

Diffusion of Medical Innovations: Minimally Invasive

Surgery in China

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After decades of development of minimally invasive surgery (MIS), this technology has become an integral part of healthcare worldwide. In the late 20th century, it was introduced into China as a surgical innovation, where it has become increasingly popular.¹ Implementation of a new procedure always comes with many cultural, social and economic considerations. However, the factors that influenced the diffusion and integration of MIS into China as a successful healthcare procedure is poorly understood.

Following in the footsteps of the first laparoscopic cholecystectomy in 1987,² China performed its first surgery of the sort in 1991.³ In comparison to the diffusion of traditional open surgery, MIS was brought to China much more quickly. Within the last twenty years, both the number and quality of these surgeries have significantly increased.⁴ In general, MIS was rather warmly welcomed into China.

This essay will demonstrate that the spread of MIS to China and its subsequent flourishing was facilitated by its fundamental principle of “minimal invasiveness”, which is in agreement with deep-rooted Chinese cultural and medical beliefs regarding preservation of the body's integrity and treating pathologies internally. I will examine this question from three aspects: the emphasis on bodily integrity throughout Chinese history, the importance of cultural impact on the fate of newly arrived foreign ideologies, and the openness to new technologies in the current state of industrialisation, modernization and urbanization in China. According to Everett Rogers, the diffusion of innovations requires four critical elements: the innovation itself, communication channels, time, and lastly, a social system.⁵ I will essentially argue that the social system is the most important element that facilitated the transmission of MIS into China.

Chinese Medicine: A tradition of internal healing

For a long time, innovations in medicine have spread between different societies. However, China was a society where Western medical, and especially surgical, sciences encountered much resistance. This is expected of when we consider the Chinese cultural belief that integrity of the body must be conserved to its fullest extent possible.

One of the fundamental texts of traditional Chinese medicine (TCM) is the “Yellow Emperor’s Internal Classic”. Interestingly enough, anatomy and dissection do occasionally appear in some parts of the text.⁶ Bloodletting was also routinely mentioned, particularly in some older texts. However, in contrast to Greek phlebotomy, which flourished until a few centuries ago, bloodletting in China faded from the medical realm in late antiquity, giving way to acupuncture, referred to by some as “bloodless surgery”.⁷ Evidently, the concept of bodily integrity and maintenance of internal balance gradually dominated Chinese medical thought.

Similarly, the fate of dissection in Chinese history was also unfulfilling. According to Confucius, the human body was believed to be sacred; it would return to the ancestors after death and any mutilations it carried would persist in the afterlife. Thus dissection was prohibited and there was limited knowledge of human anatomy.⁸ Throughout Chinese history, there were only two instances where anatomical dissection was performed on a relatively large and organized scale. Both involved the dissection of the corpses of killed rebels, with subsequent anatomy diagrams drawn.⁹ Otherwise, not much else had been done in the field of dissection until the arrival of Western medicine.

Equally as important was the underlying principle in TCM, advocating for healing by internal methods rather external ones. During the early period of transmission of

Western medicine, most Chinese people were still “deeply rooted in native medical theories and herbal medicine”, only looking to Western medicine as a last resort.¹⁰ In TCM, diseases are caused by a “break-down of the balance between Yin and Yang, in the body” and thus should be healed internally. Surgical operations were discouraged, except for superficial lesions such as abscesses.

Nevertheless, there have been records of surgical operations in ancient China. Hua To, one of the most important figures in traditional Chinese surgery is known to have used surgical methods and anesthetizing substances to treat his patients.^{11,12} Unfortunately, because ancient Chinese society placed surgeons on a low social status, surgical development mostly stagnated.¹³ Indeed, the socio-cultural context would not have allowed invasive surgery to thrive.

On the other hand, this desire to preserve the body’s integrity would have a more beneficial effect on the spread of MIS, a procedure defined as "surgical intervention involving the least possible physical trauma to the patient" in the Oxford Medical Dictionary. These paralleling principles gave MIS a much easier entrance into China.

Examining the Past: Medical encounters in China

Many of the principles of TCM continuously evolved throughout history. Coincidentally, these shifts in medical thinking were all connected to a simultaneous change in cultural belief. Naturally, new medicinal concepts are never simply accepted; they must be supported by the cultural context.

The reason why Western medicine encountered so much resistance was due to the importance of TCM in Chinese culture. It is embedded in and inseparable from Chinese

tradition. Consequently, despite ongoing efforts by missionaries, surgical procedures remained for a long time in isolated clinics without exerting much influence on the medical profession in China. It was almost as if Chinese society naturally resisted the invasion of foreign culture.^{14,15}

Occasionally, Chinese medicine modified its course due to internal debates or foreign influx. One example is the influx of Buddhist and Indian medicine.¹⁶ These exerted both an influence on TCM and on Chinese culture itself, thus leading to changes in medical theory. However, only those aspects of Buddhist medicine that agreed most with existing Chinese ideas were taken up into TCM

Similarly, fundamental concepts from local schools of thought were all incorporated into TCM in some way. TCM often transformed along with an evolving culture. Many medical concepts were formulated based on fundamental Confucian, Daoist principles etc. Several centuries later, the emergence of Neo-confucianism was also incorporated into TCM.¹⁷

As a result, Western medicine's propagation into China was rather unsuccessful until the nation fully opened up to accepting Western *culture* and in doing so, redefining its own identity. The resilience of Chinese culture, reinforced by a belief in self-superiority and a sense of antagonism towards Western influence, was remarkable.

The earliest account of Western surgery in China goes back to the Tang dynasty, yet it failed to leave a trace in Chinese history. Occasional European surgeons were also sent to China during the 16th and 17th centuries. However, most ended up serving in the imperial court without leaving much impact.¹⁸ Clearly, Chinese society had values completely different from the West, and therefore "Western medicine did not from a

scientific point of view come to environments capable of receiving it.”¹⁹ However, as Chinese society later underwent drastic changes in societal organization, Western medicine was given new opportunity to sprout, this time, successfully.

Socio-cultural context in China today: Facilitating the advent of MIS

At the turn of the 20th century, the China's attitude towards Western medicine went through an important transition phase. With repeated military defeats, China was gradually forced to open up to foreign intrusion. Soon, the educated elites realized that something had to be done to save their nation. For them, it was “science” that would revive China.²⁰ Thus began a movement of importing Western-derived science and revamping China's existing socio-political system, in order to promote modernization and to strengthen the economy and the military. One of the most important sciences among these was medicine, whose modernization could serve as a way of national defense.²¹ The Chinese government put forth favourable policies to promote the spread of Western medicine. Meanwhile, there was a sense of needing to refute old Chinese traditions, which were associated with “superstition and quackery”.²² The previous “resistance to Western economic models and their accompanying social structures” had turned around.²³

However, “unconditional support of scientific-medical practice” continued only until the mid 1950s.²⁴ Gradual efforts were then made to reintegrate certain traditions and beliefs, including in medicine.²⁵ One of the main principles of healthcare put forth by the Chinese government after 1949 was to merge TCM and Western medicine. Later, the

Cultural Revolution in the 1960s and the economic reforms after 1980 brought further changes to China's social structure, which modified medical trends again.²⁶

Today, although most people maintain the belief that science represents the sole truth, many also reverted back to believing in TCM. Thus, the cultural setting of China since the late 20th century is focused on modernization, urbanization and revival of past traditions. In this environment, MIS quickly spread into China and found a place in its medical system. This time, it was Chinese doctors themselves who decided to reach out and bring MIS into China.

Today, there are MIS specialists in major hospitals all across China, performing numerous cases of MIS.²⁷ For example, laparoscopic cholecystectomy has become the gold standard of cholelithiasis treatment.²⁸ Minimally invasive percutaneous nephrolithotomy, has been widely applied in China, with more than 10000 cases performed in 10 years.²⁹ Similarly, minimally invasive colorectal surgery, which only began in the early 1990s, was quickly adopted in China in 1993.³⁰ Such a rapid spread of new technology can probably only be explained by an immense social, cultural or economic driving force.

Interestingly, MIS was initially brought into China by a group of doctors from the United States, France, Canada etc. in 1991. Along with their skill, they also brought many pieces of hi-tech equipment devoted to MIS. They gave lectures regarding MIS techniques and performed demonstrations on pre-selected patients. The Chinese were described to be "very grateful" and enthusiastic – the lecture halls and demonstration rooms were always filled to capacity with an attentive audience. The doctors were excited to learn the new techniques, and the patients were also keen on being part of this initial

experience. One male patient who had not been chosen for a MIS operation even protested in hopes of being selected.³¹ Following-up with this experience 15 years later, the number of MIS conferences and workshops has rapidly increased. All types of operations had been performed and MIS was already widely accepted.³²

Evidently, the Chinese population demonstrated a welcoming attitude towards MIS since the very beginning. Even though hospital facilities often fell behind, MIS was still rapidly incorporated as a medical procedure. The fervour with which Chinese people wanted to import MIS is apparent.

Various journal articles written on the topic of MIS and descriptions of it on common websites etc. are all highly praiseful of this relatively new technology. There is a general consensus on the "five major benefits of MIS compared to traditional open surgery": small wound size, decreased pain intensity, faster healing and recovery, decreased length of hospital stay, and reduced blood loss".³³ These concepts recur throughout numerous studies that compare the outcomes of MIS to those of traditional surgery. The repeated emphasis on pursuing "minimal invasion" as the ultimate goal in surgery also demonstrates its importance in the Chinese surgical field.

In the encyclopedia section (similar to a Wikipedia page) of the largest search engine in China, Baidu, MIS is roughly summarized as surgery with a "small wound". The concept of "minimal invasion" is also said to have penetrated the entire medical system. Similar ideas are discussed in the encyclopedia entry for the term "minimal invasion".³⁴ Clearly, Baidu's description of MIS mostly focuses on its advantages; its possible risks and downsides are rarely mentioned. Of course, like Wikipedia, the information is not always reliable, but can represent the points of view of the general

population. Thus, we can deduce that MIS's popularity in China must be due to all the perceived benefits it may offer in terms of reducing trauma to the body.

The story of Ms. Qiao also demonstrates the importance of wound size. In the same year, Ms. Qiao was diagnosed with lung cancer soon after a recent mastectomy for breast cancer. Interestingly, her first concern this time was the size of the incision. The previous large mastectomy incision had kept her in pain for too long. This time, she wanted to have a smaller incision to reduce post-operative pain. Fortunately, a single-incision minimally invasive thoracic surgery successfully resected the cancer.³⁵ In this example, cosmetic effect and size of incision were the dominant factors that pushed the patient and doctors to choose MIS. Many other studies of single-incision laparoscopies also highlight the importance of cosmetic outcome as a major benefit of MIS.^{36,37} Perhaps in a culture that favours beauty, anything related to improved cosmetic outcome is preferred. However, this is just one of the many factors that helped MIS propagate so quickly.

The real major drivers of MIS are its benefits involving decreased blood loss, shorter recovery time etc. For example, a study on single-incision laparoscopic cholecystectomy specifically speaks of the fact that MIS has become the patients' preference for treatment of many diseases, namely because it causes less post-operative pain (with lower doses of analgesics), and faster recovery.³⁸ Another study examining the differences between laparoscopic and open total mesorectal excision also described similar outcomes: less blood loss, smaller incision size, better post-op recovery of bowel function, and fewer cases of pulmonary infections and bowel obstructions in the group that underwent the laparoscopic procedure. Based on these observations, they concluded

that the laparoscopic approach would be a safe alternative to open surgery.³⁹ As expected, throughout my literature search, I could barely find any articles focusing on the adverse outcomes of MIS. This fully reveals the receptive attitude that the Chinese medical community held towards MIS. Furthermore, the benefits of MIS mentioned in the studies are all in line with the traditional Chinese principles of maintaining bodily integrity, preserving the body's vitality, and treating the body as an integrated whole.

Many articles have also emphasized the need to promote the concept of “minimal invasion” throughout all medical and surgical procedures.⁴⁰ Authors believe that “minimal invasiveness” should be a principle of practice that physicians and surgeons abide by. To elevate its importance, some have even claimed that it was Hippocrates who first proposed this idea.⁴¹ Other more philosophical thinkers have termed MIS an embodiment of the “return of humanity to the field of medicine”.⁴²

Amidst continuous efforts to integrate TCM and Western medicine, MIS represented a perfect compromise between the two sides – it fits perfectly into the TCM principle the most important thing is to preserve the body's integrity and to treat the body as a whole. Simultaneously, the basis of MIS is also founded upon rigorous scientific testing, which respects the principles of Western medicine. These unique characteristics paved the way for MIS's smooth entrance into China.

In addition to the cultural aspects, the wide spectrum of new devices required in MIS also pushed it into one of the fastest-growing economies in the world. Oftentimes, bringing in new technology requires pioneers to lead the way. For example, Dr. Han Xinwei was one of these pioneers who led the purchase of new interventional radiology equipment after having witnessed it at an international conference. Dr. Han believes that

good quality equipment and training is of utmost importance in the transition from conventional surgery to MIS.⁴³ With an aging population, increased disease prevalence, and increased health awareness in the population, there has been a higher demand for MIS equipment. The need to develop better optical tools to improve visualisation of the surgical field was always there.⁴⁴ Many of the current limitations of MIS have also been attributed to a need for better tools.⁴⁵ Thus, there is a huge driving force to develop new, improved instruments for MIS.

In fact, endoscopes, stent grafts and energy based ablation devices have already been in high demand in the past few years.^{46, 47} From 2005 to 2011, the market for MIS devices in China increased from 12 billion US dollars to 18.6 billion. By the end of 2015, this number is expected to rise to nearly 30 billion US dollars.⁴⁸ Optimistically, the global projection for the MIS market is expected to reach 50.6 billion dollars by 2019.⁴⁹ Of this, the Asia Pacific market is expected to emerge as the fastest growing market among others.⁵⁰ Therefore, with further investment attractions, the market's forces which will drive MIS to its next peak. In addition, massive urbanization will allow more and more people to become aware of new healthcare technologies, which could boost the market demand for MIS even more.

Apart from all else, publications and education is also an important way to promote new knowledge. In order to better teach MIS techniques to students, training simulators, in the form of a cardboard box with a camera and tools inside, were developed.⁵¹ No matter how comical this seems, it shows the desire to learn MIS techniques. On another note, the creation of the "Chinese Journal of Minimally Invasive Surgery" in 2001 is an important symbol of MIS's success. Within the right social and

cultural context, this journal has become increasingly influential since its creation.⁵² This is no doubt a symbol that more people are aware of MIS and are paying attention to relevant developments in this field.

In conclusion, this essay has demonstrated that the cultural and social factors in Chinese society were the major driving forces for the spread of MIS into the nation. MIS's parallel with traditional Chinese concepts of maintaining bodily integrity is one of the most important characteristics that allowed for its acceptance amongst the Chinese population. The modern day economic and social context also played a significant role in bringing MIS to such popularity. However, despite its popularity, MIS is not without shortcomings. The overall cost and availability of equipment may prevent access to MIS for certain groups of people. The lack of good quality research and training also needs improvement. Regardless, as long as MIS stays in line with the socio-cultural context of Chinese society, it will most likely be guaranteed a relatively trouble-free propagation within this culturally-oriented country.

Bibliography

1. 夏穗生. 2001. "腹腔镜胆囊切除术信息首次传人我国纪实." *Chinese Journal of Minimally Invasive Surgery* 1 (1):2.
2. Shawn D. St. Peter, George W. Holcomb. 2008. "History of Minimally Invasive Surgery." In *Atlas of Pediatric Laparoscopy and Thoracoscopy*, edited by Keith E. Georgeson George W. Holcomb III, Steven S. Rothenberg., 1-5. Philadelphia: Saunders Elsevier.
3. 夏穗生. 2001.
4. 郑民华. 2012. "中国微创胃肠外科发展的思考." *Chinese Journal of Gastrointestinal Surgery* 15 (8):765-767.
5. Rogers, Everett M. 1983. *Diffusion of Innovations*. Third ed. 866 Third Avenue, New York, N. Y. 10022: The Free Press. A Division of Macmillan Publishing Co., Inc. (p.10)
6. 李申. 1993. "中医学与哲学（上）." In *中国古代哲学和自然科学*, edited by 胡绳, 332. Beijing: 中国社会科学出版社.
7. Kuriyama, Shigehisa. 1997. "Interpreting the History of Bloodletting." In *History of Ideas of in Surgery: Proceedings of the 17th International Symposium on the Comparative History of Medicine - East and West*, 4. Ishiyaku EuroAmerica, Inc.
8. Fu, L. 2009. "Surgical history of ancient China: part 1." *ANZ J Surg* 79 (12):879-85. doi: 10.1111/j.1445-2197.2009.05138.x.
9. 贾得道. 1979. *中国医学史略*, 141, 150-151. 太原: 山西人民出版社.
10. Ma, Qiusha. 2009. "From Religion to Science: Western Medicine's Role in Reforming China." In *Uneasy Encounters: The Politics of Medicine and Health in China 1900-1937*, 37-38. Peter Lang GmbH.
11. Hoizey, Dominique and Marie-Joseph. 1993. *A History of Chinese Medicine*, 29, 44, 57. Edinburgh University Press.
12. 贾得道. 1979. *中国医学史略*, 91. 太原: 山西人民出版社.
13. Fu, L. 2009. "Surgical history of ancient China: part 1." *ANZ J Surg* 79 (12):879-85. doi: 10.1111/j.1445-2197.2009.05138.x.
14. Borowy, Iris. 2009. "Introduction." In *Uneasy Encounters: The Politics of Medicine and Health in China 1900-1937*, 13. Peter Lang GmbH.
15. Gao, Xi. 1997. "Surgery in Nineteenth Century China: Under the Influence of Western Medicine Propagation in China." In *History of Ideas of in Surgery: Proceedings of the 17th International Symposium on the Comparative History of Medicine - East and West*, 181-183. Ishiyaku EuroAmerica, Inc.
16. 贾得道. 1979. *中国医学史略*, 101. 太原: 山西人民出版社.
17. 贾得道. 1979. *中国医学史略*, 18, 139, 141. 太原: 山西人民出版社.
18. Gao, Xi. 1997. "Surgery in Nineteenth Century China: Under the Influence of Western Medicine Propagation in China." In *History of Ideas of in Surgery*:

- Proceedings of the 17th International Symposium on the Comparative History of Medicine - East and West*, 182. Ishiyaku EuroAmerica, Inc.
19. Pierre Huard, Ming Wong. 1968. *Chinese Medicine*, 47-49. World University Library.
 20. Unschuld, Paul U. 2010. *Medicine in China: A History of Ideas*, 242-243. University of California Press.
 21. Borowy, Iris. 2009. "Introduction." In *Uneasy Encounters: The Politics of Medicine and Health in China 1900-1937*, 26. Peter Lang GmbH.
 22. Bu, Liping. 2009. "Social Darwinism, Public Health and Modernization in China." In *Uneasy Encounters: The Politics of Medicine and Health in China 1900-1937*, 114-115. Peter Lang GmbH.
 23. Unschuld, Paul U. 2010. *Medicine in China: A History of Ideas*, 235. University of California Press.
 24. Unschuld, Paul U. 2010. *Medicine in China: A History of Ideas*, 247. University of California Press.
 25. Wang Zhenguang, Chen Ping, Xie Peiping. 1999. *History and Development of Traditional Chinese Medicine*, 263. Science Press.
 26. Anderson, James G. 1992. "Health Care in the People's Republic of China: A Blend of Traditional and Modern." *Central Issues in Anthropology* 10 (1):67-75. doi: 10.1525/cia.1992.10.1.67.
 27. Song, C., C. Zheng, and W. Meng. 2010. "Chinese map of minimally invasive therapy and technology." *Minim Invasive Ther Allied Technol* 19 (6):318-9. doi: 10.3109/13645706.2010.527776
 28. Zheng, M., M. Qin, and H. Zhao. 2012. "Laparoendoscopic single-site cholecystectomy: a randomized controlled study." *Minim Invasive Ther Allied Technol* 21 (2):113-7. doi: 10.3109/13645706.2011.577787.
 29. Li, X., Z. He, K. Wu, S. K. Li, G. Zeng, J. Yuan, Y. He, and M. Lei. 2009. "Chinese minimally invasive percutaneous nephrolithotomy: the Guangzhou experience." *J Endourol* 23 (10):1693-7. doi: 10.1089/end.2009.1537.
 30. Li, X., Z. He, K. Wu, S. K. Li, G. Zeng, J. Yuan, Y. He, and M. Lei. 2009. "Chinese minimally invasive percutaneous nephrolithotomy: the Guangzhou experience." *J Endourol* 23 (10):1693-7. doi: 10.1089/end.2009.1537.
 31. Unger, S. W., D. O. Olsen, A. G. Nagy, K. A. Zucker, R. J. Fitzgibbons, Jr., N. J. Soper, J. B. Petelin, J. M. Sackier, N. Katkhouda, D. S. Edelman, and et al. 1994. "Laparoscopic surgery: surgical education in the People's Republic of China." *Surg Laparosc Endosc* 4 (4):277-83.
 32. Li, J. H., D. B. Witzke, and R. J. Gagliardi. 2007. "Laparoscopic surgery: surgical education in the People's Republic of China: changes after 15 years." *Surg*

- Laparosc Endosc Percutan Tech* 17 (3):153-5. doi: 10.1097/SLE.0b013e31804b48b5.
33. "微创手术." Accessed 2015-04-06. http://baike.baidu.com/link?url=h7ZN7t1r-MY5-9OutJliAtSo0TJewybEedBqI233TOKYQHOCkmLFf6CPWe0sjBNGYP9_QjDJtKDwEn_FJA_Tha.
 34. "微创." <http://baike.baidu.com/view/1907447.htm>.
 35. 张妍. "深圳微创手术量成功率领先全国." Last Modified 2013-09-23 Accessed 2015-06-27. http://www.sznews.com/news/content/2013-09/23/content_8550121.htm.
 36. Yu, J., Y. N. Wang, Y. F. Hu, X. Cheng, L. Zhen, and G. X. Li. 2011. "Single-incision laparoscopic appendectomy performed above the pubic symphysis - a new scarless approach." *Minim Invasive Ther Allied Technol* 20 (1):18-21. doi: 10.3109/13645706.2010.518672.
 37. Ching Li, L., H. Ming-Te, C. Soul-Chin, W. Po-Li, W. Chih-Hsiung, and W. Weu. 2010. "Initial experience of single incision laparoscopic cholecystectomy (with video)." *Surg Laparosc Endosc Percutan Tech* 20 (4):243-6. doi: 10.1097/SLE.0b013e3181e9bbeb.
 38. Ching Li, L., H. Ming-Te, C. Soul-Chin, W. Po-Li, W. Chih-Hsiung, and W. Weu. 2010. "Initial experience of single incision laparoscopic cholecystectomy (with video)." *Surg Laparosc Endosc Percutan Tech* 20 (4):243-6. doi: 10.1097/SLE.0b013e3181e9bbeb.
 39. Zheng, M. H., B. Feng, C. Y. Hu, A. G. Lu, M. L. Wang, J. W. Li, W. G. Hu, L. Zang, Z. H. Mao, T. T. Dong, F. Dong, W. Cai, J. J. Ma, Y. P. Zong, and M. K. Li. 2010. "Long-term outcome of laparoscopic total mesorectal excision for middle and low rectal cancer." *Minim Invasive Ther Allied Technol* 19 (6):329-39. doi: 10.3109/13645706.2010.527771.
 40. 姜洪池. 2004. "微创化：外科学发展的不懈追求." *中国实用外科杂志* 24 (8):472-474.
 41. "'微创'是未来手术发展的趋势." <http://www.maydeal.com/news/23536.html>.
 42. 杜治政. "医学人性的复归：微创医学与全人医疗." *医学与哲学杂志社*.
 43. Yi, Chen. "An Essential Trend in the Future of Surgery: How a Chinese professor helps to transition from conventional surgery to minimally-invasive treatment." Accessed 2015-01-17. <http://www.healthcare.siemens.com/news-and-events/mso-minimally-invasive-procedures>.
 44. Cadeddu, J., R. Fernandez, M. Desai, R. Bergs, C. Tracy, S. J. Tang, P. Rao, M. Desai, and D. Scott. 2009. "Novel magnetically guided intra-abdominal camera to facilitate laparoendoscopic single-site surgery: initial human experience." *Surg Endosc* 23 (8):1894-9. doi: 10.1007/s00464-009-0459-6.

45. Yu, J., Y. N. Wang, Y. F. Hu, X. Cheng, L. Zhen, and G. X. Li. 2011. "Single-incision laparoscopic appendectomy performed above the pubic symphysis - a new scarless approach." *Minim Invasive Ther Allied Technol* 20 (1):18-21. doi: 10.3109/13645706.2010.518672.
46. "Increasing Demand for Minimally Invasive Surgeries Drives Growth in the Endoscopy Systems Market, According to New Report by Global Industry Analysts, Inc." Accessed 2015-06-27. <http://www.laprotrainer.com/increasing-demand-for-minimally-invasive-surgeries/>.
47. "Trend of minimally invasive surgery boosts growth of Chinese stent grafts market." *Surgical Tribune* Accessed 2015-06-27. http://www.surgical-tribune.com/articles/business/asiapacific/9319_trend_of_minimally_invasive_surgery_boosts_growth_of_chinese_stent_grafts_market.html.
48. "2013年我国微创手术器械市场前景分析." Accessed 2015-06-27. <http://www.chinairn.com/news/20130403/103046500.html>.
49. <http://myvaobgyn.com/blog/minimally-invasive-surgery/>.
50. "Increasing Demand for Minimally Invasive Surgeries Drives Growth in the Endoscopy Systems Market, According to New Report by Global Industry Analysts, Inc." Accessed 2015-06-27. <http://www.laprotrainer.com/increasing-demand-for-minimally-invasive-surgeries/>.
51. 鞠打闯, 杜红兵, 胡军红. 2013. "自制腹腔镜模拟训练系统在基层医院的应用." *Chinese Journal of Gastrointestinal Surgery* 16 (6):512.
52. 傅贤波. 2011. "在微创外科发展激流中勇进的《中国微创外科杂志》 -- 庆贺《中国微创外科杂志》创刊 10 周年." *Chinese Journal of Minimally Invasive Surgery* 11 (1).