COVID-19 beds' occupancy and Hospital complaints: a predictive model

MSR32

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Background

- Taking rational and adequate decisions, maximizing their expected utility, represents the major challenge of the decision-making processes in healthcare (Von Neuman, 2007)
- The use of big data surely improves decision-making process
- Accurate and timely information will be the greatest asset to drive successful and serious healthcare organizations (Sun and Scanlon 2019)
- The capability to handling a huge amount of data has been playing a key-role, with the COVID-19 pandemic (Cobianchi et al., 2020)
- Information generated at hospital and national level, has been mainly used to manage the COVID-19 epidemiological profile (Bamidele Awotunde et al., 2022)
- Data could also be exploited with a managerial approach, supporting the estimation of number of beds, healthcare professionals, equipment, and other resources, extremely scarce during the pandemic crises (Vaishya et al., 2020)
- The routine utilization of big data and artificial intelligence approaches to model crises, identify and understand the weaknesses of existing systems (close to real-time) would be necessary to strengthen existing organizational assets

Objective

To predict the number of patients requiring any type of hospitalizations, considering not only patients affected by COVID-19, but also other severe viral diseases, including untreated chronic and frail patients, and also oncologic ones, with the main aim to forecast the occupancy of hospital beds and to estimate potential hospital lawsuits and complaints

The development of such model could support hospital management and public institutions in implementing an impact analysis to decide whether to invest resources, to increase critical care surge capacity

Methods

An unsupervised learning approach of artificial neural network's called Self-Organizing Maps (SOM), grounding on the prediction of the existence of specific clusters and useful to predict hospital behavioral changes, has been designed to forecast the hospital beds' occupancy, using pre and post COVID-19 time-series

Data came from the UK National Health Service (NHS) statistic and digital portals, concerning a 4-year time horizon, related to 2 pre and 2 post COVID-19 years

Information	Data Explanation	Data Source
1 COVID-19 Hospital Activity	Numbers of patients in hospital with Covid (including those in mechanical ventilation), and number of patients admitted, diagnosed to hospital, and discharged from hospital	england.nhs.uk/statistics
2 Critical Care Bed Capacity and Urgent Operations Cancelled	Number of urgent operations cancelled and the critical care capacity	england.nhs.uk/statistics
3 Overnight Bed Availability and Occupancy	Number of available and occupied beds	england.nhs.uk/statistics
4 Data on Written Complaints in the UK NHS	Number of complaints about NHS services in England	digital.nhs.uk/data

Results

- The UK NHS dataset is composed of a total of 116 hospitals, covering 5 different healthcare types: most hospitals are acute healthcare organizations (41%) and are in town area (76%)
- Clusters revealed two principal behaviours in selecting the resources allocation
  - Cluster 0 is characterized by a reduction in the number of complaints, which is linked to an increment of non-COVID admitted patients. In fact, there was a -54.67% decrease in complaints from the non-COVID period to the COVID period, with a marginal decrease in the number of occupied beds (-6.29%), which was not significant from an organizational perspective
  - In cluster 1 a lower number of non-COVID admitted patients reflects a higher number of complaints since hospitals are congested by COVID patients. On the one hand, there was an increment in complaints from the non-COVID period to the COVID one (+16.66%); on the other hand, there was a considerable reduction in the number of beds occupied (−25.78%)

Cluster No.	Period	Saturation	Complaint	Ratio	Bed available	Bed occupied
0	2020-2021	103.67	57.21	109.57	768.06	639.06
0	pre-COVID	87.17	126.20	145.56	777.19	681.97
1	2020-2021	88.15	164.36	640.63	746.10	501.93
1	pre-COVID	87.48	140.89	163.48	768.36	676.30

Complaints remained at the same level, except for those hospitals that decide to reduce the beds available for the occupation, decreasing the possibility to accept patients

The complaints are not related to the level of saturation, but many potential patients needing the delivery of a healthcare service, complained when they were artificially turned away and directed to another hospital

Conclusions

The model could significantly support the management of hospital capacity, helping decision-makers in taking rational decisions under conditions of uncertainty

This model is highly replicable also for the estimation of current hospital beds, healthcare professionals, equipment, and other resources, extremely scarce during emergency or pandemic crises

Due to its scalable nature, this tool could be implemented to support other complex decision-making processes, such as:

i) planning and coordinating the transfer of patients to different hospitals

ii) planning in advance non-Covid-19 treatments, surgery, and staff allocation

iii) defining a greater budget for claims management and settlement, in case of need

Managerial Implications

- A strong **correlation exists between the management of beds capacity during the pandemic and the claims filed by patients**: hospitals may decrease the chances of complaint by avoiding to fix a quota for COVID-19 patients' beds
- This information could be useful to **define the proper structural or level investments** to be implemented at hospital and at regional/national level
- The advanced knowledge of the potential problems generated on the basis of the structural choices implemented at hospital level, as well as the consequent legal costs related to such choices, would be able **to identify disinvestment areas within the hospital budget, to prefer a medium-term (or long-term) investments, being consistent to one of the main objective of the healthcare systems worldwide**, characterized by the capabilities to meet the demand, with an optimization of the resources' productivity and an increase in the processes transparency (Abdulsalam et al., 2015)

Legal Implications

- The definition of the adequate number of hospital beds is crucial, since the management of Covid-19 pandemic **has presented a significant number of issues for the healthcare sector**
- Due to the high number of infections that caused an unprecedented number of patients requiring hospitalization in Europe, **many patients were rejected from hospital admission or from ICUs**
- In addition, **non-Covid-19 patients suffered from the consequences of hospital beds saturation as well**
- Hospitals concentrated all their resources to face the emergency, **postponing non-urgent cases**
- **The delay in treatment, however, may have caused significant damages to non-Covid-19 patients, often classified as "not urgent"**, such as late or failed diagnosis, or late treatments, causing the worsening of their conditions or even death
- Under those circumstances, **patients may have a ground to complaint and seek for economic compensations**

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