

## Artificial and medical innovations applied to anesthesia

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Given the ongoing exponential growth of medical technology, informatics, systems automation, and computer processing power we are witnessing, it is becoming evident that a deep understanding of how new technologies will impact medical practice (not just clinical care, but also research, education, and management) is of major importance for those of us who will be in practice for the next 20 to 30 years and want to remain at the forefront of our chosen specialty<sup>(1)</sup>. Understanding technology will be as important in anesthesia as understanding anatomy, physiology, and pharmacology.

Of course, new technologies will not drive changes in the practice of anesthesia alone. Other, much stronger forces will drive most of these changes, and technology will just be a natural tool facilitating the adaptation to and implementation of these forces. Patient safety will be the principle motivating force for change<sup>(2)</sup>, but cost control will also play a key role<sup>(3)</sup>. Additionally, healthcare globalization will have a profound effect as developing nations play technology «leapfrog» in bottom-up innovation<sup>(4)</sup>.

In 2002, a committee of the National Research Council and the Institute of Medicine organized a conference to examine key health care trends and their impact on medical innovation<sup>(1)</sup>. In this conference, two major observations about the characteristics of medical innovation were made: «First, innovation in diagnostics, therapeutics and devices are important but are not the whole story. Corresponding innovations in the health care *delivery system* have not taken place and are badly needed if the full benefits of innovations in diagnostics, therapeutics and devices are to be achieved». The second

highly relevant observation was that «early cost-effectiveness studies for devices are likely to present worst-case scenarios and could lead to premature abandonment»<sup>(1)</sup>.

In this lecture we will first review the evolution of technology related to anesthesia during the last century. We will then discuss the reasons why technology will inevitably play a more and more important role in our anesthesia practice. From these descriptions, we will try to predict where technological innovations may lead anesthesia in the next 20 years, and perhaps in the next 100. Finally, we will discuss the current barriers to the implementation of cutting edge technologies, the reasons for these barriers, and ways in which they might be reduced without compromising patient safety.

This lecture is not an evidence-based analysis. It reflects the author's beliefs based on personal experience and discussion with other experts in the field (we believe for example that non invasiveness and automation in anesthesia are inevitable). In point of fact, predicting the future may actually be more difficult as technology advances. The «Black Swan Theory» that states that it is unexpected events of large magnitude and consequence that play the dominant role in history and these cannot be predicted, despite their seeming obviousness in hindsight<sup>(5)</sup>. More profound still is the concept of a «Technological Singularity», an explosion in machine intelligence beyond which any predictions about the future are meaningless<sup>(6)</sup>. As Paul Valery, a French poet and politician, said: «*The trouble with our times is that the future is not what it used to be*».

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