Big Data in healthcare: personalisation and early diagnosis, a new paradigm for medicine

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ABSTRACT

The integration of Big Data in healthcare systems today represents a fundamental lever for the transformation of the sector, making possible an increasingly predictive, preventive and...

The integration of Big Data into healthcare systems today represents a key lever for the transformation of the sector, enabling an increasingly predictive, preventive and personalised approach to health. The ability to collect, manage and analyse huge amounts of data from heterogeneous sources — such as genomics, imaging, wearable devices and clinical data — is already generating tangible changes in everyday medical practice.

The objective is twofold: firstly, to improve clinical outcomes for patients, and secondly, to optimise the operational processes of healthcare facilities. This is no longer a future perspective, but a reality that is being realised through pilot projects and large-scale implementations in Italy and Europe. In this article we analyse some specific applications, which testify how the advanced use of Big Data is redefining contemporary medicine.

Predictive analysis and personalised treatment in complex cancers

In the field of oncology, the integrated analysis of genomic, clinical and environmental data has enabled the construction of high-performance predictive models for highly biologically complex tumours. These models support the early identification of molecular features of the malignancy, allowing clinicians to target personalised therapies and increase the probability of a positive response to treatment.

The Big Data approach not only allows patients to be stratified more accurately, but also reduces the time to treatment, improving overall prognosis.

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Digitalisation and advanced pathological image analysis

The use of digital pathology platforms, combined with artificial intelligence algorithms, now enables the transformation of histological samples into high-resolution digital data. These systems, fed by increasingly large and complex data sets, are able to perform morphometric analysis and recognise pathological patterns with levels of accuracy comparable — and in some cases superior — to manual evaluation.

The effect is twofold: reporting times are drastically reduced and decision support is enabled for high-incidence pathologies, such as oncology, ensuring greater diagnostic standardisation.

Remote monitoring and proactive management of chronic patients

Through the integration of mobile applications and wearable devices, data on patients' physiological parameters are collected in real time and analysed by advanced data analytics platforms. Predictive models derived from these information streams enable early detection of signs of clinical deterioration, facilitating timely interventions.

The use of such solutions is particularly effective in the management of neurodegenerative diseases, where progression can be monitored in detail, personalising therapeutic and rehabilitation strategies.

Artificial intelligence applied to imaging

In mass screening contexts, artificial intelligence algorithms specifically trained on radiological datasets are able to improve diagnostic sensitivity and specificity, especially for high-prevalence cancers. These tools complement and amplify the skills of radiologists, detecting suspicious lesions early and helping to reduce missed diagnosis rates.

The most recent implementations show how automated image analysis can reduce false negatives and enable more efficient management of diagnostic pathways.

Interoperability and exploitation of health data at

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European level

The construction of interoperable health data spaces is a crucial step towards a more integrated and evidence-based European healthcare. The secure and regulated sharing of medical information enables the creation of a wealth of data that can be used not only for patient care, but also for clinical research and drug innovation.

Through these digital ecosystems, patient data follows the care pathway anywhere in Europe, ensuring continuity of care and fuelling future applications of artificial intelligence and predictive analytics.

Conclusions

The value of Big Data in healthcare lies in its ability to transform clinical complexity into operational knowledge, improving the quality of care and supporting the sustainability of healthcare systems. The concrete applications available today demonstrate how the integration of data, algorithms and clinical expertise is already revolutionising medicine, offering new perspectives on treatment and prevention. Looking ahead, the challenge will be to consolidate these models on a large scale, ensuring interoperability, security and ethical governance of data.

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