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Therapeutic substitutions in the midst of new technology diffusion: The case of treatment for localized prostate cancer

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ABSTRACT

Robotic surgical systems have become increasingly popular worldwide. Robotic assisted radical prostatectomies have been widely adopted in the treatment of localized prostate cancer, replacing the conventional open surgeries. However, it is not clear whether this was achieved by substitution within the same treatment type (i.e., replacing open surgeries with robotic-assisted surgeries) or substitution across treatment types (i.e., expanding the proportion of patients receiving surgery while crowding out other forms of treatment for localized prostate cancer). Given the large number of patients undergoing these procedures each year, it is important to study the impact of the fast diffusion of robotic surgical systems on the overall treatment pattern of localized prostate cancer. We addressed this question using state-level cancer epidemiology data (256 observations) extracted from 2002 to 2010 National Cancer Database, and supply-side variables (e.g. density of robotic surgical systems, urologists) obtained from Area Resource File as well as investor presentations posted at the website of the manufacturer of robotic surgical systems. Recognizing that the purchase decision of robotic systems is potentially endogenous, we used an optimal instrumental variables panel estimation method to examine the impact while taking into account of the panel structure and the potential endogeneity of the density of robotic surgical systems and its quadratic term. We found that the density of robotic systems at state-level had a significantly positive impact on the rate of surgery and a significantly negative impact on the rate of radiation therapy. Further, our age-stratified analysis showed that the increase in surgery rate was most pronounced in the younger population. In conclusion, our findings suggest that part of the increase in the rate of surgery was driven by substitution across treatment types with a large proportion originating from the younger population.

1. Introduction

Diffusion of new technologies has long been recognized as one of the major contributors of escalating healthcare costs (Cutler and McClellan, 2001; Meropol and Schulman, 2007). Over the past 5 years robot-assisted surgeries have become increasingly popular worldwide. Robotic surgical systems make it easier for surgeons to perform laparoscopic procedures and possibly reduce length of stay. The number of robot-assisted procedures performed in the United States has skyrocketed from 80,000 in 2007 to 205,000 in 2009. During the same time period, the number of U.S. hospitals that acquired the da Vinci Surgical System, the device to perform robotic-assisted surgeries, grew from 800 to 1400 (Barbash and Glied, 2010). Fig. 1 depicts the number of new robotic systems in each state for year 2000 and 2008, respectively. In 2000, only a few states had facilities equipped with robotic systems. By the end of 2008, there was an explosive growth of robotic systems across states; all but two states (North Dakota and Kansas) had at least one robotic system. By 2010, every state in the United States had at least one robotic machine (figure not shown). It was estimated that robotic surgery adds 13% to the cost of surgery (Barbash and Glied, 2010).

Da Vinci Surgical System was approved by the FDA in 2000. All da Vinci Surgical Systems are manufactured by one company, Intuitive Surgical Inc. The price of a da Vinci system can be up to $2.5 million, plus an annual maintenance fee of in the range of $100,000 to $170,000 (Intuitive Surgical, 2015). It is considered

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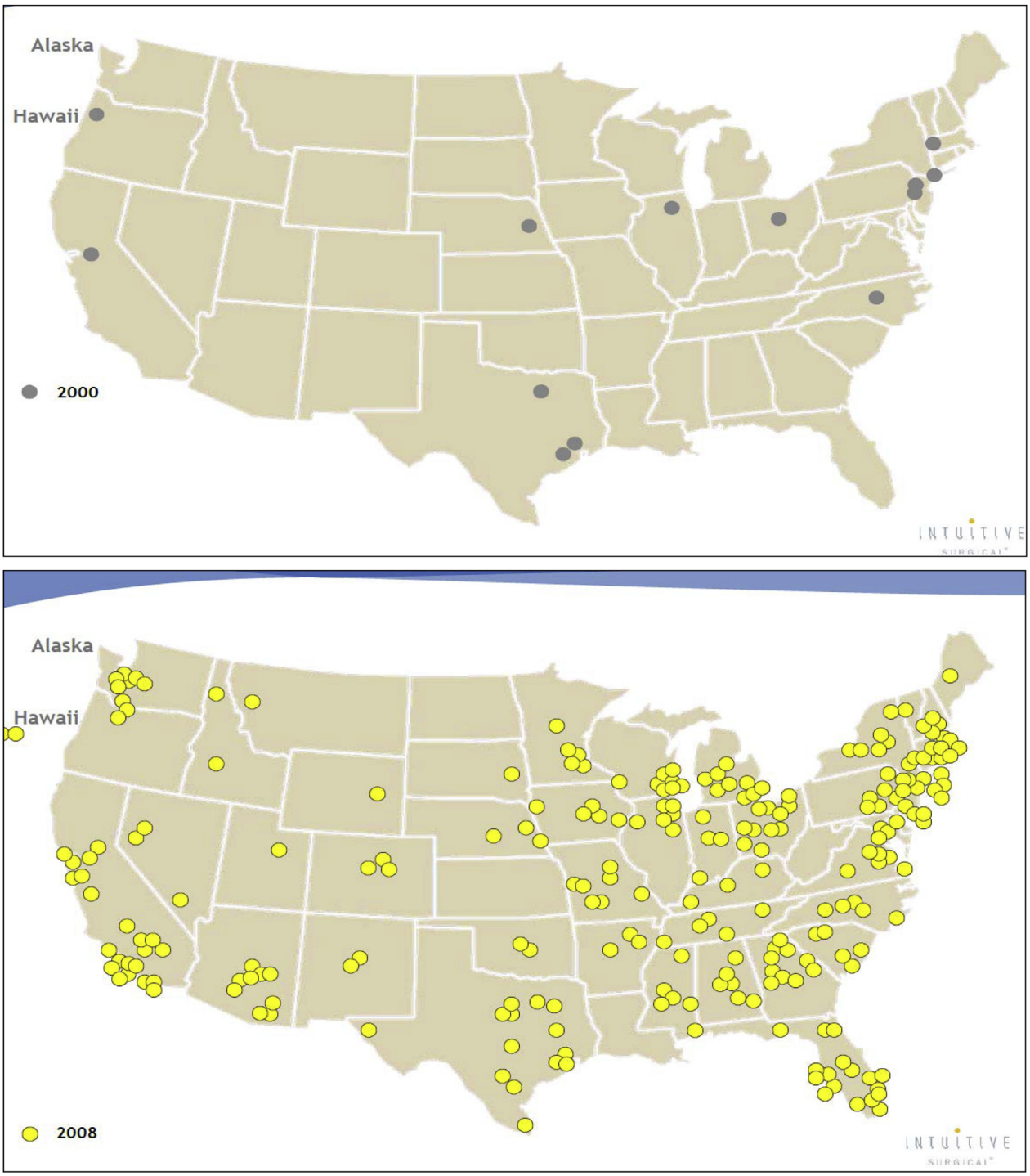

Fig. 1. Number of robotic systems by states, 2000 vs. 2008.

"one of the most expensive equipment in American operation rooms today"(Makary, 2012). Robotic surgery in its current form is not a true "robot" in that it lacks full automation. Surgery with this master-slave system is sometimes described as "computer assisted surgery" to avoid potentially confusing the patient and to leave room for the future development of true independent surgical robots. As designed and originally marketed, the da Vinci surgical system was meant to enhance minimally invasive cardiac surgery. However, efforts to market the da Vinci Surgical Systems for cardiac surgery were not successful.

Re-branded for prostate cancer surgery, the system was introduced to urologists as a tool to reduce the difficulty involved in performing a laparoscopic radical prostatectomy (RP) (Artibani et al., 2008; Ficarra et al., 2007). The marketing effort to urologists was hugely successful, as was evident by the trend in open vs. laparoscopic RP in the 2000s. Laparoscopic RP, also known as minimally invasive radical prostatectomy (MIRP), can be performed as standard or robotic-assisted laparoscopic procedures although it is believed that most MIRP performed in hospitals with da Vinci Surgical Systems would be robotic-assisted (Lepor, 2009). Despite