

Automation in Pathology for patient safety

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The letter by Eccher et al. ¹ describes a very unusual near miss event: the possibility, due to a very trivial human error, to throw away a huge amount of precious human samples, which we have the duty to preserve and archive both for clinical and medico-legal reasons.

This gives us the opportunity to share some thoughts about automation and tracking in our discipline, and how these may be extremely relevant for patient safety.

Automation can involve two aspects of our workflow: the activities and the process. The *activities* are the different discrete phases where the samples are manipulated and/or transformed: accessioning, grossing, processing, embedding, microtome cutting, staining, scanning and archiving. *Tracking* is the ability of our laboratory information systems (LIS) to follow and document step-by-step the workflow from one activity to another. The *process* is the series of handlings and transferring of different materials, such as vials, containers, biocassettes, tissue blocks, slides, which are continuously transferred from one technician to another, from one instrument to another and from one area to another in our laboratories. It is our opinion that a complete level of automation of the whole process should be the evolution of our workflow, defining the desirable goal for the organization of a modern surgical pathology laboratory.

Automation of the activities in the pathology laboratories has received increasing attention from industry and most of them have already been, at least partially, automated ². The first automation started in tissue processing in the first half of the 20th century, with the introduction of machines able to dehydrate and infiltrate with paraffin the tissue samples. However, in other activities, beside embedding, slide staining and mounting, automation is still in evolution and some special activity will probably remain in the realm of human skills, like grossing, embedding of special and delicate cases, or microtome cutting of very small and unique samples.

Automation of the complete process in the pathology lab from accessioning, transferring of the materials to different instruments until the definitive storage of the materials, has received much less attention from the industry, at variance with the clinical pathology laboratories where almost all analyzers are physically connected through an automated chain which moves the vials from the accessioning lab to all analyzers up to their final storage. By comparing the clinical pathology workflow with the surgical pathology workflow, the automated analyzers are the counterpart of the surgical pathology activities now based on instruments and human labor. No automated chains are available in surgical pathology laboratories, where the process is done by the technicians with the help

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of the LIS allowing tracing and tracking with very limited automation support. Recently, some pilot institutions have begun to adopt solutions for integrated automation and traceability of the process, introducing a LIS-integrated automated transport system which automatically moves the tissue blocks from the inclusion platforms to the microtome workstations and finally to the archival station. Other producers have developed robotic devices able to transfer material from one instrument to the subsequent one.

We envision that in the future all aspects of the process should be automated: transferring of tissue samples from accessioning laboratory to the grossing stations, transport of biocassettes to tissue processors and from tissue processors to inclusion workstations, transport of the paraffin embedded tissue block to the microtome workstations and subsequently of the slides to the automated stainers; following the automatically mounted slides could be automatically loaded in a scanner to obtain corresponding digital slides, which will be dispatched to the pathologists; finally the slides and the tissue blocks could be automatically archived. In this workflow, the human activities will be mainly restricted to grossing. Even the complete process of microtome sectioning, which may seem too complex requiring high degree of technical skills, may be completely automated: some new instruments, loaded with for batches of paraffin blocks, are able to automatically produce histological sections ready to be stained, promising high levels of reproducibility and safety.

The ideal goal of future pathology laboratories should be the complete automation of the activities and the

process, with a LIS governing individual processing steps and the transfer of the materials from the beginning to the end of the process until the final storage of processed products (slides and paraffin blocks).

In an ideal world, the LIS will be able to support and coordinate not only all aspects of the laboratory process, but, with the integration with AI algorithms, may also optimize the diagnostic reporting workflow, increasing pathologists productivity and patient safety, dispatching cases to the appropriate pathologist and integrating computer assisted diagnostic systems.

Total laboratory automation (TLA) in surgical pathology is a goal toward which we hope our discipline will evolve in the future, and we hope that industry will increasingly support us. Naturally TLA is not without its problems and limitations, as also suggested for the Clinical pathology laboratories³. However in a completely automated and traced environment, a potentially catastrophic error such as the one described by Eccher et. al.¹ would never have happened.

References

- ¹ Eccher A, Fabbri VP, L'Imperio V, et al. Pathology Laboratory Archive at the University and Hospital Trust of Modena / UNIMORE: "Disaster Recovery" frame by frame. *Pathologica* 2025;117:52-54. <https://doi.org/10.32074/1591-951X-1116>
- ² Munari E, Scarpa A, Cima L, et al. Cutting-edge technology and automation in the pathology laboratory. *Virchows Arch.* 2024 Apr;484(4):555-566. <https://doi.org/10.1007/s00428-023-03637-z>. Epub 2023 Nov 6. PMID: 37930477; PMCID: PMC11062949.
- ³ Lippi G, Da Rin G. Advantages and limitations of total laboratory automation: a personal overview. *Clin Chem Lab Med.* 2019 May 27;57(6):802-811. <https://doi.org/10.1515/cclm-2018-1323>. PMID: 30710480.