trouver un équilibre financier lui permettant de couvrir ses coûts sans réaliser de bénéfice sur le transfert d'échantillons biologiques. Cette complexité est due au fait que les bioéchantillons ne sont pas des produits commerciaux, ce qui rend le chiffrage d'un coût plus difficile. De même, les indicateurs de performance classiques ne peuvent pas être utilisés. Il est donc nécessaire de définir des indicateurs spécifiques, tels que le rapport stockage/déstockage des échantillons, véritable marqueur de l'activité de la biobanque, ou encore la notoriété de la biobanque dans le paysage scientifique, qui peut être évaluée en analysant sa contribution aux publications scientifiques. La « biobankonomics » permet donc une étude globale des coûts, et facilite la gestion d'une biobanque par la modélisation d'outils de gestion. ◊

***Biobankonomics*: the sustainability indicators of biobanks**

LIENS D'INTÉRÊT

Les auteurs déclarent n'avoir aucun lien d'intérêt concernant les données publiées dans cet article.

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NOUVELLE

Étude du système de gestion de l'information (*biobank information management system*) pour les annotations clinico-biologiques des biobanques

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Une partie des étudiants de ce master n'écrivant pas en français, mais étant très intéressés par cette volonté de *médecine/sciences* de « donner la parole à nos jeunes pousses », se sont proposés pour effectuer le même travail que leurs homologues francophones de ce même master.
Exceptionnellement, *m/s* leur a donné l'occasion d'effectuer cet exercice en anglais, tout en leur souhaitant un bon apprentissage de notre langue auprès de leurs enseignants et de leurs collègues étudiants.

› The biobank information management system (BIMS) is an essential tool that gathers the data of a laboratory information management system (LIMS), commonly used in laboratories to track samples and all other informatics systems involving information related to patients and samples (e.g., electronic medical report, freezer temperature monitoring systems, etc.). Biologists and clinicians are increasing their efforts to unravel the biological pathways that underlie human diseases. The use of omics analyses (e.g., genomics, transcriptomics, proteomics) has generated extremely large data sets. The analysis and integration of these data, as well as the constitution of database platforms, represent an ongoing challenge. This article aims to introduce the construction of BIMS in relation to a biobank workflow, the multiple solutions that currently exist on the market, as well as its importance in public and private research.

Constructing a BIMS

A laboratory information management system (LIMS) is a software allowing the whole management of samples workflow,

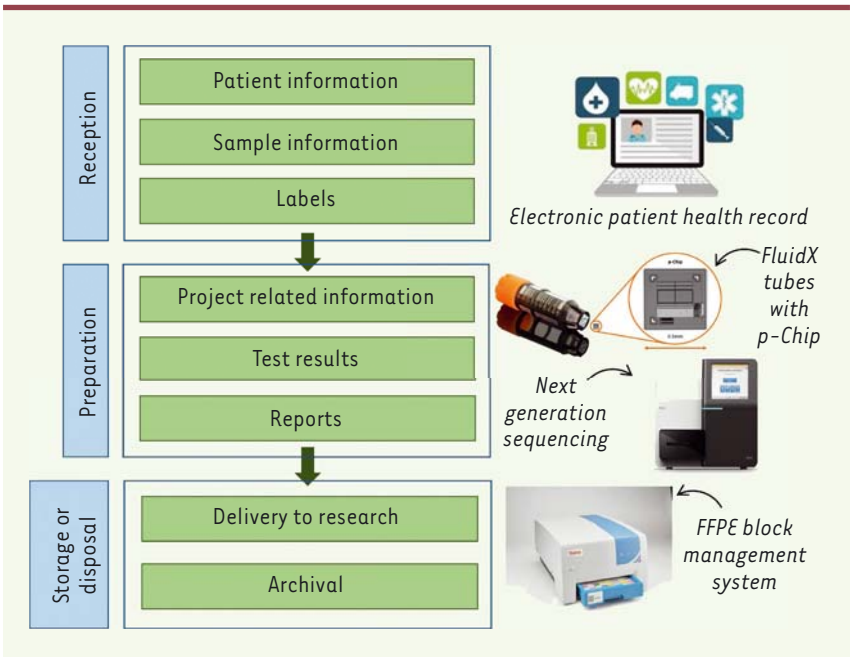

Figure 1. ***Representation of a typical biobanking data workflow with examples of associated technologies.*** In blue are the main steps related to sample flow, and in green the actions related to data. On the right are examples of devices that provide data about the sample. The biobank is keeping in its record information related to the samples for traceability, for example data delivered to research will remain in the biobank archives.

including their reception, preparation, storage and delivery (or the delivery of results of external tests performed on these samples) (*Figure 1*). This type of software facilitates the standardization of tests and procedures, and provides accurate controls of processes [1].

By contrast to a LIMS, a BIMS integrates different pieces of information concerning both sample characteristics and clinical data related to the patients (including informed consent), as shown on *Figure 2*. Hospital information systems (HIS) and clinical database (CDB), which are sources of clinical data concerning the patients, are governed by strict regulations especially regarding anonymity [2]. These databases are either accessible from hospital-owned servers within the biobank or connected to the BIMS through specific informatics languages [3] in accordance with European general data protection regulation 2016/679 [4] and as recommended by the Health Level 7 international standards for transfer of data between software applications.

BIMS can also incorporate information from monitoring systems (MS), such as the freezer temperature or liquid nitrogen level in tanks. The quality management system (QMS) is often saved on separated software. However, preparation procedures or documents related to corrective actions in case of non-conformity can be available through the BIMS. Finally, it can integrate interoperability with test instruments, such as sequencing machines, in order to suppress the step of manually adding data to the software.

As BIMS store sensitive and confidential data, they are usually localised in local area networks (LAN), a computer network that interconnects computers within a restricted area (e.g., hospital or enterprise). Nevertheless, researchers can search sample availability, from a virtual catalogue on the internet (wide area network), according to predefined criteria. This catalogue can also gather information from different sites of a multisite biobank, for example in the case of UK Biobank.

The use of BIMS can be varied ; thus, they are usually sold with a certain number of licenses, i.e. access accounts. As the information can come from different entities (hospital, external or internal laboratories, biobank) it is crucial that the biobank controls the access to its BIMS. Limited access can be created so that a specific member of staff can only enter a specific information. For example, hospital staff can add barcodes and time of sampling, the clinician can add patients' data, and biobanking staff can manage the sample workflow. All requests regarding the access and use of the BIMS should be discussed prior to the development of biobanks.

Biological or clinical information collected and stored on a BIMS are varied, and the data format heterogeneous. They are linked together through data models that need to be thoroughly studied in order to avoid mistakes in analysis. Data registered from various sources and gathered manually increase the time of entry and the risk of error, whereas BIMS allows automatic integration, thus reducing potential mistakes. Therefore, it leads to complexity in terms of software design and storage space. An efficient BIMS needs to be flexible enough to support from the smallest to the largest collection of samples, and to manage different stakeholders' accesses. Finally, the BIMS design has to take into account the permanent update of the stored data and the necessity for users to easily have access to these data.

The wide BIMS market

The growing market surrounding data management does not leave biobanking behind, as shown by the multiplication of BIMS solutions available. Companies[1] such as *LabVantage Solu-*

[1] La revue *médecine/sciences* (journal de l'Inserm) ne cite pas de noms de compagnies sauf cas très particulier où l'omission du nom nuit à la compréhension du texte. *médecine/sciences*, the journal of Inserm, does not refer to the name of private business companies, except when deleting the company name prevents the reader from a clear understanding of the manuscript.

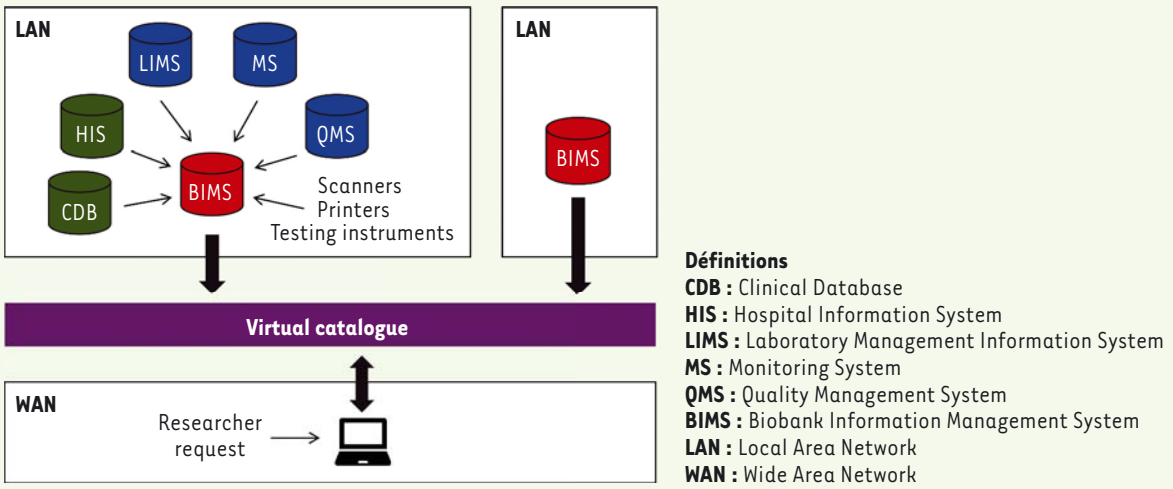

Figure 2. ***Representation of a BIMS.*** Various databases are integrated in the BIMS, to preserve the confidentiality of informations. The software is hosted in the LAN, a network that links computers within a restricted area. Information from the BIMS can be extracted and displayed in a virtual catalogue, available to researchers. This system allows multisite biobanks as the catalogue can be linked to more than one BIMS.

tions Inc., *Genohm*, *Brooks Life Sciences*, *Technidata*, *Modul-bio*, and *Thermo Fisher Scientific* all developed their own BIMS solution in adequacy with different customers' needs [5]. Variability exists in terms of possible interoperability, personalisation of modules, maintenance efficiency, etc. The cost includes software initial installation, maintenance and upgrade. It also depends on the number of sites, licenses and modules needed. Open source of made in-house software also exists and represents a cheaper alternative. However, this kind of approach requires an informatics competent staff that can modify the software source code.

The quality of a biobank service is assessed by both the number of valuable samples and the full chain of custody of these samples. Data quality is the core business of a biobank as samples have limited value in research without accurate and reliable data. Although a BIMS is not mandatory to obtain accreditation according to the biobank French norm NFS 96-900, it is a long-term investment that will facilitate the certification, the management of growing sample amount and the homogeneity of data.

This BIMS solution used to record laboratory and sample data in an electronic system thus helps to improve the robustness of quality systems and sustainability of biobanking structures.

How does a BIMS improve research?

BIMS is a highly recommended and valuable management system used by biobanks to improve and maintain the quality of research results.

Prior to clinical trials, clinical annotations such as phenotypic, genotypic, and environmental information gathered through BIMS can allow the determination of patient groups, e.g., analysis of patient's DNA sequences to determine different groups of patients in order to determine the right concentration of drug to treat each group [6]. Integration of the maximum of data related to the patient and the sample could help clinicians and researchers to discover new therapeutic targets, develop innovative strategies and drugs.

The data may originate from various research studies, small and large, where data formats and data collection methods vary significantly [6]. Managing data through BIMS provides a unique access, thus enhancing public availability of clinical and biological annotations (e.g., *UK biobank*).

Currently, hospitals produce a large amount of data incoming from daily care that is not exploited at the maximum capacity [7]. BIMS or data centres are a solution to gather data and use them for *in silico* studies, i.e., computer-based studies.

Big private pharmaceutical companies are interested in building their own biobank to support their medical research such as drug development or *in vitro* diagnostic tests [8].

Smaller companies can collaborate with public biobanks to have access to rare samples. Moreover, building a private collection is costly and not valuable if it only serves one purpose. Instead of building its own collection of formalin fixed paraffin embedded blocks, (FFPE blocks) from cancer patients, a pharmaceutical company can make a contract with a biobank to obtain slides and data from those patients. Thereby both stakeholders can share their expertise. During the different drug development stages, a lot of samples are required, processed and stored. A partnership with a biobank allows using their expertise in sample collection and already existing

storing facilities. Nevertheless, pharmaceutical companies aim to work with top quality biobanks, thus valorising quality, full data set, traceability, etc., all of which can be provided through BIMS.

Conclusion

BIMS softwares are complex to build and require knowledge and expertise in the fields of informatics and biobanking. Currently the main challenge is the lack of interoperability between existing LIMS and software used in healthcare. The future of medicine lies in the use of clinical annotations for *in silico* studies, i.e., studies performed using computer simulation. Creating a catalogue of massive data integrating online analysis will allow an easier access to shared data for all researchers. ◊

Practical use of biobank information management system (BIMS) for clinical-biological annotations in biobanks

LIENS D'INTÉRÊT

Les auteurs déclarent n'avoir aucun lien d'intérêt concernant les données publiées dans cet article.

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