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Monitoring the Patient Flow using Data Analytics

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Abstract:
The emphasis of big data is growing largely in many sectors including biomedicine, life sciences and scientific research, mainly due to advancement in technologies and data analytics. Medical sciences can rely on a large amount of biomedical information and Big Data can aggregate information around multiple scales, from the DNA to the ecosystems. The big data in Accident and Emergency services in hospitals worth being analysed to provide clinical decision support to medical staffs and medical information to patients. A systematic review of the literature has been done to identify the studies that implemented the application of big data in EDs and to describe what have already been done and what are the expectations, issues and challenges in this field. The study aims to examine the trade-offs of various safety and quality outcomes in an Emergency Department: waiting time and occupancy (acute beds and waiting room) in primary, on the adjustments of various factors (e.g. Admission volumes and staff numbers) in order to evaluate how an accident and emergency system in any hospital could be more efficiently operated.

1. INTRODUCTION

There is a tremendous and expanding enthusiasm on Big Data and its applications. Big Data can be defined as a volume of heterogeneous data. A clear common definition is through the "4V's": Volume (quantity), Velocity (speed and analysis of real time data), Variety (forms of data), and Veracity (quality assurance of data). The first three V's are the characteristics of big data while the last V could be considered as the goal. Despite the challenges that big data needs to overcome, advanced analytics promised through big data offer staggering, open doors for most partners in medical sciences. Emergency Departments (EDs) are the most imperative units among the hospital. Accident and Emergency (A&E) aims to provide access to hospital services for urgent cases. The Emergency Departments (ED) provide a high standard of A&E service for critically ill or injured persons who need urgent medical attention. EDs produce a vast amount of data that can really benefit from big data analytics which, in turn, may offer a great opportunity to improve resource use, reduction of costs, optimize supplies and staffing, decrease wait times and eventually improve the quality of care provided to patients and outcomes. The aim of this review is to analyze the results of the studies that implemented the applications of big data in ED and to portray what have just been done and what are the desires, issues and difficulties in this field.

2. EXISTING SYSTEM

A patient flow system is an e-health guidance system that optimizes the patient journey for your patients by integrating powerful electronic journey boards, mobile EMR data capture. Keep everyone on the same page about demands on your hospital by providing an integrated platform that supports the workflows of doctors, nurses, allied health and bed managers and allows them to seamlessly share information about the

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status of each patient. Allow Access and Bed Managers to track hospital capacity and respond to demand issues wherever they are using a patient flow system. Tracking technology can facilitate holistic oversight and coordination across a hospital – completely transforming how flow is managed.

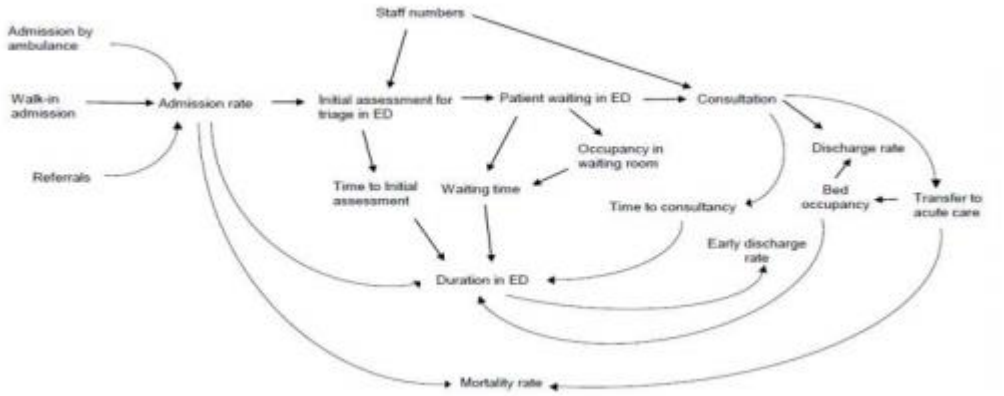

Fig.1. A pictorial representation of the usual patient flow in the ED of an A&E service.

Fundamental to this is a manned control center where clinical and non-clinical staff monitor color-coded data on admission, occupancy, bed cleaning and portering jobs. They can prioritize the cleaning and turnover of beds based on the case-load of patients waiting to be admitted – pushing particular jobs to porters and cleaning teams across the hospital; they can use the data to prioritize discharge expedition efforts. Ultimately, the data provides a clear view of timeframes for a seamless flow of patients through the hospital.

3. LIMITATIONS OF THE EXISTING SYSTEM

To summarize the various limitations in the current functioning and operations of monitoring the patient flow in the Emergency Department of an Accident & Emergency services are:

● Long stays in the Emergency Department.

● No timely admission / discharge.

● Overcrowding in ED which may result to more serious patients waiting for a long time for a ward or a bed.

● Patient flow in operating suites isn't smooth-sailing.

● Coordination with health providers to provide medical attention isn't consistent.

4. THE PROPOSED SYSTEM

In UK, Accident and Emergency (A&E) performance of 4 hour waiting time target is a key metric used to assess hospital metrics, and patient flow through the clinic has been ascribed to be a contributing variable. To understand this, a data driven analysis was performed on two of the major hospitals in the UK, namely,

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King's College Hospital NHS Foundation Trust, and Princess Royal University Hospital [PRUH] and designed a data- drive analysis for hypothesis-generation that would be able to identify patterns of patient flow associated with good or poor A&E performance.

4.1 METHODS

1. Data Extraction

Data was extracted from the patient administration system (PAS) and electronic records at both King's College Hospital NHS Foundation Trust, and Princess Royal University Hospital [PRUH]. Any identifiable patient records were not collected in order to save the security concerns. A database query was run to extract all A&E patients on both the sites.

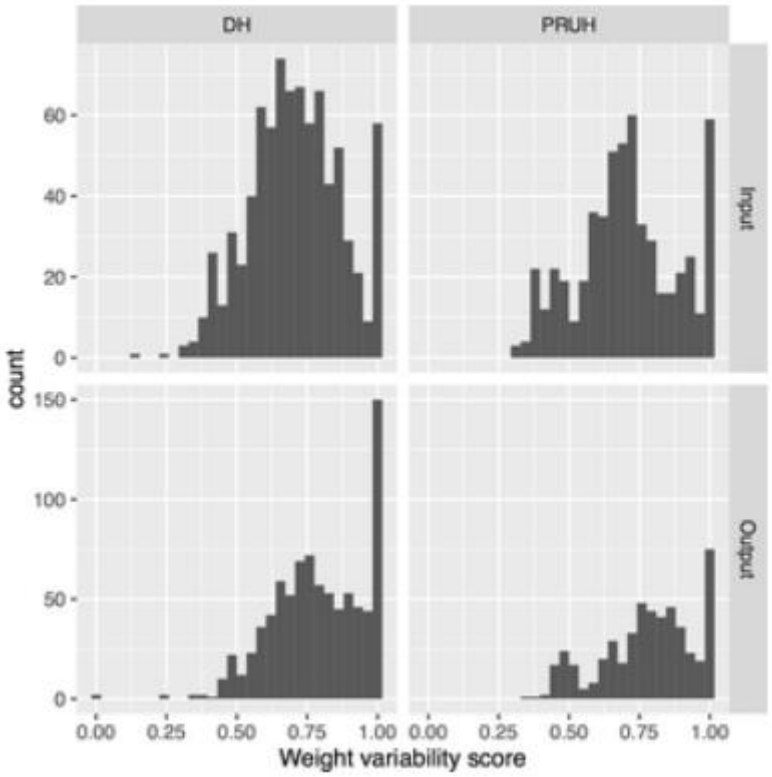

Fig.2.Weight variability distribution

2. Ethical approval

All the extracted data was reviewed by King's College Hospital Information Governance committee and approved with continued oversight. The basis for secondary use was for service improvement analysis and other medical analysis.

3. Graph Construction

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All the patient inflow to an emergency department were modelled as a directed graph. The graph nodes were in proportion to the transfers (in and out flow) with the number of patients at a given time.

4. Variability score formulation

Variability score information is the property that calculates the observed deviation from a balanced distribution of its input and output edge as proportion of maximum possible deviation.

5. RESULTS

The patient in/out flow dataset for an Emergency department (EDs) and Accident and Emergency (A&E) contained 194,410 transfers for 78,400 hospital admissions (includes both King's College Hospital NHS Foundation Trust, and Princess Royal University Hospital [PRUH]) over 570 days. The weighted graph contains analysis of all in/out flow of patients to ED during A&E. From the transfer data, it is possible to specify the path for each entry and exit of a patient from the time of entry to an ED till the time of discharge from medical services from the medical organization. From the unique values obtained from the formulation of variability, we can see that at the King's Trust, the distribution of inflow of patients directed to a path corresponds to 0.34% over 0.53% of the PRUH site.

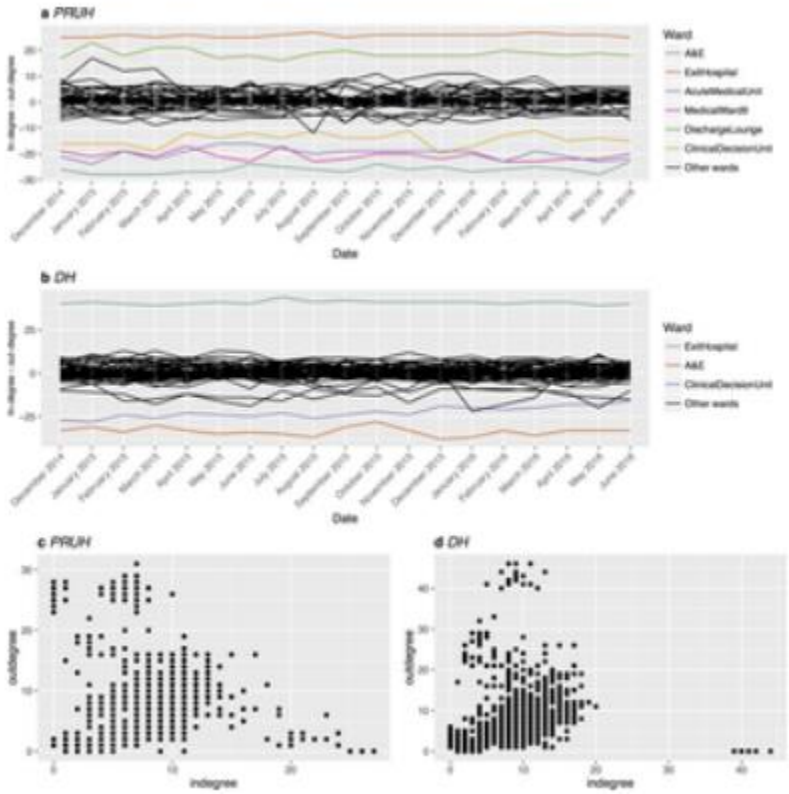

Fig.3. Difference between in-degree and out-degree of flow of patients.

CONCLUSION

On observation of a completely data-driven analysis of patient flow using data analysis and modern graph theory, we can conclude that the local network structure of a medical organization on a monthly basis, remains constant with respect to the patient flow to an ED in case of A&E. Most flows are relatively balanced with respect to the in-degree and out-degree except for a surge in case of unforeseen circumstances and unforeseen calamities Changes in performance in these specific areas (EDs and A&Es) will affect most patients, and therefore may also impact the wider hospital system. The ability to identify the key areas for in-depth review in an unbiased fashion is a major advantage of this modern graph theory analysis. The analysis confirmed that prior data of A&E attendance rate is poorly correlated to the hospital's performance statistics. Flow through these pathways may be modifiable factors affecting A&E performance, however further work is required to determine whether this is a causal association, and direction of the causality. Major component analysis and differential network analysis identified the changes in the distribution of the flow of patients to EDs thus helping in analyze the best case and the worst case scenarios for efficient flow of patients in an Emergency Department.

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