the probabilistic dependencies among them and provide the list of various prediction, which can provide the probability of presence of the diseases. Bayes classifier is pretty interpretable and comprehensible. All the specialist knowledge should be needed to be incorporated to express the facts in form of probabilistic distribution.

Barzi et al. [55] proposed a Bayes network based CDSS to provide the assistance to staff during triage practice in the ED (emergency department). In the initial phase, all the sub domains like vomiting, pain, etc. are described evidently then the symptom and the significant information are acknowledged. The authors developed a graphical based model with the support of Bayesian network for representing the promising association between prior information. As a result provide the list of all the probable diagnose.

Liebow [56] introduced a DX plan based DSS, which propose the workflow to provide the guidance to the hospital staff ,which in return reduces the COS (cost of service) for DRGs (Diagnostic Related Groups) for differential diagnosis disease. The authors applied the Bayesian logic for the differential diagnosis and provide the list of possible probabilities. The authors conclude that this method will progress the excellence of care and reduce the cost significantly among hospitals.

V. CONCLUSION

In the domain of commercial, the decision support systems extensively adopted and implemented at triumph rate; on the other hand in healthcare domain the adoption rate is quite limited. The prime objective of this review was to familiar the physician and strategy makers to understand various methodologies of the CDSS mentioned above which will assist them during the development and deployment phase, that will provide a clinical support to physician and staff during their routine practice. The accomplishment phase of the clinical decision support system provides a equilibrium between the administration and the health center requirements. With the proper understanding of CDSS physician can guide vendors the proper clinic requirements at the design stage, which CDSS methodologies are preferable with respect to their requirements at the accomplishment phase ,validation can be performed with involvement of participation of staff and finally the deployment stage implement with the alliance of the admin for proper adoption of the system. Policy makers should take the initiative to enforce the health care centre for proper adoption of the CDSS for their practice routine to improve the patient care outcomes.

Finally the preferable potential guidelines for the proper implementations of CDSS's are:

1. proper schema for the construction of the knowledge base with efficient domain collection.
2. a strong inference engine that can build a powerful association between the expert's reviews and formulated rules.
3. provide the automate recommendation along with the prediction.
4. should be accurate and user friendly.

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