

## Robotics and Automation in Transfusion Medicine

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By now humankind has passed through four different levels of industrial revolution which were based on increased levels of automation, exploitation of new natural resources and advances in electronics with expanded use of computers with increasing capabilities [1,2]. Robotics innovation as well as digitalisation support the broad development and application of artificial intelligence in complex fields including medical science [3].

In transfusion medicine automation started some decades ago in the clinical/ hematology laboratory with instruments with increasing levels of mechanical and optical sophistication supported by software allowing for improved electronic workflow management, data analysis, transfer and storage. Laboratory Information Systems (LIS) or Blood Bank Information Systems (BBIS) ideally manages the flow of electronic information from the instruments through electronic interface compatibility [4, 5].

Modern molecular techniques like the polymerase chain reaction, once a very laborious multi-step technology, is now available at full automated level and allows for detection of multiple pathogens in a single specimen, while its use has expanded to immunohematology with the aim to better identify donor/recipients pairs as well as in the detection of hematological malignancies [6]. Next generation sequencing technologies in blood group typing have achieved high grades of automation, reducing processing time, increasing number of investigating samples per operator and decreasing variability between samples [7,8].

Currently we see in the field of blood processing an increased level of automation targeted at reducing strenuous repetitive steps, streamlining tasks, increasing productivity, reducing waste and human errors [9]. Automation leads to improved consistence of output, which means better standardised blood components [9,10]. The software supportive of this technology not only allows for improved documentation and compliance with regulatory

standards, but increases traceability of source i.e. blood donor to final blood components. Besides that, cloud computing enables remote assistance aiming to increase efficiency, decrease costs and avoid unnecessary human reallocation times of restrictive resource utilisation to reverse climate change. Labor resources freed up through the automation of blood processing may be redirected to new developments in the medical field of blood, tissues and organ collection and transplantation, including the very exciting field of cellular therapy.

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