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EDITORIAL

The future of paediatric surgery: What the next few years hold for us☆

El futuro de la cirugía pediátrica: qué nos deparán los próximos años

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I was honoured to be invited by the Spanish Association of Paediatrics to write this editorial. I accept the challenge in homage to the surgeons who preceded me and marked out a path, to my mentors who taught me the art of paediatric surgery, to those who have worked with me during my 37 years' professional practice and also to the younger colleagues who have stimulated me and taught me so much.

To discuss the future of paediatric surgery or discern the changes that will take place is an exceedingly fraught exercise. We only have to go back 50 years in this profession to realise how extraordinarily challenging the task may be. Take, for instance, a date such as 1965, the year the Hospital Infantil ''La Paz'' opened and a period in which transplants, laparoscopy, ultrasound, foetal surgery, ECMO, congenital heart defect surgery, prenatal diagnosis, and so on, were completely unheard of. It was around that time that the first attempts at liver transplantation in the world were being performed in Denver by Dr Starzl. This is perhaps one of the few changes that could have been foreseen; as for the others, probably just a few ideas would have been suggested. I do not have a crystal ball, but on the basis of the experience I have accumulated in my work as a surgeon I can share some thoughts on possible winds of change that might be introduced in the field of paediatric surgery in the next few years. In many of these my role will be limited to that of an observer.

Many new developments lie ahead in paediatric surgery, but I am going to concentrate on three basic factors which will be largely responsible for these events: technological changes, innovation by professionals, and new instruments in clinical training. Many of these changes will depend on the decisions we make now, and these decisions will affect clinical practice for the next 20 years.

Molecular research at the protein level, organ transplants and the field of imaging will be responsible for clinical development. The annotation of the human genome is now practically complete and by the end of the last century (17 years ago) the complete sequence and genetic map of chromosome 22 had already been determined. Our approach to the treatment and prevention of many diseases will depend on knowledge of the structure and function of each gene. We know that there are 27 disorders associated with genetic abnormalities on chromosome 22, including abnormalities in foetal developmental, DiGeorge syndrome, spinocerebellar ataxia and chronic myeloid leukaemia. Tumours, together with accidents, are the main causes of mortality in childhood. The high number of cancer patients makes their treatment one of the priorities of scientific research. Gene therapy offers new hope in the field of oncology. It is already well known that carbohydrate chains are directly related to tumour growth, which can be reduced, for example, by knocking out the *MGAT5* gene with gene therapy.

As knowledge of the genome progresses, therapeutic strategies will be modified. Mutations in mitochondrial DNA from saliva cells have already been detected in patients with certain types of tumours. This will enable us to develop preventive strategies in the field of oncology, using exclusively non-invasive techniques.

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An important issue in cancer treatment is the administration of targeted drugs that will enable us to reduce the toxicity of chemotherapy. The use of nanorobots has become an innovative field of engineering, with the object of placing sensors in critical positions in tumours. Biosensors, using nanowires, can detect tiny chemical changes that will serve as targets for detection of early-stage metastasis. Nanorobots could also help surgeons to achieve more efficient and precise resectioning of tumours. Specific tumour-binding ligands are conjugated to nanoparticles that can then label cancerous cells, making the surgeon's task easier. These quantum dots, which are nanocrystals that emit fluorescence through electron stimulation, can be easily identified for extirpation. These intelligent robots can navigate through the human body, identify tumour cells, transmit signals for the surgeon or make it possible to administer a specific drug to eliminate the tumour.

The development of transplants in recent years has been spectacular, and the progress achieved at the Hospital Infantil ''La Paz'' in Madrid will serve as an example. The first paediatric kidney transplant there was performed in 1985 (Dr E. Jaureguizar and colleagues), the first liver transplant in 1986 (Dr J. A. Cienfuegos and colleagues), the first living-donor liver transplant in 1993 (Dr J. Vázquez and colleagues), the first heart transplant in 1995 (J. Cabo and colleagues), the first intestinal transplant in 1999 (Dr López Santamaría and colleagues), the first multivisceral transplant in 2001 (Dr López Santamaría and colleagues) and the first lung transplant in 2013 (Dr A. Varela and colleagues). I could scarcely have imagined thirty years ago that I would participate in and observe over 1000 solid organ transplants performed at my hospital.

Although very high graft survival rates are achieved with technical experience, the histocompatibility complex constitutes the main barrier to immune tolerance of transplanted organs. The numerous genes implicated in this complex are located on the short arm of chromosome 6. Genetic immunomodulation may be a crucial step towards achieving tolerance of transplanted organs. More rigorous knowledge of the 100,000 genes human beings possess will determine preventive and curative strategies. We are now in a more personalised phase of medicine, with treatments tailored to the individual patient, and the biological revolution is going to be more spectacular than the technological one.

Twenty-first-century hospitals are making major changes to adapt to the new era and be able to respond to different social needs, and they will continue to do so. Paediatric care in the next 20 years will bear little relation to how it was at the end of the twentieth century. Paediatric hospitals will have to change their structures and also their organisational models.

An area that is constantly developing and expanding is imaging. Surgical operations will depend on more precise knowledge in this field. Images are already used through endoscopic cameras and three-dimensional endocavitary ultrasonography, and operating theatres will shortly install open magnetic resonance systems. The development of 3D printing models with the aid of imaging will enable surgeons to familiarise themselves with corrective surgical techniques. Virtual surgical exploration simulated in models designed using imaging and 3D printing will make it possible to practise and guide surgical gestures on a personalised basis, preventing unexpected microlesions. The use of remote-controlled nanorobots will also allow operations to be performed in mobile theatres. In a study carried out at Guy's Hospital in London the success of simulated surgery using traditional methods was compared with that of remote operations. The use of nanorobots was clearly more successful for targeting and resolving renal calculi.[1,2]

Robot-assisted surgery can be seen as the surgery of the future that is almost here already. This type of surgery is a confluence of imaging technology, surgical procedure and use of robotic instruments. It is now 15 years since the famous ''Lindbergh operation'' was performed, consisting of a cholecystectomy operation carried out by surgeons in New York on a patient who was in Strasbourg. Robotic surgery is a major developing area in minimally invasive surgery. Instruments of this kind allow greater precision, notably reduce the number of complications (haemorrhages, accidental sectioning of nerve branches, etc.) and can even be used remotely. It is a very attractive type of surgery, but currently very expensive and difficult to introduce in health care systems with severely limited budgets.[3]

Most advances will come from innovation associated with curiosity, in its various forms. It is curiosity that makes surgeons ask questions and consequently develop creative strategies that produce innovative results. There is really no consensus in the surgical community on distinguishing between innovation and research, and this is probably due to the fact that they are closely related. For example, curiosity about the use of laparoscopic access, following its appearance, rapidly led to application in many fields: thoracoscopy, laparoscopy, robotic telesurgery, laparoscopy by natural orifices, etc. The laparoscopic revolution has been a clear example of innovation used by one person, popularised through scientific networks and disseminated to the surgical community worldwide. Unfortunately it is usually only in countries with a high level of investment in health care research that innovations in surgery are developed, although other countries clearly benefit from such contributions.[4]

Simulation-based medical education (SBME) is a new area of medical training that is growing rapidly around the world. A large part of the reason for its success is the fact that high-fidelity medical simulation is a powerful tool that makes it possible to improve the safety and quality of patient care. Moreover, both health care professionals and patients are in favour of optimum use being made of simulation before putting patients at risk by using them as a ''training platform''.

It is now possible to achieve high-fidelity simulation of any medical scenario or medical/surgical procedure. Simulation-based medical education offers medical specialists, residents, nurses and students the opportunity to learn and train, independently or in teams, in unusual scenarios. Professionals and students also have an opportunity to observe and assess their response to stressful situations and to correct it in subsequent simulations, all without posing a threat to patients. In addition, students' experiences of stimulation lead them to reflect thoroughly on the physiology and physiopathology of the process, helping them to understand and assimilate concepts to which they only have access in the theoretical sphere.

Simulation-based medical education enables the teacher to assess the student's response to situations that require them to put into practice their theoretical knowledge, integration of clinical information, technical skills, relationship with the patient and ability to respond in stressful clinical situations. It is also an excellent tool for certifying the knowledge and skills of students, residents and specialists.

In the training of surgeons, practice and experience determine the quality of the results. We know now that the volume of surgical practice is not the most decisive factor, although it plays an essential role. New educational models are supplemented outside the operating theatre in clinical simulation areas or centres. Supervised practice achieves better results and allows not only for working on technical skills but also for training in non-technical skills. The practice surgeons obtain faced with simulated critical events is a tool with great potential to promote the development of leadership, teamwork, two-way communication and proper use of resources. These new educational tools seek to protect patients and achieve greater efficiency in the use of surgical techniques.

There are many challenges still to come. In this editorial I have discussed only a tiny part of what probably lies ahead. What does seem clear is that the future will be written by young surgeons, those that are currently starting to study Medicine or even that have not yet begun. It is the curiosity of these young people, the questions they ask themselves, the challenges they set themselves and their interest in innovating to improve quality for patients that will produce the new winds of change in the future.

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