

Research Article

Trends in Medicare Reimbursement for Adult Cardiothoracic Surgery Procedures: 2007 to 2020

Keyana Zahiri ¹, Aditya Khurana,² Laura Scrimgeour,³ and Adam E. M. Eltorai^{1,4}

¹Warren Alpert Medical School of Brown University, Providence, RI, USA

²Department of Radiology, Mayo Clinic, Rochester, MN, USA

³Department of Cardiothoracic Surgery, UCSF, San Francisco, CA, USA

⁴Department of Radiology, Brigham and Women's Hospital, Boston, MA, USA

Correspondence should be addressed to Keyana Zahiri; keyana_zahiri@brown.edu

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Background. Cardiovascular disease has been the leading cause of death in the US for decades. Over half a million cardiothoracic surgery procedures are performed per year, with an increasingly aging population and rising healthcare costs. The purpose of this study was to evaluate trends in Medicare reimbursement rates from 2007 to 2020 for various cardiothoracic surgery procedures. **Methods.** The Centers for Medicare & Medicaid Services Physician Fee Schedule Look-Up Tool was queried for common procedural terminology codes for 119 common cardiothoracic surgery procedures to obtain reimbursement data by year. Procedures were organized into cardiac, CABG, and thoracic subgroups. All monetary data were adjusted for inflation to 2020 US dollars. Adjusted data were analyzed to calculate compound annual growth rates (CAGR), average annual change, and total percent change for each procedure. **Results.** After adjusting for inflation, the reimbursement rates for cardiothoracic surgery procedures decreased by 10.20% on average. Reimbursement rates for cardiac, CABG, and thoracic surgical procedures decreased by 8.74%, 14.46%, and 10.94%, respectively. The mean annual change overall was $-\$14.47$, and the CAGR was 0.82%. CABG procedures had the greatest decrease in CAGR (-1.11%), annual change ($-\$30.30$), and total percent change (-14.46%). **Conclusions.** Medicare reimbursements for cardiothoracic surgery procedures steadily decreased from 2007 to 2020, with CABG procedures experiencing the highest percentage of decline. Dissemination of these findings is crucial to raising awareness for healthcare administrators, surgeons, insurance companies, and policymakers to ensure the accessibility of these procedures for high-quality cardiothoracic surgery care in the United States.

1. Introduction

The United States has one of the most expensive healthcare systems in the world, and healthcare costs are continuing to increase rapidly with an aging population, new medical technologies, and increasing specialization driving up prices [1, 2]. According to the Center for Medicare and Medicaid Services (CMS), National Healthcare expenditures rose by 4.6% in 2019 to \$3.8 trillion or \$11,582 per person, accounting for 17.7% of GDP. This spending is projected to reach \$6.2 trillion by 2028, at an average annual rate of 5.4% [3]. Medicare and Medicaid account for a large portion of

the overall national healthcare expenditure (21% and 16%, respectively, in 2019), making the CMS a major target of policy makers for reform [4]. In the last decade, there have been a number of congressional changes to Medicare policies which have impacted hospital and physician reimbursement rates.

The current system by which Medicare reimburses hospitals and physicians for services involves a network of common procedural terminology (CPT) codes for each medical procedure along with associated prices and payment rates matched with a relative value unit (RVU) based on the skills, training, and time required to perform

a procedure. For each CPT code, respective reimbursement rates are calculated by accounting for resource and practice costs, physician work, and malpractice expenses and then multiplied by a geographic cost index [4, 5].

A few studies have analyzed Medicare reimbursement trends in various fields such as orthopedic surgery, reconstructive plastic surgery, and general surgery; however, analysis for the field of cardiothoracic surgery is limited. Analyzing and understanding cost management and procedural reimbursement trends in cardiothoracic surgery are imperative for maintaining a successful, high-quality, and equitable practice. The aim of this study was to analyze Medicare reimbursement trends for adult cardiothoracic surgery procedures from 2007 to 2020.

2. Materials and Methods

All the data used in this study were publicly available, and therefore, no local institutional review board evaluation was required. Common procedural terminology (CPT) codes for 119 cardiothoracic surgery procedures such as valve replacements, LVAD insertions, pericardiectomy procedures, transplants, and more were identified using a list from the Centers for Disease Control and Prevention (CDC) and categorized into 3 surgical subgroups: cardiac, coronary artery bypass graft (CABG), and thoracic procedures. The CABG group includes bypass procedures with either veins only or arterial grafts. The Centers for Medicare & Medicaid Services (CMS) Online Medicare Physician Fee Schedule Look-Up Tool was utilized to collect comprehensive reimbursement data from 2007 to 2020 for each procedure. The year 2007 was chosen as the start year for analysis since this was the first year that national payment data were available in the CMS Look-Up Tool. National payment data under a global modifier was collected for all procedures. Reimbursement amounts were adjusted for inflation to 2020 US dollar values using Consumer Price Index (CPI) data from the US Department of Labor's Bureau of Labor Statistics to compare changes to reimbursement amounts over time [6]. Total percentage changes and compound annual growth rates (CAGRs) were calculated using data adjusted to 2020 dollars to analyze mean growth rates for each surgical procedure. CAGRs represent the annual rate of change over a certain period of time, assuming the growth compounds exponentially. CAGRs were calculated using the following formula:

$$\text{CAGR} = \left[\left(\frac{\text{2020 value}}{\text{2007 value}} \right)^{1/2020-2007} \right] - 1. \quad (1)$$

R-squared values were calculated, as well as the means for the CAGR, annual change in dollars, and total percent change for each of the three subgroups. The inflation-adjusted values were used to analyze trends in reimbursement for cardiothoracic surgery procedures from 2007 to 2020. A two-tailed *t*-test was performed, and the statistical significance was set at $P < 0.05$.

The total number of providers as well as providers per capita (per 100,000 Medicare beneficiaries) was also calculated to evaluate trends in reimbursement in the context of provider numbers using the CMS Provider and Other Supplier Public Use File (POSPUF) database. The number of unique national provider identifiers (NPIs) that billed to Medicare under "Cardiac Surgery" or "Thoracic Surgery" was extracted. The number of Medicare beneficiaries was extracted using Kaiser Family Foundation, a third-party organization that maintains up-to-date statistics on Medicare enrollment. The number of providers in a year was divided by the number of beneficiaries in the same year to calculate the number of providers per 100,000 Medicare beneficiaries. Because the data availability for this database is different from that of the Medicare Physician Fee Schedule, at the time of data extraction (April 2022), only the years 2013–2019 were available. CAGR for these values were also calculated for comparison in a standardized metric to CAGRs for reimbursement.

3. Results

Medicare reimbursement data from 2007 to 2020 was analyzed for a total of 119 adult cardiothoracic surgery procedures, including 56 cardiac surgery procedures, 10 CABG-related procedures, and 53 thoracic surgery procedures. Reimbursements changed at variable rates from 2007 to 2020, and the overwhelming majority of procedures experienced decreases in both the annual change in reimbursement and the total percent change (Table 1). The mean CAGR, mean annual change, and mean total percent change for the top and bottom 10 procedures with the highest and lowest CAGRs are depicted in Table 2.

The average unadjusted Medicare reimbursement rates for adult cardiothoracic surgery procedures overall increased 12.21%. With the adjustment to 2020 US dollars, the adjusted Medicare reimbursement rates decreased by 10.20% on average. Average adjusted reimbursement rates decreased by 8.74% for cardiac surgery procedures, decreased by 14.46% for CABG-related procedures, and decreased by 10.94% for thoracic surgery procedures. The mean annual change and CAGR were $-\$14.47$ and -0.82% , respectively, for cardiothoracic surgery procedures overall, $-\$16.04$ and -0.74% for cardiac surgery procedures, $-\$30.30$ and -1.11% for CABG procedures, and $-\$9.83$ and -0.85% for thoracic surgery procedures, respectively.

No statistically significant differences in overall reimbursement rates between the cardiac surgery, CABG, and thoracic surgery groups were identified per ANOVA ($p = 0.45$). CABG procedures experienced the greatest decrease in CAGR (-1.11%), annual change ($-\$30.30$), and total percent change (-14.46%). Cardiac surgery procedures experienced the lowest decrease in CAGR (-0.74%) and total percent change (-8.74%), while thoracic procedures experienced the lowest decrease in annual dollar change ($-\$9.83$).

In addition, there was a slight decrease in the number of providers per capita from 2013 to 2019 with a CAGR of -0.53% (Table 3).

TABLE 1: Reimbursement trends summary by group.

Groups	2007 unadjusted values rate	2007 adjusted values rate	2020 values rate	Mean CAGR (%)	Mean annual change	Mean total percent change
Total (N=119)	\$1,617.52	\$2,021.90	\$1,820.15	-0.82	-\$14.47	-10.20
Cardiac surgery (N=56)	\$1,851.81	\$2,314.77	\$2,093.15	-0.74	-\$16.04	-8.74
CABG (N=10)	\$2,287.12	\$2,858.90	\$2,450.56	-1.11	-\$30.30	-14.46
Thoracic surgery (N=53)	\$1,243.62	\$1,554.53	\$1,412.89	-0.85	-\$9.83	-10.94

4. Discussion

This study evaluated trends in Medicare reimbursement rates from 2007 to 2020 for adult cardiothoracic surgery procedures. Recent relevant work has looked at trends in Medicare payment rates for noninvasive cardiac tests and the implications of the 2020 Medicare payment rule for cardiothoracic surgery [7, 8]. In addition, a 1996 study analyzed trends in reimbursements for cardiac procedures in a California medical center from 1987 to 1992 [9]. To the author's knowledge, this research is the first to analyze national reimbursement trends in cardiothoracic surgery over a period of over a decade.

Overall, Medicare reimbursement rates for cardiac, CABG, and thoracic surgery procedures decreased from 2007 to 2020 (Figure 1). This trend is consistent with findings from Levitski (1996) regarding reductions in Medicare reimbursements over time for cardiac surgery [9]. Decreasing Medicare reimbursement rates over time have also been reported in other fields such as neurosurgery (25.8% decline, CAGR -1.66%), general surgery (24.4% decline, CAGR -1.6%), reconstructive plastic surgery (14% decline, CAGR -0.8%), oral maxillofacial surgery (13.4% decline, CAGR -0.88%), orthopedic trauma surgery (30% decline, CAGR -1.5%), reconstructive microsurgery (26.92% decline, CAGR -1.35%), shoulder surgery (26.9% decline), and foot and ankle surgery (30% decline, CAGR -1.5%) [10-17].

Reimbursement rates for CABG procedures, including those with venous or arterial grafting for one or more coronary vessels, experienced slightly higher rates of decline compared to cardiac and thoracic procedures. In general, as the prevalence of cardiovascular diseases continues to rise in the US, the number of older individuals in need of cardiothoracic surgical interventions is also increasing, with CABG being the most common [18, 19]. The majority of CABG surgeries are funded by Medicare (~51%), with the remaining ~36% covered by private insurance and ~13% by Medicaid, health service contractors, and out-of-pocket costs by patients [20]. Roughly a quarter of the practice of cardiothoracic surgeons is funded by CABG reimbursed by Medicare [20]. With hundreds of thousands of CABG surgeries performed per year, this procedure remains a highly common and effective method for treating coronary artery disease (CAD), although developments continue to be made towards more minimally invasive procedures such as percutaneous coronary intervention (PCI) [21, 22]. Furthermore, studies have found more optimal survival outcomes associated with CABG compared to PCI procedures [23]. Since the late 1980s, however, Medicare

reimbursements for CABG have decreased by nearly 50% [8, 24]. Given the consistently high volumes of CABG operations, this surgery has become one of the most standard procedures used to evaluate general trends in cardiothoracic surgery, and trends in this procedure can be indicative of the field overall. This notion is consistent with findings from this analysis since all subgroups experienced a decrease in reimbursement over time. It should be noted that a recent study with Medicare beneficiaries found that reimbursements for PCI have also declined over time, with a 14.5% decline in physician reimbursement for CABG and a 36.6% decline for PCI from 2010 to 2018, and volumes of CABG and PCI procedures performed for Medicare enrollees were found to have slightly decreased from 2010 to 2018, so reimbursement can be assumed to be a result of market forces, since with less demand, there is less reimbursement [25]. However, the less invasive procedure that overtook cardiothoracic surgery is experiencing declines as well, raising concerns about reimbursement declines being experienced across this field overall.

Models of physician reimbursements are consistently evolving, which may impact the accessibility of various surgical procedures over time. The current landscape suggests that the overall demand and volume of procedures performed are increasing, yet the reimbursement for these procedures is decreasing. Studies with longitudinal panels of physicians in Washington and New York have found that higher volumes of CABG procedures were performed in both the private and Medicare markets by surgeons whose incomes were most impacted by reductions in Medicare reimbursements [20]. This specialty is deeply tied to hospital-based value metrics used in the CMS Hospital Compare database, and there are numerous quality metrics in place regarding the amount of reimbursement for severe heart-related conditions (e.g., myocardial infarction and heart failure). In addition, we found a slightly decreasing number of providers per capita over time, according to CMS data (Table 3). However, the CAGR of providers per 100K beneficiaries from 2013 to 2019 was only -0.53%, so the decrease is essentially negligible in comparison to the decreasing reimbursement rates for cardiothoracic procedures. A report on the STS Adult Cardiac Surgery Database also found that the overall volumes of cardiac surgeries performed annually increased over time, with a 3.3% rise in volumes from 2010 to 2019 [26]. Moreover, a recent study performed using AATS data also found a shortage of cardiothoracic surgeons over time, yet a growing pool of patients [27]. This study projected that by 2035, there will be 853,912 cardiothoracic surgery cases to perform, which is a roughly 61% increase from 2010, resulting in an estimated

TABLE 2: Mean adjusted reimbursement trends from 2007 to 2020.

CT surgery CPT code	Code summary	Mean CAGR (%)	Mean annual change (\$)	Mean total percent change
33031	Pericardiectomy, subtotal, or complete; with cardiopulmonary bypass	3.04	95,471	52.15
33030	Pericardiectomy, subtotal, or complete; without cardiopulmonary bypass	2.24	62,244	36.41
43117	Ivor Lewis esophagectomy	1.17	40,058	17.63
33120	Excision of intracardiac tumor, resection with cardiopulmonary bypass	1.10	39,158	16.59
33315	Cardiotomy, exploratory (includes removal of foreign body, atrial, or ventricular thrombus); with cardiopulmonary bypass	0.85	28,644	12.63
20101	Exploration of penetrating wound (separate procedure); chest	0.78	4,544	11.47
33976	Insertion of ventricular assist device; extracorporeal and biventricular	0.76	23,294	11.19
33412	Replacement, aortic valve; with transventricular aortic annulus enlargement (Konno procedure)	0.48	39,087	6.91
43107	Transhiatal esophagectomy	0.37	15,108	5.30
33305	Repair of cardiac wound with cardiopulmonary bypass	0.33	0,832	4.76
32658	Thoracoscopy, surgical; delt with removal of clot or foreign body from pericardial sac	-1.39	-10,347	-17.83
32662	Thoracoscopy, surgical; with excision of mediastinal cyst, tumor, or mass	-1.39	-13,173	-17.85
33533	Coronary artery bypass, using arterial grafts; single arterial graft	-1.41	-30,508	-18.04
21615	Excision first rib	-1.62	-11,728	-20.39
33977	Removal of ventricular assist device; extracorporeal and single ventricle	-1.68	-24,481	-21.11
32960	Pneumothorax, therapeutic, and intrapleural injection of air	-1.69	-2,815	-21.20
32100	Thoracotomy; with exploration	-2.20	-26,300	-26.76
33979	Insertion of ventricular assist device; implantable intracorporeal and single ventricle	-2.69	-82,585	-31.75
31600	Tracheostomy	-2.88	-10,713	-33.60
33980	Removal of ventricular assist device; implantable intracorporeal and single ventricle	-5.91	-237,487	-57.35

TABLE 3: Number of providers and providers per capita, 2013–2019.

Years	2013	2014	2015	2016	2017	2018	2019	CAGR (%)
Absolute number of providers	3593	3586	3571	3580	3628	3614	3609	0.07
Providers per 100k Beneficiaries	9.71	9.62	9.48	9.35	9.45	9.41	9.41	-0.53

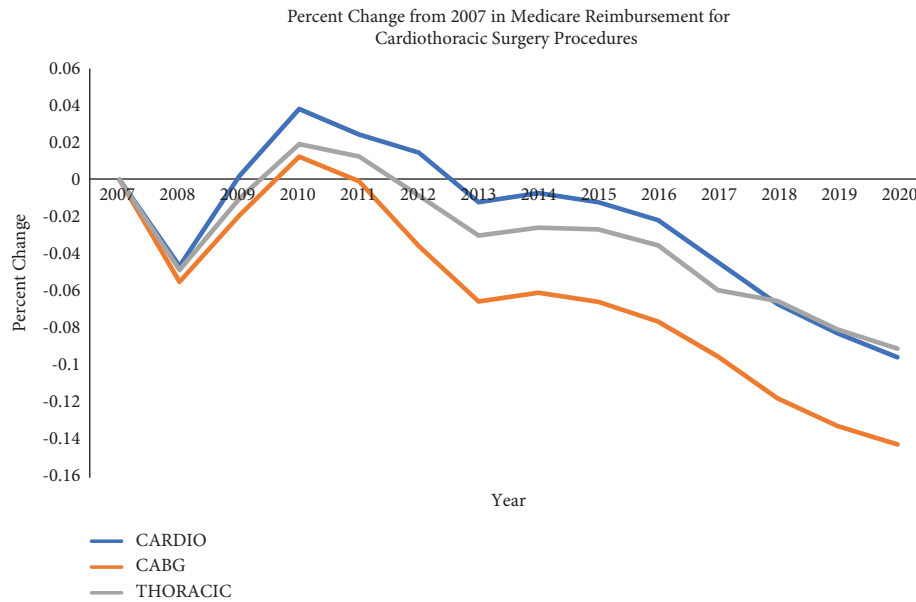


FIGURE 1: Percent change from 2007 in Medicare reimbursement for cardiothoracic surgery procedures. Cardio refers to cardiac surgery procedures, CABG refers to coronary artery bypass grafting procedures, and thoracic refers to thoracic surgery procedures.

121% increase in the caseload per cardiothoracic surgeon in 2035 [27]. This reflects a severe imbalance in supply and demand and is an alarming trend for this field, particularly given the pattern of decreasing Medicare reimbursements.

Data from the CMS has been integral to the Society of Thoracic Surgeons' (STS) evaluation of long-term outcomes and costs of cardiothoracic surgery [28]. Significant advances have been made in the field over the past 20 years, which have concurrently resulted in increased expenses due to the increased costs of nurses and clerical staff, new technologies, rising malpractice costs, and more [8]. However, Medicare reimbursements for this specialty have been decreasing over time. Earlier changes in reimbursement can largely be explained by the sustainable growth rate (SGR) under the Balanced Budget Act of 1997 that aimed to balance the US Federal Budget [29]. The annual SGR, which was active until 2015, was sensitive to expenditures in the previous fiscal year, which prompted a trend of declining Medicare reimbursements for physicians over time due to budget deficits [11, 29]. This may explain some of the volatility in reimbursement trends in earlier years (Figure 1). In 2015, SGR was replaced with the Medicare Access and CHIP Reauthorization Act (MACRA), which aimed to introduce more flexible reimbursement models and 0.5% increases in annual Medicare reimbursement rather than scheduled cuts [30]. Since January 2021, however, reimbursements for cardiac surgery overall have been cut by 8% and for thoracic surgery by 7% as

a result of a new Medicare payment policy [3, 8, 30]. Current policy discussions are debating decreasing cardiothoracic surgery reimbursements by as much as 20% [8]. One reason for declining reimbursement rates may be explained by the CMS policy of budget neutrality, in which increased budget allocation to one sector forces a proportional decline in payment for another sector [8]. The 2020 Medicare Final Payment Rule called for increased reimbursements and additional coding for outpatient evaluation and management (E/M) services without increasing reimbursements for these services when they are combined in the global surgical package for reimbursement, since CMS believes that postoperative care is primarily handled by primary care physicians or other clinicians rather than surgeons, as stated in policy perspective from Speir et al. [8, 31]. This, combined with rising inflation, subsequently resulted in decreased reimbursements for cardiothoracic surgery overall, as well as for other surgical specialties over time [8]. In addition, another factor that impacted Medicare reimbursement cuts for cardiothoracic surgery stems from a research study on postoperative care during the global period conducted by Medicare contractors, which has been scrutinized by AATS and STS leaders for being highly flawed for a number of reasons outlined by Speir et al. [8].

These financial threats pose a barrier to both access to affordable care for patients in need of cardiothoracic surgery and the viability of the field as a whole. Increasing reductions in reimbursements over time may largely impact the ability

of many private practices to remain in operation, limiting access to cardiothoracic surgical care for patients [8]. In addition to this, in response to the new Medicare reimbursement cuts, a survey from the American College of Surgeons revealed that the majority of surgeons anticipate longer wait times and care delays for patients [32]. These delays may potentially impact patients' quality of life and care outcomes, as evidenced by a study in Canada that found an association between longer waiting times and more adverse postoperative events and decreased physical and social functioning of patients in need of CABG [33]. In terms of overall outcomes, however, the mortality rates from 2016 to 2021 for major cardiothoracic surgery procedures such as CABG, aortic valve replacements, and mitral valve replacements have not changed significantly according to STS data, despite the drop in reimbursements over time [26, 34]. Therefore, the question of whether changes in reimbursement over time impacts quality of cardiothoracic surgical care warrants further long-term investigation. Moreover, cuts to reimbursement have yielded an imbalance between practice costs and revenue, resulting in many physicians no longer accepting new Medicare patients due to financial pressures, thus impacting access to care for these patients [35].

Aside from this, declining reimbursements may reduce the cardiothoracic surgery workforce further and potentially lead to consolidation in urban areas, further complicating access to care for patients.

As hospitals switch to more value-based models of care in efforts to maintain the high value standards within their practice, cardiothoracic surgery will be one of the specialties impacted early on. These models are believed to allow for flexibility around reimbursements, thus improving services integral to high-quality cardiovascular care such as team-based care, remote monitoring, and social and community interventions [36, 37]. In recent years, the American Heart Association (AHA) launched the "Value in Healthcare Initiative," which outlined the following objectives aimed at improving the value and quality of cardiovascular healthcare in the US: "Predict and Prevent," "Partnering with Regulators," "Prior Authorization," and "Value-Based Models" [36]. The "Value-Based Models" learning collaborative proposes a value-based payment system for heart failure with an emphasis on longitudinal disease prevention and management [36, 37]. Successful implementation of this initiative depends on wide-scale cooperation and collaboration with different stakeholders, from physicians and hospitals to private and public insurance companies and even patients.

Although this study provided a comprehensive analysis of reimbursement trends for cardiothoracic surgery procedures, the holistic group analysis for cardiac, CABG, and thoracic respective groups masks specific effects of individual CPT codes due to the averaging of all procedures without a subgroup. In addition, this study solely focused on global reimbursement trends, rather than technical vs. professional reimbursements. This study does not directly evaluate the volume of procedures to see if there is any relation between reimbursement rates and the volume of

procedures performed. Furthermore, the volume of procedures performed does not take into account the number of years of training, which is amongst the highest for cardiothoracic surgeons. In addition, this study did not analyze the impact of new surgical centers and private practice centers in specific. The impact of market forces on the surgeon workforce is another valuable factor to consider, as it was not explored in this study. Lastly, this analysis covered solely Medicare reimbursement data due to restricted data availability, therefore not accounting for other modes of insurance markets. Future studies should further analyze specific contributors to these declining reimbursement rates and the impacts of these reimbursement changes on different factors pertaining to the field (such as procedure-specific volumes and patient outcomes) to identify appropriate mitigation strategies.

5. Conclusion

This study comprehensively analyzed trends in Medicare reimbursements from 2007 to 2020 for cardiothoracic surgery procedures. After accounting for inflation, Medicare reimbursement rates decreased for cardiac, CABG, and thoracic procedures. Understanding these trends is imperative for surgeons, hospital administrators, and policy-makers alike to secure reimbursement models that allow for sustainable cardiothoracic surgical practices in the United States, as well as equitable access to care for patients in need of cardiothoracic surgery.

Data Availability

Data are available on The Centers for Medicare & Medicaid Services (CMS) Online Medicare and Physician Fee Schedule Look-Up Tool.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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