

A Survey on Patient Flow Prediction via Mutually-Correcting Process

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Abstract – Over the past decade due to increasing the population Overcrowding in emergency care unit (CU) departments is a problem in many countries around the world, including the United States and Chile. This Emergency department (ED) overcrowding causes problems for indispensable for shortening the length of hospital stays, improving patient outcomes, allocating critical care resources, including increased waiting times. As crowding increases, the quality of care is reduced due to lack of adequate resources. Generally predicting the transition processes of patients (PFP) IS more difficult and crucial process, because predicting patient flow includes patients' duration time within each care unit and transition probability among different units, and including patient's underlying condition and clinical state, disease progression, and availability of care team and staff resources. So Data mining is an effective way to solve such problems in the medical service. This paper surveys various techniques and methods used to Patient Flow Prediction in the Medical care units.

Index Terms – Patient flow, emergency care unit, mutually-correcting process, electronic health records, data mining.

1. INTRODUCTION

Hospitals are most highly challenged to provide timely patient care while retain high hospital resource utilization. Recent survey result has highlighted an increasing demand for care units in the United States due to an improved life expectancy and a larger aging population. Over the past 30 years, a dramatic change has occurred. The majority of admissions is now unscheduled .Patient crowding in the emergency department (ED) has become a daily challenge to providing high-quality care in worldwide and is a critical problem. Patient management and reducing waiting time, particularly in the Emergency Department and intensive care unit is crucially important to improving quality of care, outcomes, and the overall patient satisfaction in hospital [1].

Overcrowding exists when there is no space left to meet the timely needs of the next patient requiring emergency care. If the care of urgent problems is delayed due to congestion, then overcrowding exists. Although the most important cause of bottleneck in the Overcrowding occurring as a result of prolonged length of stay (LOS), inadequate healthcare personnel appointment, delayed response to ED consultations,

and hospital-specific factors (size and location, lack of available inpatient beds).Therefore, the problem of predict Overcrowding is a difficult task due to a number of factors . Each and every major hospital must have a plan to address the growing problem of crowding then only they can able to give better health care service. However, few hospitals have been able to develop an effective strategy to combat the daily occurrence of Emergency crowding. These hospitals consider many factors such as increased patient volume information, nursing staff shortages, decreased inpatient beds, increased acuity of patients entering the ED, and increased number of patients boarded, but still it creates several issues relating to Patient Flow Prediction.

1.1. Patient Flow

Patient flow is the move forward of patients through a healthcare facility. This is the movement of patients inside the hospital care from check in to check out time interval. It mostly involves the medical care unit, physical resources, and internal systems unit effectively needed to get patients from the point of admission to the point of carry out while maintain the quality and patient satisfaction. Mostly patient flow problem arise due to some Inefficient scheduling its leads to some patient flow problems.

Improve patient flow is a serious constituent of process management inside the hospitals environments and other healthcare facilities. During the transition process patient having some cardiac surgery, so that need Anesthesia Services. At the same time pregnant woman having Anesthesia Services for a Caesarean section surgery, There is a partial overlap between the need of the elderly patient and that of the pregnant woman for anesthesia services.

In this case Caesarean section surgery Such an urgent requirement gives rise to an important problem of predicting the transition processes of patients, known as the patient flow this includes and determined by a number of factors such as patients under lying condition and clinical state, Disease progression, and availability of care team and care resources, which may cause scheduling conflicts and may require advanced planning and scheduling to reduce waiting times. The

patient flow can be able to easily predict via time sensitive, feature selection and Data sparsity and case imbalance and effective machine learning algorithms and with the help of computer technology.

1.2 Strategies to Improve Patient Flow Problems:

Patient flow problem can enhance some of the factor these factors are list out and explain here.

1.2.1 Identify bottlenecks:

Bottlenecks are obstructions within the workflow that delay patient care and disrupt your daily routine. By correcting inefficiencies that congest up the care process, patients can move hospital environment more smoothly from check in to check out.

1.2.2. Schedule to enhance efficiency:

A smooth patient flow starts with a structured scheduling process. Scheduling policy which has more efficient scheduling ability to avoid long waiting in the hospital. For that improve the better scheduling process health care template necessity. In that to plan accordingly, evaluate and average how much time is needed for each type of visit. Make a open appointments daily in this schedule, so that easily can improve scheduling process.

1.2.3. Planning:

One of the most critical and effective strategies, planning ahead of time prepares the physician and care team for each patient visit. A lot of time during the visit could be wasted if service, tests, equipment, etc. aren't readily available or accessible. In order to make and manage effective patient flow make sure relevant resources are readily accessible by any time.

1.2.4. Simplify check-in and check-out processes

Patient check-in is a simple process. The number of staff assigned at check-in is inadequate for the number of patients arriving. This results in patients standing in line to check-in and usually creates delays for patient. Improve this process schedule an appointment earlier when they check in to their visit hospital patient no need t wait long time. A simplify check in-out process can improve the quality of services and the utilization of hospital resources.

2. LITERATURE REVIEW

This paper [1] authors had presented Outflow Patient Flow by Symptoms and Outcome. EMR It provides various temporal events such as diagnosis dates for various symptoms. This paper describe the Outflow visualization technique, designed to summarize temporal event data that has been extracted from the EMRs of patient .The objective of the system is the study of predict the Patient Flow using symptom and outcome. The results showed prediction patient flow is effectively.

Authors in [2] presented a patient-oriented Workflow model for predict the patient flow using potential value of work flow model. Initially organizes the building block of work around the patient and health care. Patient-oriented Workflow model design and Implement patient treatment types is used to estimate the crowdedness of emergency department.

In this paper [3] authors proposed that, Temporal Progression Model via cHawk. Initially, capture the three aspects of HER health records such as, namely disease relations, context-sensitivity of diseases and temporal dynamics of disease. This result showed that cHawk is able to predict future diseases more accurately than the other traditional method. So that we can identify useful relations between various patient features and the risk of disease occurrence.

In this paper [4] authors proposed Markov chain (MC) model. A Markov process is a stochastic process having the property that, given its present state, the future states are independent of the past. This property is called the Markov property. Markov process the system can change or keep its state, according to a certain probability distribution. This model use for calculate the flow of patients having a certain kind of diseases from discrete time series or aggregate data.

In this paper [5] authors described about a model using data mining techniques mainly vector auto-regressive (VAR) model. VAR is used to combine the information from different time periods and across measures within each condition.

These measures are then used to compare current and past quality of care. The system calculates the flow of patients having a certain kind of diseases or not. This method is well suited to measure and predict provider quality of care.

In this paper [6], authors proposed hidden Markov model (HMM) scheme for predicting the flow of patients having a certain kind of diseases or not . As recognized throughout this survey paper, hidden Markov models (HMMs) have been used to model disease progression, they are not suitable in general because they assume that measurement data is sampled regularly at discrete intervals. It is a need to have combinational approach to increase the accuracy of prediction for patient has disease or not.

In this paper [7] Author intention of this paper is to propose that, logistic regression and decision trees methods to improve patient flow and prevent overcrowding. Routinely collected administrative data from hospital compare contrasting machine learning algorithms in predicting the risk of admission.

In data set identify several factors related to hospital admissions, including hospital site, age, arrival mode, triage category, care group, previous admission in the past month, and previous admission in the past year. This paper highlights the potential utility of three common machine learning algorithms in predicting patient admission.

In this paper [8] workflow of surgical operations is explored to reduce the disruption by creating a continuous time Markov chain (CTMC) model and then solving the Markov chain to conduct the related performance analysis. CTMC model can predict system status in future on the basis of properties in Markov process.

This paper directly generates the model using CTMC. The drawback of such direct modeling approach comes from the state space explosion problem when a system has complex behaviors or massive instances.

In this paper [9] Authors Yu-Ying Liu proposed the Continuous-Time Hidden Markov Model (CT-HMM) is an attractive approach to modeling disease progression due to its ability to describe noisy observations arriving irregularly time. Present the effective earliest absolute characterization of efficient EM-based learning methods for CT-HMM model.

Generally Learning trouble consists of evaluation posterior state probabilities and the computation of end-state conditioned statistic these two major difficult challenges problems has been solved this paper using equivalent discrete time-in homogeneous hidden Markov model. The experiment can also be performed on glaucoma dataset. The result shows predict disease progression with 80% accuracy.

In this paper [10] authors proposed that, temporal graph for such event sequences process. The temporal graph is informative for a variety of challenging analytic tasks, such as predictive modeling, since it can capture temporal relationships of the medical events in each event sequence.

By using temporal graph approach can get effectively extract characteristic features from EHR this achieved by a graph-based model, All these works can be viewed as feature extraction methods for EHRs. From the analysis, the discovery of several problems has been mentioned this obtained feature applied to other problem like constructing disease network.

In this paper [11] authors Long ford proposed that, nonparametric algorithm for multi feature multi category problems. This algorithm maximizes the mutual information gain at each partitioning step in the local scene, and therefore gives rise to a locally optimum decision tree. The resulting partitioning tree produced by the proposed algorithm can be used for classification and as well as for data interpretation and pattern similarity analysis, All these works can be proposed to learn models from imbalanced data.

In this paper [12] authors proposed that, Logistic regression for re-balance data. Initially samples in the minor classes have large weights while those in the major ones have small weights. The weights are added to unlabeled samples when training logistic regression, which can be viewed as the prior knowledge of model. From the analysis, effectively learn

model produce from imbalanced data. Experiments show that the method performs well.

An author in this paper [13] recommends that, novel dictionary learning method in the semi-supervised setting by dynamically coupling graph and group structures. This algorithm proposed for the classes with extremely few samples. In this proposed model mostly unlabeled samples are used as auxiliary samples in the training phase and additional to minor classes adaptively. However, they do not consider the data imbalance problem in the classification task.

An author in this paper [14] proposed that, fuzzy min-max neural network (FMM). The FMM neural network forms a set of hyper boxes by learning through data samples, and the learned knowledge is used for prediction.

In addition to providing predictions, decision rules are extracted from the FMM hyper boxes to provide an explanation for each prediction.

In order to simplify the structure of FMM and the decision rules, a optimization method that simultaneously maximizes prediction accuracy and minimizes the number of FMM hyper boxes is proposed to predict admissions from the ED, comparing the ability of fuzzy min max neural networks (FMM) to other data mining algorithms The experiment results using a large data set shows that the proposed method achieves comparable or even better prediction accuracy.

In this paper [15] authors proposed that, Multitask Point Process Predictive Model. Point process data are commonly observed in fields like healthcare and the social sciences. Designing predictive models for such event streams is an under-explored problem, due to often scarce training huge volume of data so introduced simple predictive strategy, propose this model leveraging information from all task via a Gaussian process.

In this predictive model nonparametric learning functions implement by a Gaussian Process, which effectively map from past events to future rates, allow analysis of flexible arrival patterns. From this paper analysis, results are shown on both synthetic data and as well as real electronic health-records data with this model predict an event arrival patterns more accurately.

In this paper [16], author's research aims to observe the correlation between patient flow in a social network and corresponding network characteristics. This research, a simulation model developed to describe the patient flow. Nevertheless; simulation also has some drawbacks in time-consuming preserve high efficiency.

There is still some large gap in the achievement especially in developing new solutions to improve the patient flow.

Paper No	Technique	Advantages	Disadvantage
1	Outflow visualization technique	Extract effective temporal event data from the EMRs, prediction patient flow is Accurate.	Combine large patient records into Graph based visual presentation is tedious process.
2	Patient oriented Work flow model	This models can potentially lead to better treatment Plans and improves in patient compliance.	difficulties in conducting workflow studies in both formal and informal health setting
3	Temporal Progression Model	predict future diseases more accurately than other traditional method	This method not able to predict Risk of disease occurrence.
4	Markov chain (MC) model	This model result which offers better accuracies for patient flow.	It does not always offer the speed.
5.	vector auto-regressive (VAR) model	Flow of patients calculated with 90% accuracy based on patient having kind of diseases.	Needs more parameters and deep study is necessary, so that can't able to apply big data analytics.

6	hidden Markov model (HMM)	Highly scalable, make probabilistic patient flow predictions.	This HMM model is expensive, both in terms of memory and compute time.
7.	Logistic regression and decision trees.	Effectively predicting the risk of admission and avoid overcrowding.	Very slow prediction generation every time because each and every time identifies several factors related from data set.
8.	continuous time Markov chain CTMC model	This model is Easy to implement with a large number of data set. CTMC predict system status in future effective manner.	Time spent in a state is the same for all states, So Takes more time.
9	CT-HMM	visualize and predict disease progression more accurate	Complexity and inability to recover from dataset corruption
10	Temporal graph Model	Can get and perform effectively extract characteristic features from EHR.	This model Effects time series analysis will lead to some other problems

Paper No	Technique	Advantages	Disadvantage
11	Non Parametric Algorithm	System is completely used effective classification and as well as data interpretation and pattern similarity analysis.	Non-parametric models (can) become more and more complex with an increasing amount of data. This is tedious process.
12	Logistic Regression Model	This model predicts categorical and multinomial outcomes with high accuracy.	logistic regression could not be used to predict the continuous outcomes
13	Novel Dictionary Learning Method	Efficient way of dealing with high dimensional data. Robust to noise and distortion	This method does not consider the data imbalance problem in the classification task.
14	Fuzzy Min–Max (FMM)	This model result which offers better maximizes admissions prediction accuracy	Large number of hyper boxes which affects the complexity process needs more attention.
15.	Multitask Point Process Predictive Model	Predict the event arrival patterns more accurately.	Map from past events to future rates, more difficult and time consuming process.

3. CONCLUSION

Overcrowding is one of the major problems in nowadays which reduced quality of care in medical industry. In this paper, the

problem of finding Overcrowding and patient flow predicting techniques are investigated. There are numerous researches from various domains are continuously working towards developing Predict the patient flow in health care sector. The aim of this survey was to summarize the recent researches and its demerits in patient flow prediction. This paper gives the merits and demerits of the recent techniques and its capabilities are studied. This paper concludes that there is no effective prediction method not applies and concentrates on the patient flow prediction with high accuracy. So, further approaches should overcome all the above issues. Further implementation has to be done in order to predict patient flow with more accurate in a big data environments.

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