

AUTOMATED MEDICINE: THE FUTURE OF HEALTHCARE

It May Be Sooner Than You Think

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This is the first in a quarterly series of white papers intended to stimulate discussion and strategy.

Abstract: The future of medicine will be fundamentally reshaped by a fusion of three forces: Genetics, Artificial Intelligence, (“AI”) and automation. Genetic advances have been underway for decades and are taking root in many areas, most notably cancer diagnosis and care. AI advances, while less discussed, are increasingly exponentially; over a dozen AI applications have been approved by the FDA, and dozens more are in the pipeline. AI will reshape much of the diagnostic processes and will impact the need for (and roles of) Radiologists, Pathologists, Dermatologists, Oncologists and Cardiologists among others.

The future of interventional and surgical capabilities has not been as widely discussed. Demand for these services has risen dramatically in recent years, fueled by an aging population, rising wealth and technology innovation (making surgery less intrusive and more affordable). However, the supply of surgeons has stagnated and may soon begin declining. This supply and demand mismatch, absent a disruptive force, creates a fundamental mandate to leverage advanced technology. In addition to Genetics and AI, the technologies that will drive automation in this sector include advanced robotics, 5G Internet, 3D printing, miniaturization, and nano-technology.

Issue 1: Misalignment of Surgery Supply & Demand in the US

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Background

The National Institute of Health estimated the US surgical market was \$572 billion in 2005 and forecast an increase to \$912 billion in 2025 (constant 2005 dollars). Surgical services fall into three categories: emergent, urgent and elective. Emergent and urgent surgical procedures occur within a hospital and typically have an associated inpatient admission. The top non-elective surgeries performed are shown below.

Table 1: Top 10 Surgical Procedures

Procedure	Number of Procedures	Cost Per Procedure
Cataract Removal	3 million	\$2,300 - \$3,000 per eye
C-Section	1.3 million	\$13,000 per delivery
Joint Replacement	1.050 million	\$17,000 to \$33,000 per joint
Circumcision	1 million+	\$250 per case
Broken Bone Repair	670,000	\$8,000 - \$12,000 bone
Angioplasty / Atherectomy	500,000	\$20,000 per procedure
Cardiac Stent	454,000	\$18,000 per artery
Hysterectomy	500,000	\$10,000 - \$15,000
Cholecystectomy	460,000	\$24,000 – \$32,000
Coronary Artery Bypass Graft	395,000	\$40,000 per case

Source: HealthGrades.com August 28, 2019

Elective surgeries can be medically necessary but are largely cosmetic in nature. Elective procedures are performed in hospital outpatient settings, Ambulatory Surgery Centers and physician offices. Elective procedures are further segmented into “surgical” and “minimally invasive.” Examples of the latter include Botox and soft tissue filler injections. There were 17.7 cosmetic procedures performed in 2018; this is an increase of 200,000 from 2017. Of this total, 1.8 million were considered surgical and 15.9 million were minimally invasive. Top cosmetic procedures are shown below.

Table 2: Top Cosmetic Procedures in 2018

Surgical Procedures	
Breast Augmentation	313,735 surgeries
Liposuction	258,558 surgeries
Nose Reshaping	213,780 surgeries
Eyelid Lifting	206,529 surgeries
Tummy Tuck	130,081 surgeries
Minimally Invasive Procedures	
Botox	7.44 million injections
Soft Tissue Filler	2.68 million injections
Chemical Peel	1.38 million treatments
Laser Hair Removal	1.1 million treatments
Micro-Dermatology Abrasion	709,000 treatments

Source: American Society of Plastic Surgeons. March 11, 2019

Against this demand backdrop, the supply of surgeons has remained relatively stagnant, especially considering population growth and aging.

“An April 2019 report prepared for the AAMC by the health care consulting firm IHS Markit Ltd., titled *The Complexities of Physician Supply and Demand*, estimates a shortage of 14,300 to 23,400 surgical specialists by 2032. And a 2016 Department of Health and Human Services [workforce analysis](#) projected shortages in nine out of 10 surgical specialties by 2025, with the greatest shortages in ophthalmology, orthopedic surgery, urology, and general surgery.” *aamc.org April 26, 2019*

“The shortage of general surgeons in the U.S. is projected to get worse as the number of these doctors entering the workforce each year fails to keep pace with population growth, a U.S. study suggests. Researchers predict shortages based on their estimates of population growth by 2050 and the number of medical schools and hospital-sponsored general surgery trainee positions in the U.S. By 2050, there will be a deficit of 7,047 general surgeons nationwide, researchers calculated. That’s higher than the shortage of 6,000 they projected a decade ago.” *Reuters Health. August 24, 2018.*

Somewhat surprisingly, the cost (as measured by surgeon salary) does not show a clear and consistent trend that reflects increasing demand and constant supply. The Table below shows that for three of four surgical specialties the annual rate on compensation increase barely surpassed the economy wide increase in annual wages (2% to 3%).

Table 3: Compensation for Select Surgical Specialties

Specialty	Compensation: 2014	Compensation 2019	% Change
Ophthalmology	\$374,201	\$393,254	5.1%
Orthopedics	\$568,319	\$623,227	9.7%
General Surgery	\$395,456	\$429,577	8.6%
Plastic Surgery	\$447,752	\$518,882	15.6%

Other physician compensation surveys show a similarly mixed picture. The major reason for this departure from traditional economic theory of supply and demand seems to center around the role of Medicare and Medicaid as price setters. Combined these programs account for major portions of payments for Ophthalmology, Orthopedics and General Surgery procedures. The looming financial insolvency of these programs mandate that reimbursements be suppressed for all services, devices and supplies. Plastic Surgery is an outlier to this overall trend and has the lowest exposure to Medicare and Medicaid payments. Perhaps this is a truer representation of the true underlying dynamic?

Unless and until the economic law of supply and demand is repealed, there are only a handful of scenarios for the future of surgical services:

1. Compensation from Medicare and Medicaid will more accurately reflect supply and demand, and the current labor intensive model is sustained. More people choose to enter medicine as their career.
2. Compensation will continue to be suppressed by Medicare and Medicaid, and the current surgeon led manpower model does not change. In this case, fewer people will enter medicine as a career, and eventually procedures will be delayed and or rationed.
3. Automation enters the sphere of surgical procedures. The same number of surgeons will (collectively) oversee dramatically more procedures. Surgeons incomes will be maintained or even improved, and the supply of surgeons will be maintained.

In **Issue 2** we introduce the autonomous operating solution (“AOS”) concept that could help bridge this gap.