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Article

Translational Education

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Abstract
The issue of translational education of healthcare professionals is a major one. It is clear that a great degree of upskilling is already required and, to keep pace with the science, this must be ongoing. Stakeholders need to achieve this together – with agreed-on standards across the board so that no patient is denied a suitable, virtually tailor-made treatment due to a lack of knowledge or understanding on behalf of the healthcare professional treating and diagnosing him or her. A key partner in tackling this is the healthcare community, and one way to achieve the goal is through increased EU-wide investment in translational education and training of healthcare professionals.

Background

Strong commitment to translational research over the last 10 years has led to many of the personalised medicine innovations being introduced today. We have seen the European Medicines Agency (EMA) approvals of drugs requiring a companion diagnostic vary between zero and two per year from 1998 until 2010, and then expand to 10 or more per year on average since 2013 [1]. Moreover, legislation supporting orphan indications in both Europe and the USA has led to a sharp increase in the number of medicines treating orphan indica-

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tions. According to the 2016 EMA annual report on the use of orphan medicinal products, over 1,805 orphan designations have been issued by the European Commission since 2000. At the time of the 2016 publication, 128 had resulted in authorised medicinal products [2].

While these innovations are being introduced into the market, they are not getting to patients fast enough, if at all. Many of these innovations are supported by robust evidence published in top-tiered journals and presented at major congresses, but information on the application of these innovations is not getting disseminated fast enough, in the right context, nor to the right audiences. Actionable information needs to be delivered just in time at the point of care as "one-size-fits-all" approaches are becoming obsolete.

Many of the required solutions exist today, and it is imperative that these best practices are identified and implemented broadly.

Role of the EU in Continuing Medical Education

The question arises about the role that the EU can play in the ongoing education of healthcare professionals. While healthcare is a Member State competence, it seems that no single country can "go it alone" in this regard. Medical science is moving too quickly and, while ongoing translational education has to be Member State driven, by definition the EU needs to step up its role as a facilitator.

The involvement of universities, societies and research houses will be key, across all of Europe.

What is abundantly clear is that the way in which healthcare is delivered to the patient is changing and changing fast. Advances in personalised medicine will and must fundamentally alter the scope, content and manner in which healthcare professionals are trained and educated.

To move forward in any significant manner, the education of healthcare professionals in personalised medicine must be placed on the policy and political agenda as a priority and matter of urgency.

If this fails to occur, the result will be a scarcity of the healthcare professional capital needed to support the implementation of personalised medicine. The subsequent lack of knowledge and skills will bring about delays in its delivery, to the detriment of patients across Europe.

All healthcare professionals in close contact with patients or their families need to possess a solid knowledge of the current aspects of personalised medicine and its latest breakthroughs, in order to better understand patients' concerns.

These professionals are being asked to move beyond traditional reactive medicine towards proactive healthcare management, employing screening, early treatment, and prevention, and to classify and treat diseases in a new way, interpreting information from across sources that blur the traditional boundaries of individual specialties.

Education as a Barrier to Personalised Medicine Adoption

One stakeholder survey sponsored by PerMed and the European Alliance of Personalised Medicine flagged up that a lack of training and knowledge is one of the biggest barriers blocking the full integration of personalised medicine today. It is, therefore, vital to develop training for professionals whose disciplines are essential to the successful development of personalised medicine. This is in order to promote the shared understanding and collaborative development of necessary tools [3].

To this end, universities, employers, professional organisations, certification entities, regulatory agencies, patient groups and others will have to be involved in effecting the necessary changes.

Specifically, going forward, location- or cell-based diseases will become further stratified and replaced by disease entities that derive their identity from their molecular makeup, exponentially increasing their number in the process.

To prevent or diagnose these diseases, genetic testing and imaging will become more sophisticated and widespread. "-Omics" technologies, defined as testing of multiple genes together ("targeted sequencing") will certainly gain ground. And big data (and big bandwidth and big computing power) will enable real-time diagnosis by genotyping against large databases all around the globe.

Personalised treatment of diseases will entail tailored (combinations of) drug prescription through pharmacogenomics, minimising adverse reactions and decreasing the pool of patients who are predisposed to not respond to certain treatment.

Yet, none of the advances in personalised medicine will benefit patients if they are not applied or explained correctly. Healthcare professionals – including general practitioners, medical specialists, lab technicians, biostatisticians, and specialised nurses – must be aware of these fundamental and rapid changes in patient care. They must know what they must know to incorporate these benefits into daily practice and care.

Of course, this is different for different professionals and may very likely cause a shift in the mix of skills and competences that are required for the proper execution of one's job.

Some lab technicians, for example, will need a thorough training in novel diagnostic approaches, while other medical specialists, for instance, must know what tests are available, understand when a patient is eligible for a test, and be able to interpret the data.

At the same time, healthcare professionals must be capable of navigating the ethical, legal and social issues that, for instance, surround the use of genetic testing.

In addition, they must be able to adapt the way in which they attain knowledge and skills to accommodate the rapid advancement in science, which, in turn, impacts exponentially on the availability of diagnostic tools and tests, treatment options, patient care and quality of life.

Patients will miss out on the benefit of this valuable knowledge if professionals do not have the skills to identify, translate and utilise this knowledge to diagnose and treat their patients. The EU must act to ensure that this occurs.

Expanding the Knowledge of Healthcare Professionals

As medical innovation is advancing rapidly, so is the advancement of other technologies which can enable new solutions that can help close the knowledge gap related to personalised medicine. These approaches that translate education will complement current clinical practice by

- providing innovative ways for clinicians to gain experience,
- leveraging multidisciplinary team decision-making for better patient care, and
- utilising advanced analytics tools, such as machine learning to enhance clinical decision-making.

Experiential Learning in Medicine

An educational priority should be providing clinicians with experience in a simulated environment or with real-time coaching to allow them to progress along the experience learning curve more quickly. It has been well established that, across many medical disci-

plines, increased experience and specialisation lead to better outcomes and fewer medical errors. Some solutions that could be implemented to ensure that healthcare providers have an optimal level of experience include knowledge-based referrals, virtual reality and telemedicine.

Surgical practice is the specialty where the correlation of a physician's experience with improved outcomes is most pronounced.

In a recent systematic review conducted by Maruthappu et al. [4] that included 1,061,913 cases and 35 procedure types, performed by 17,912 surgeons, that increased case volume was associated with significantly improved health outcomes. While improvements in medicine can be made by better matching patients with those specialist physicians who are best suited for managing a disorder or disease, a referral-based approach is not always feasible, as most healthcare systems rely on generalists to deliver most healthcare services. However, it is important for physicians to be aware of their own capabilities and to refer to experts when their experience is insufficient.

Over the last decade, virtual reality has been a high-potential solution to address this experience gap that has the potential to be more accessible than cadavers and animal models. Although early experiences with these technologies did not meet expectations, technological advances are increasing the utility of virtual reality.

In 2016, the Royal College of Surgeons in Ireland (RCSI) developed the world's first virtual reality medical training simulator that is publically available. The RCSI VR Medical Training Sim app based on the Oculus Virtual Reality platform (Samsung Gear VR; Samsung Electronics Co., Ltd.) simulates working in a trauma centre and requires that clinicians make rapid decisions and perform life-saving operative procedures as a surgeon as they would in a real-world setting [5].

While the application of virtual reality to improve technical skills is an obvious application, greater potential may exist in non-technical settings. For example, virtual reality may have application in helping psychiatrists diagnose schizophrenia and differentiating it from other psychiatric disorders.

Another opportunity to supplement physicians' lack of experience is to utilise telemedicine to provide virtual coaching, ideally by highly experienced clinicians. This approach could expand the knowledge of clinicians and allow them to effectively manage conditions with low incidence rates. Both virtual reality and telemedicine have the potential to accelerate the time it takes new scientific knowledge to be translated from bench to bedside.

The application of these approaches across medicine has the potential to improve care. This is true whether it is a radiologist requesting a second opinion when reading a digital breast tomosynthesis, a paediatrician leveraging a telemedicine platform to connect a patient with an allergist to select a more targeted food allergen panel, or a rheumatologist using a virtual reality platform to simulate the selection of lab tests and discuss results with a rheumatoid arthritis patient. The implementation of these solutions could raise the level of experience of physicians, which could lead to better outcomes [6–9].

Multidisciplinary Team Education

Multidisciplinary team meetings provide another opportunity to rapidly translate innovation into clinical practice. Tumour boards, which are multidisciplinary team meetings where all cases are standardly reviewed, have become commonplace across oncology. There is emerging evidence that these approaches lead to better outcomes [10, 11].

In some countries, such as Belgium, France, and the Netherlands, these meetings are mandatory [12]. Having multiple perspectives combined with a breadth of knowledge supporting treatment decisions is likely to provide the best option for patients.

Therefore, as new disciplines play an increasingly important role in medical decisions, rather than expecting each clinician to know everything about the new area, it is best to supplement the current team with a specialist from that discipline. Following this approach has dual benefit in that the required knowledge is immediately integrated into clinical practice while educating the broader team about the emerging discipline.

An example which relates strongly to personalised medicine is the growing importance of genetics in the development of new treatments as these therapies are more likely to succeed with a genetically defined indication [13]. Including a geneticist or genetic counsellor in the multidisciplinary team meeting may be the best way to build this capability, rather than train general practitioners on the intricacies of genetics.

Also, as more patients are suffering from multiple chronic diseases, the coordination of care for these patients requires a multidisciplinary approach.

For example, the treatment plan for a patient with chronic migraine, diabetes, and depressive disorder is probably best designed by a general practitioner, neurologist, endocrinologist, and psychiatrist. Besides bringing the right expertise to individual cases, relying on multidisciplinary team meetings provides a platform for addressing healthcare system issues around the delivery of care.

As personalised treatment becomes more commonplace, the complexity of treatment approaches, including combination therapies and molecular testing, will require that a multidisciplinary team manage patients. Besides better patient care, a second benefit of the team approach will be that the discussion of these cases will broaden the knowledge of the full team.

Clinical Decision Support Systems

Clinicians navigating through the care of complex patients could benefit from advanced analytic techniques such as machine learning to supplement their own knowledge.

One of the biggest opportunities is to use these technologies for the diagnosis of disease. For example, many cases of ovarian cancer are diagnosed late because these patients present with symptoms such as back pain, fatigue, abdominal pain/bloating, constipation, and urinary symptoms which are not distinguishable from other ailments [14]. Having a decision support system based on common symptoms would flag clinicians on possible diagnoses.

These systems should not be designed to replace clinicians but should aid them like a conscientious tutor.

Developing these decision support systems needs to be validated in clinical trials to demonstrate superiority over standard-of-care decisions. One example was the ERNIE 2 study, which used a decision tree to identify paediatric patients at risk of a serious infection requiring hospitalisation.

The study concluded that "[t]he decision tree consisting of a gut feeling, dyspnea, temperature >40 °C and diarrhea is able to safely exclude serious infection that warrants hospital admission."

However, this tool falsely identified many acutely ill children as potentially at risk of a serious infection, and while these results are not ideal, physicians can manage the need for additional testing [15].

Decision trees and nomograms are simple examples of analytic tools that supplement the knowledge of physicians. Advanced solutions using machine learning and algorithms that integrate electronic health records and laboratory tests could transform medicine.

Some examples of these prediction tools in development include those to predict the neutropenia risk for cancer patients and ones that predict exacerbations in asthma patients [16, 17]. As these tools become more commonplace in clinical practice, continuing medical education is likely to shift its focus to building other physician capabilities relating to these new tools. The shortcomings of these systems due to insufficient data or high false positive rates could be a new challenge that physicians face. A priority for physicians will be to become more proficient in facilitating decision-making and behaviour change based on risk and probability-based information [18].

Summary

Evidence generated from personalised medicine studies that analyse target patient groups will require a transformation of medical education to enable physicians to integrate these discoveries into clinical practice. The era of the all-knowing physician will diminish and the new period of medical education will be defined by simulated physician experience, multidisciplinary team management, and machine learning/cognitive computing decision support tools.

Current medical education practices will move away from knowledge-based didactic conferences and medical journals to a system that is more skills based and focused on real-time, experience-driven education.

Physicians and other healthcare professionals will select educational programmes and formats that best address their needs in this rapidly changing healthcare environment of evidence-based medicine and shared decision-making.

Fortunately, novel educational approaches are already being implemented that could be used as exemplars for broad adoption of these approaches.

As a political "ask" in this instance, the writers of this document believe that the EU should work with all relevant professional organisations, as well as universities across Europe, to address the educational deficit in the case of healthcare professionals.

It may well be possible to achieve this through grants from, for example, the European Regional Development Fund and the European Solidarity Fund.

The key issue is coordination, because without such coordination there is a risk that the integration of the fast-moving science currently being developed will be under-utilised, leaving patients suffering unnecessarily.

The upshot of such a scenario will increase the load on an already over-burdened society in respect to healthcare, and lead to a lower quality of life for patients.

There exists a clear willingness from stakeholders to achieve the necessary goals, but it cannot be stressed enough that a more institutional EU framework and a political will are essential to allow the entire educational programme to be structured in a way that will benefit the EU's 500 million potential patients across the 28 Member States.

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