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COMMENTARY

Artificial intelligence: Training the trainer

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Including artificial intelligence in haematological education is compulsory but should not be limited to students. Experienced haematologist and decision-makers in the clinical environment have at least similar needs. This is because of the tremendous potential, opportunities and benefits the timely inclusion of artificial intelligence offers in diagnosis, prediction and personalised therapy.

Commentary on: Chai et al. Integrating artificial intelligence into haematology training and practice: opportunities, threats and proposed solutions. Br J Hematol 2022;198:807–811.

In their paper, Chai *et al.*[1] (i) stress the necessity to include artificial intelligence into medical education and (ii) show the potential of artificial intelligence for haematological practice. This is very timely and should be supported full scope. However, both points deserve additional comments.

The inclusion of machine-learning concepts and artificial intelligence (AI) into medical education is not just the integration of additional knowledge such as, for example, new molecular pathways that explain the genesis of a disease and provide new treatment strategies. It is much more than that, it is a disruptive technology that enables so far impossible opportunities. To illustrate this point, I would like to remind the older among us the time when we had no computers in our lives and for the younger ones, yes, there was a time without computers. When computers became consumer products in the 1980s it required efforts (education) in all age groups to make them the useful tools that they are now. In contrast, nowadays, youngsters grow up with mobile devices and the use of a computer needs (almost) no additional education.

Now, the situation is similar with AI: we do need educational efforts, but not just for the next generation of physicians in general and haematologists in particular, but in all age and career levels, because it is now that AI tools need to be integrated in routine procedures. Therefore, decision-makers in the clinical environment need the education most, also because artificial neural networks (ANN) need to be trained by experts (training the trainer!). Although I have to admit that ANN are increasingly designed as self-learning networks, they still require human validation, which just shifts the task a little bit. To address the established haematologists that are in leading positions, I hope the current discussion in the *British Journal of Haematology*[1–3] will contribute.

Young people now grow up with AI (from web search machines to autonomous driving) but need an adaptive education over the coming years. There is no doubt that AI is required to be part of medical education also in future. A basic understanding and knowledge of the limitations and dangers are just a few aspects medical use of AI requires. In this context the article by Chai *et al.*[1] is an enrichment.

By the way, the 1980s, when computers became available to a wider public, was quite some time after the first digital computers were built in the 1940s. The situation is similar with AI in haematology: The first applications were designed and tested in the 1990s[4,5] but now is the time when the required calculation power becomes affordable and hence AI applications widely available.[6]

When it comes to the integration of AI in haematological practice, Chai *et al.*[1] provide a number of nice and relevant examples. Since it is a rather loose collection of methods and applications, I would like to emphasise the ground-breaking aspects. (a) The integration of big data and all kinds of different data entities provides unreached opportunities in diagnosis, prediction and personalised therapy. This data composition does not need to be causally understood but will be, as often in medical practice, just

evidence-based. (b) Interregional interconnection and the increase in cloud-based data processing have the potential for a rapid and continuous refinement of ANN over time. This means that with every use of the ANN they become a bit better and the worldwide connection of (haematological) expert centres will also improve the diagnosis and treatment of rare and very rare diseases considerably. (c) AI will enable new technologies to be used in haematological practice. Just an example: Blood films are a useful tool and a gold standard in numerous diagnostic procedures. However, can dried/dead cells be representative of living cells in the blood flow? For a number of settings this is indeed the case and justifies the success of blood film investigations. But the question illustrates the so far unused potential in analysing blood cells, for example, in microfluidic flow,[7] for which AI is compulsory. Similar technological boosts may come from microvesicle analysis in blood,[8] haematological omics investigations[9] or electrophysiological measurements.[10] In addition to AI, these methods also rely on automated data acquisition.

In summary, AI is now readily available for numerous applications but the integration into clinical haematology is at best still in its infancy. The technological implementation remains a challenge but is not the limiting factor, which is the willingness to incorporate AI in haematological judgements. Like most novel technologies, AI also frightens both physicians and patients as outlined by Chai *et al*.[1] However, the potential, the opportunities and benefits are so enormous, they require and deserve educational efforts on all levels. Let us train the trainer!

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