The "Iceberg Phenomenon": As Soon as One Technological Problem in NOTES Is Solved, the Next One Appears!

Though already proclaimed about 7 years ago, natural orifice transluminal endoscopic surgery (NOTES) is still in its early stages. A multidisciplinary working team tried to analyze the technical obstacles and identify potential solutions. After a comprehensive review of the literature, a group of 3 surgeons, 1 gastroenterologist, 10 engineers, and 1 representative of biomedical industry defined the most important deficiencies within the system and then compiled as well as evaluated innovative technologies that could be used to help overcome these problems. These technologies were classified with regard to the time needed for their implementation and associated hindrances, where priority is based on the level of impact and significance that it would make. Both visualization and actuation require significant improvement. Advanced illumination, mist elimination, image stabilization, view extension, 3-dimensional stereoscopy, and augmented reality are feasible options and could optimize visual information. Advanced mechatronic platforms with miniaturized, powerful actuators, and intuitive human-machine interfaces could optimize dexterity, as long as enabling technologies are used. The latter include depth maps in real time,
precise navigation, fast pattern recognition, partial autonomy, and cognition systems. The majority of functional deficiencies that still exist in NOTES platforms could be overcome by a broad range of already existing or emerging enabling technologies. To combine them in an optimal manner, a permanent dialogue between researchers and clinicians is mandatory.