Big Data supporting Public Health policies

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Background: Health Care Management

To illustrate the power of **Health Care Management**, we report the following examples regarding a centred pathway analysis. In [1], the author applies system dynamics to the development of national policy guidelines for the U.K. health service. The tested policies include the use of 'intermediate care" facilities aimed at preventing patients needing hospital treatment. Intermediate care, and the consequent reductions in the overall length of stay of all patients in community care, is demonstrated here to have a much deeper effect on total patient wait times than more obvious solutions, such as increasing acute hospital bed capacity.

More generally, the key message is that affordable and sustainable downstream capacity additions in patient pathways can be identified, which both alleviate upstream problems and reduce the effort for their management.

Operations Management (OM) and **Operations Research (OR)** methods proved to be effective in developing and evaluating strategies to adapt health systems to changing environment taking into account limited resources.

Background: Applications of OM and OR techniques

In [2] we report the results of a pluriannual collaboration with the Emergency Medical Service of Milano, Italy. The study shows that the Milano EMS provides a high level of performance, and yet it can benefit from the policy analytic techniques to improve the quality of the delivered service and to better exploit limited and expensive resources.

In [3] we evaluated the impact of optimized resource allocation along different phases of the surgical pathway for elective patients. The study shows how the effect of optimized allocation in one phase can be nullified by non optimized allocation in the subsequent phases due to inherent stochasticity of the operating times. This requires to introduce a real time management approach, that is the problem of supervising the surgery plan execution and, in case of delays, to take the more rational decision regarding the surgery cancellation or the overtime assignment, as reported in [4]. The numerical results show the capability to keep high levels of the operating room utilization (outputs) while reducing the number of cancellations and the patient access time (i.e., days to surgery) (outcomes).

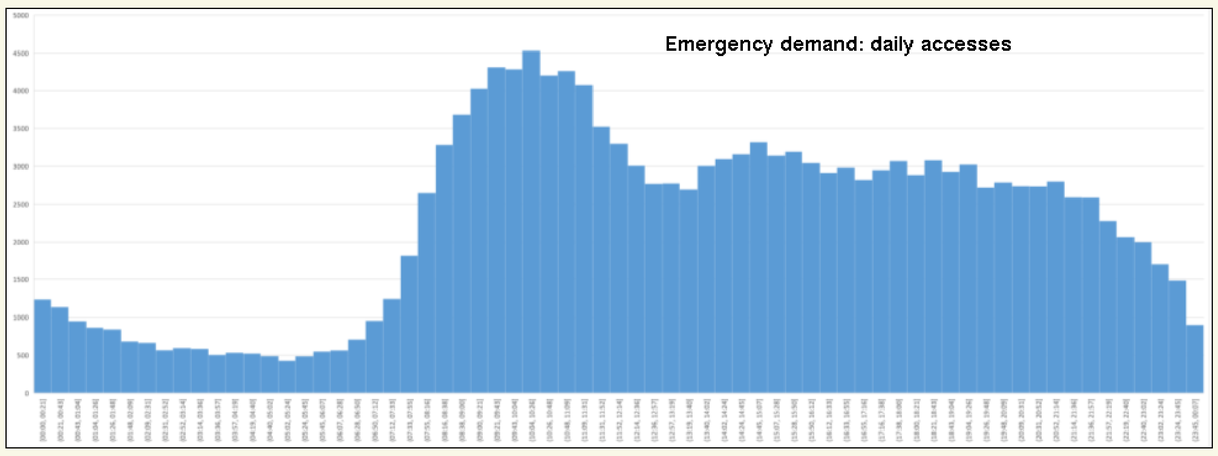
Big Data and Health Care Management

A defining characteristic of today's data-rich society is the collection, storage, processing and analysis of **immense amounts of data**. This characteristic is cross-sectoral and applies also to health care. **Big Data** is generated from an increasing plurality of sources and offers possibilities for new insights, for understanding human systems at the systemic level to develop personalized medicine, prevent diseases and support healthy life.

From the **Health Care Management perspective**, Big Data are a **key enabling technologies** to support detailed health system analysis. Exploiting big data, one can replicate the behaviour of a whole health system modelling how each single patient flows within her/his pathway. Such a possibility opens the road to many analysis at the health system level.

Case Study: Overcrowding

Large number of non-urgent patients: in 2013, the 90.53% of (total 1,768,800) of the accesses to the ED network of Piemonte are non-urgent.



Case Study: Simulation approach

Discrete Event Simulation to evaluate the impact of 5 clusters, which are:

- **Area of Turin**: the largest one, 20 EDs
- **Cuneo 1**: close to Liguria, 7 EDs
- **Cuneo 2**: close to area of Turin, 6 EDs
- **Valle di Lanzo**: 2 EDs
- **Alba and Bra**: 2 EDs

5 different scenarios obtained by varying the percentages of EMS patients (i.e., transported by EMS): from 7% to 27%. Currently ranges in $[13.3\%, 14.2\%]$.

Case Study: dynamic allocation policies for a regional network of emergency departments

At the regional level, the **Emergency Department (EDs)** system can be seen as a network of EDs cooperating to **maximize** the network outputs (number of patients served, average waiting time, ...) and **outcomes** in terms of the provided care quality.

Usually, an **Emergency Medical Service (EMS)** transports the patient to the **closest** ED that can handle the need of immediate care. Further, EMSs usually do (or can) not take into account the **ED workload** level when assigning and transporting a patient to an ED. More than the 85% of patients arrives at the ED **autonomously** (**no-EMS patients**).

Dynamic Allocation Policies (DAP): **EMS patients are allocated to the ED having the current minimum workload among those belonging to the closest cluster of EDs. Otherwise, the closest ED rule applies**.

Case Study: Preliminary Results

- **General improvement** of the waiting times of the EMS patients.
- **Larger improvements** for the EMS patients are obtained for larger clusters: from 35 to 51 minutes in Turin, which means a reduction ranging from 28.25% to 45.32%.
- As soon as the percentage of **the EMS patients are greater than 20%**, also the waiting times of **no-EMS patients improves** (up to 7.58% in Turin).

Conclusions

Health Care Big Data can enable the development of **accurate quantitative models** representing several health systems (**supply side**). On the other side, **Regional Health Systems** need tools for evaluating their performance (at large) in the light of planned re-organization (**demand side**). **It is worth noting the need of promoting the matching between the supply and the demand**.

Ongoing work: improving DAP forecasting the ED demand and the corresponding workload, which depend on the gravity of the forecasted patients.

References

[1] Wolstenholme E. A patient flow perspective of U.K. health services: Exploring the case for new "intermediate care" initiatives. System Dynamics Review, 15(3):253–271, 1999

[2] R. Aringhieri, G. Carello, and D. Morale. Supporting decision making to improve the performance of an italian Emergency Medical Service. Annals of Operations Research, 236(1):131-148, 2016.

[3] R. Aringhieri and D. Duma. The optimization of a surgical clinical pathway. In "Advances in Intelligent Systems and Computing", volume 402, pages 313-331. Springer, 2015. Invited Chapter.

[4] D. Duma and R. Aringhieri. An online optimization approach for the Real Time Management of operating rooms. Operations Research for Health Care, 7:40-51, 2015.

[5] R. Aringhieri, D. Dell'Anna, D. Duma. Big Data supporting Public Health policies: assignment policies for a regional network of emergency departments. ORAHS 2016 proceedings.

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