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## Letter to the Editor

### The physician of the future and the future of physicians



The advent of laparoscopic surgery in 1990 established a new dimension for the future of surgery, one in which the physicians' outlook on medicine as a profession had to shift and adapt to an uncharted journey. The fluctuations of that era were not disruptive, because the transition to a minimally invasive approach was rather smooth, almost seamless, so there was little if any instability. But now, almost thirty years later, we have reached a moment when the changes that have been accumulating over the last three decades are beginning to coalesce and point to another evolutionary step in the course of the medical profession. These changes are driven, mostly, by technological advances that are abundant, sophisticated, and distinctly interconnected despite their apparent uniqueness.

Take a look, for instance, at medical students, who train in a quasi-obsolete organizational structure. There is in place already an effort to modify their instruction, some proposing accelerated graduation, earlier clinical experience, and population- and team-based care, with wireless technology and virtual reality as tools to mentor them. Such progression will before long become the educational norm. Hospitals too will undergo a radical shift in the way they operate. Most of them still function following the classic model, one that will not survive for long, while many recognize that the majority of the hospital care of the future will soon be administered in the patient's own home, managed by nanosensors and virtual providers. The actual hospital of the future will in fact be an institution that will serve trauma and critical care patients almost exclusively, with less beds, less practitioners and less jobs.<sup>1</sup> It is said that Physician Assistants and Nurse Practitioners are or will be able to perform 80 to 85% of a physician's job. Artificial intelligence is permeating our world at an increasingly fast pace, causing exhilaration in some and fear in others who anticipate a decline in the human aspect of this developing paradigm.

So how will these scientific and technological changes alter the role of the physician? The physician of the future will indeed remain an integral element of the healthcare system, but his or her mission will change fundamentally, a transformation that will modify his or her current perception as an authority into an expert member of a cyber team instead, a team with multiple healthcare providers. Physicians will advise patients of the future through telemedicine, and patients will be equipped to make many of their own healthcare decisions using their increasing knowledge of genetics and the promise of pharmacogenomics. And to remain relevant and competitive, physicians will need to possess superior social and communications skills, a commitment to lifelong learning and an understanding of information management.

What should the physician of the future be prepared for? Initially, he or she will face an avalanche of data that will require learning and mastering new technology. Currently, the academic

literature is already a bottleneck, with 50 million published papers, growing at a rate of 1 million articles per year. However, the emerging software programs will allow physicians to use smart data that is streamlined to answer only indispensable questions. Information will be stockpiled in quarter-sized discs that can store up to 360 terabytes of data, resist temperatures of a thousand degrees Fahrenheit, and remain functional for 13 billion years. Physicians of the future will need to become experts in nanosensors technology, liquid biopsies, immunotherapy and telekinesis with external sensors.<sup>2</sup> He or she will have to develop an understanding of brain-digital interfaces, and the ability to move prosthetic limbs with the power of thought. They will have to know about the upcoming changes in life expectancy, regenerative medicine, and transplantation without immunosuppression. They will have to be cognizant of the progress in exoskeletons, robotics, and the administration of stem cells to treat stroke patients.<sup>3</sup> They will need to be familiar with the advances creating an intestinal anastomosis by a robot without a human operator,<sup>4</sup> robotic eye surgery,<sup>5</sup> and with the success of gene therapy in some types of hemophilia,<sup>6</sup> junctional epidermolysis bullosa<sup>7</sup> and in Leber congenital amaurosis.<sup>8</sup> They will be expected to advise patients about the development of an implantable artificial kidney (by the University of California and Virginia University) powered by the patient's blood pressure with an indefinite lifespan, and be aware of the use of 3D printed ovaries to restore fertility in mice.<sup>9</sup>

The physicians of the future will also have to recognize what the future will offer, such as a single dose of Trodusquemine to reverse heart disease,<sup>10</sup> or reading dreams,<sup>11</sup> or the possibility that bariatric surgery might disappear through the use of bioengineered proteins like GDF15.<sup>12</sup> There is a possibility that we will see the eradication of hepatitis C,<sup>13</sup> read minds,<sup>14</sup> cure Alzheimer's disease,<sup>15</sup> and halt aging. And there are those who predict that the exponential growth of computational power will achieve the power of one human brain by 2030 and of all human brains by 2045. And keeping in mind that Nabi Tajima was 117 years old in February of 2018, some predict that by the year 2150 we will see the first humans reaching age 150. All of these alterations should be interpreted within the context of non-medical technological changes, such as self-driving vehicles, energy produced by solar and wind sources, extracting water out of the air, printing houses, magnetic levitation transportation and automation doing away with more jobs that it will produce.

Whether these advances will happen or not is irrelevant, because change is inevitable. So it does not matter if or when these predictions take place. What matters is how humanity will adjust to these reformation probabilities, because social change often lags behind technology. So this transitional century in which we live will have to generate the social adjustments that we will

need to survive as thinking, sensitive and creative people, and protect our human legacy regardless of how long we live.

### Conflicts of interest

None.

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