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DATA QUALITY AND BLOCKCHAIN TECHNOLOGY

Dear Editor, we recently read with great interest a paper published in your journal entitled "Big data and targeted machine learning in action to assist medical decision in the ICU" by *Pirracchio et al.* [1]. It is an extremely precise analysis of the most recent developments in the fields of big data, technology, and statistics. These innovations can lead to increasingly tailored health treatment; real-time processing of data might also allow their application in time-dependent medical specializations, such as in the case of perioperative medicine and intensive care.

On the basis of these technologies, innumerable amounts of data become essential, making data collection paramount, not only in the research or epidemiological context, but also in daily clinical practice; all of this means that the quality of data has to be "excellent". In addition, thanks to the rapidity of technological development and to the expansion of health system computerisation, these technologies need no longer be regarded as belonging to the distant future.

Yet, before entering routine practice, it is reasonable to think that they will have to collide with legislative and related administrative questions. A solid foundation based on high quality data might be the key factor that helps overcome these barriers, thus facilitating their introduction into everyday clinical practice.

In such a context, data properties of immutability and verifiability become a necessary requirement. We feel that the application of blockchain technology could offer numerous advantages.

Currently, the management of medical data is often organised by one or more centralised system, with hierarchical interaction, and the breakdown of a single link could lead to the failure of the whole system [2]. This new paradigm consists of a distributed ledger made up of blocks whose chaining mechanism is represented by an irreversible hash function [3] that identifies the block in a univocal way and allows its connection with the previous block. It uses decentralised technology, where nodes are linked in a peer-to-peer network crossed by a consensus algorithm; consequently,

hierarchical relationship is eliminated.

The immutability of data is another fundamental characteristic of this technology. An important role is played by the cryptographic hash at the base of the concatenation; it works by checking the integrity of the previous block [3]. It is not possible to modify a block, as this would lead to hash modification of in every successive block, thus provoking modification in all ledger [3].

Cryptography guarantees data-sharing security; only those with the proper key can proceed with decryption, thus preventing any malicious unauthorized access. Furthermore, transparency allows the traceability of each and every action that takes place throughout the network [4].

Moreover, being distributed technology, it does not have a single weak point. The bigger the network becomes, the more complex it will be; however, its expansion will lead to increasingly fewer possibilities of tampering.

In addition, privacy is guaranteed at a level that is probably unattainable when using other methods; transitions and access to data bound to multiple-signature contracts, which can be flexible over time, could, together with encryption, create health data management that is truly centred on the patient [5].

Monitoring has a central role, both in the intensive care unit and in the operating room. Various vital parameters and their traces are recorded continuously for hours, days, or even weeks in every patient. The administration of such a large amount of data is still an ongoing challenge, even for this new technology, which has difficulty in storing this quantity of information. We believe that, even in this context, blockchain technology could play a significant role. In addition to the previously described properties, following the model proposed by *Cichosz et al.*, its deployment might also allow the secure management and sharing of large files [5]. Indeed, parameter registrations could reside outside the blockchain itself, in encrypted data storage called “Data Lake”. Only those in possession of the correct decryption key would be granted [5].

However, this technology is not without potential problems. Numerous platforms exist, including *Bitcoin* and *Ethereum*. When selecting a data preservation system, *Li et al.* decided to choose *Ethereum* blockchain technology for three main reasons: shorter confirmation time, smaller blocks, and greater recording capacity [2]. However, the technical features of the *best platform* (*e.g.* level of access, authentication mechanism to insert a new block, etc.) should be evaluated according to specific needs, and at present there is no general consensus on this matter.

Another problem is related to patient consent, especially regarding privacy; underlying complexity could lead to difficulty in understanding the system, resulting in poor patient confidence.

Finally, security decentralisation could lead to more complex management. As pointed out by *Patel*, each node should carefully keep its key safe; a lost key might result in access being blocked, which might then require a complicated recovery path [3]. A similar situation might arise in the event of emergency and/or patient loss of consciousness, representing a further challenge for the real implementation of this technology. *Cichosz et al.* proposed the introduction of trusted parties, permitting the recovery of specific clinical data through a detailed procedure in the presence of emergency medical conditions [5].

In conclusion, in parallel with technological progress, data quality will inevitably become increasingly important. Blockchain technology might represent a valid choice to ensure adequate data quality, and permit secure data sharing. However, further investigation is required to verify the effective applicability of this type of technology in health systems.

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