


German Heart Surgery Report 2024: The Annual Updated Registry of the German Society for Thoracic and Cardiovascular Surgery

Andreas Beckmann¹  Renate Meyer² Jana Eberhardt¹ Jan Gummert³ Volkmar Falk⁴

¹ German Society for Thoracic and Cardiovascular Surgery, Langenbeck-Virchow-Haus, Berlin, Germany

² BQS Institute for Quality and Patient Safety, Hamburg, Germany

³ Clinic for Thoracic and Cardiovascular Surgery, Heart and Diabetes Center NRW, Bad Oeynhausen, Germany

⁴ Department for Cardiac, Thoracic and Vascular Surgery, German Heart Center Charité, University Medicine, Germany

Address for correspondence Andreas Beckmann, MD, Deutsche Gesellschaft für Thorax-, Herz- und Gefäßchirurgie [DGTHG], Langenbeck-Virchow-Haus, Luisenstr. 58-59, 10117 Berlin, Germany (e-mail: gf@dgthg.de).

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Abstract

Based on a voluntary registry, founded by the German Society for Thoracic and Cardiovascular Surgery (DGTHG) in 1980, well-defined but limited datasets of all cardiac and vascular surgery procedures performed in 77 German heart surgery departments are reported annually. For the year 2024, a total of 178,547 procedures were submitted to the registry. A total of 103,617 of these operations are defined as heart surgery procedures in a classical sense. The unadjusted in-hospital survival rate for the 28,843 isolated coronary artery bypass grafting procedures (relationship on-/off-pump 2.5:1) was 97.8%. A total of 97.2% for the 45,422 isolated heart valve procedures (24,957 transcatheter interventions included) and 99.3% for 20,114 pacemaker/implantable cardioverter defibrillator procedures, respectively. Concerning short- and long-term mechanical circulatory support, a total of 3,168 extracorporeal life support/extracorporeal membrane oxygenation implantations, and 809 ventricular assist device implantations (L-/R-/biventricular assist device, total artificial heart) were reported. In 2024, 348 isolated heart transplantations, 287 isolated lung transplantations, and 2 combined heart–lung transplantations were performed. This annually updated registry of the DGTHG represents nonrisk-adjusted voluntary public reporting encompasses actual data for nearly all heart surgical procedures in Germany, constitutes trends in heart medicine, and represents a basis for quality management (e.g., benchmark) for all participating institutions.

Keywords

- ▶ heart valve surgery
- ▶ congenital heart disease
- ▶ coronary artery bypass graft surgery
- ▶ aorta/aortic
- ▶ transplantation, heart
- ▶ transplantation, heart–lung

Introduction

Legitimate demands for a sophisticated quality management in medicine—by authorities, scientific organizations, health care companies, and patients all over the world—have stimulated a quality awareness. This resulted in the development of multiple quality assurance activities such as benchmark

projects, public reporting, and registries. More than 30 years ago the board of directors of the German Society for Thoracic and Cardiovascular Surgery (DGTHG, www.dgthg.de) decided to set up an annual data collection of all cardiac surgical procedures performed in Germany in terms of a voluntary, unaudited registry.^{1,2} Since 1989, the registry is updated on an annual basis and published in the scientific journal of the

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DGTHG each year.³⁻⁷ The aims are: to detect developments and upcoming trends in cardiac surgery in Germany, to compile various acute in hospital outcomes, to provide each participant with a benchmark of the institutional results in comparison to the nationwide achievements and to facilitate the comparison on an international level.

The registry covers all relevant techniques and innovative technologies including minimally invasive cardiac surgery and structural transcatheter heart valve interventions (e.g., transcatheter aortic valve implantation [TAVI]; transcatheter mitral valve repair, transcatheter tricuspid valve procedures).

Data presented in this report comprehend the survey of the year 2024.

Materials and Methods

Since 2004 a standardized questionnaire gathers specific information for well-defined procedures, exactly described by an annually updated German adaption of the International Classification of Procedures in Medicine called “operation code” (OPS: Operationen-und Prozedurenschlüssel).

All participating institutions were asked to complete the structured questionnaire by January 20, 2025, submitting all performed procedures and related in-hospital mortality. The recommended path for data export is an electronic transmission of an encrypted file to the society office in Berlin. After transaction, the data were decrypted, evaluated for completeness, and compiled for further analysis, thus ensuring anonymity for each participating institution. This compilation algorithm enables a high compliance for submission of complete datasets.

Inclusion criteria for the registry data 2024 were all cardiac surgical procedures performed on patients from January 1 to December 31, 2024, unrelated to the date of patients' admission or discharge as compared with other registries. Like in the earlier years, the number of procedures was counted rather than individual patients. For example, if a patient initially required isolated coronary artery bypass grafting (CABG), later followed by a mitral valve reconstruction due to an undesirable event, one count in the category “coronary surgery” and a second one in the category “mitral valve reconstruction” are enumerated. Thus, the registry contains more procedures than the real number of patients operated on.

Death of patients was defined as in-hospital mortality. Per definition, the observed mortality is always attributed to the first cardiac procedure, e.g., the death of a patient requiring a replacement of the ascending aorta due to a complication after CABG would only be attributed to the coronary procedure.

The main reason for this structural set-up of the registry - established over four decades - is to keep in accordance with the German data privacy act with its specific regulations for patients. Furthermore, it seemed to be relevant to get detailed information about all performed procedures and not only the number of treated patients. Finally, the process

of data acquisition had to be standardized and feasible for all participating departments in Germany, thus enabling the submission of a complete dataset, regardless of the hardware and software used locally.

In 2024, a total of 77 institutions performed heart surgery. As in the years before, all departments answered the questionnaire and delivered a complete dataset for the surgical details, including unadjusted in-hospital mortality rates. In addition, comparisons between the registry data and the external quality assurance in accordance with §§ 135a/136/137 SGB V, obligatory for licensed German hospitals (§ 108 SGB V), are possible.

For descriptive statistical analyses categorized tables and a summary registry data file consolidate the transmitted information of all departments, providing the basis for this and further publications. Longitudinal data from earlier registry specifications are also included in the presentation. Developments are shown for a restricted period mostly covering the past 10 years.

Categorical data are displayed as absolute and/or relative frequencies. Due to lack of complete data for patients' risk profiles, mortality rates generally are not risk-adjusted. Quantitative data are presented as absolute frequencies and arithmetic mean values. Where appropriate, the value range is presented additionally. Patient age, although originally a quantitative variable, is only available in age groups and therefore treated as a categorical variable. German population-based measures are calculated as frequencies per 100,000 inhabitants and are based on the latest published data of the Federal Office for Statistics (Destatis) dated December 31, 2024.

The questionnaires were compiled using Microsoft Visual Basic for Applications. Analyses were performed with IBM SPSS Statistics v23 and Microsoft Excel 2010, charts and tables were created with Microsoft Excel 2010.

Limitations

Since the data of this registry are voluntary and an external monitoring is not provided reporting bias is possible. Due to missing data for appropriate risk estimation, a risk adjustment cannot be performed, even if this would be highly desirable.

Registry Data 2024

► **Table 1** shows the distribution of cardiac surgical procedures between the 16 German states, based on the population count of the Federal Office for Statistics as of December 31, 2024. The range of heart operations per 100,000 inhabitants shows a minimum of 106.4 (Bavaria, population: 13,248,928) and a maximum of 168.9 (Saxony-Anhalt, population: 2,135,597), whereas the nationwide mean value at the end of 2024 was 123.1 (► **Table 1**).

The size of programs can be analyzed by department dimension, which categorizes 9.1% into the cluster < 500, more than 59.7% into those from 500 up to 1,499 procedures (2024: 46/77) respective 31.2% into the two clusters from 1,500 up to a maximum of 5,319 performed procedures (► **Table 2**).

Pediatric heart operations in patients suffering from congenital heart disease (<1 year, with extracorporeal circulation [ECC]) are conducted in 22 centers, isolated heart transplantations in 19, and combined heart–lung transplantations in 1 institution (►Table 3).

Overall, as shown in ►Tables 4 and 5, 178,547 procedures were reported to the registry for the year 2024, an increase of 5.7% compared with 2023 (168,841 procedures) as well as compared with the prepandemic period (2019: 175,705 procedures). In 2024, the total number of 103,617 heart surgical procedures showed an increase compared with the previous year (100,606 procedures). Regarding CABG procedures, the numbers just showed a discrete difference, whereas heart valve and thoracic aorta procedures increased by 4.4% resp. 6.3%. In addition, the ventricular assist device procedures increased by 4.8% compared with 2023 (►Table AD).

The number of procedures using ECC from 2015 to 2024 is illustrated in ►Table 4. There was a gradual reduction until 2019, with a sharp decline in 2020 due to the severe acute respiratory syndrome coronavirus-2 pandemic. Even in 2024 the prepandemic level was not reached. This presumably reflects the growing field of transcatheter heart valve therapies.

Concerning gender distribution, the registry shows an overall male/female ratio of almost 2:1 with the greatest difference (4:1) in the patient group with coronary procedures (►Table 5). A total of 11,856 (11.4%) operations were classified as emergency procedures, and 7,056 (6.8%) were reoperations (►Table 6). These proportions appear quite consistent over the past years.

As shown in ►Table V1 16,803 (37.0%) isolated heart valve procedures were performed as single, 3,126 as double (6.9%) and 328 (0.7%) as triple valve procedures. Furthermore, 3,926 (45.0%, $n = 8,723$) aortic valve and 4,814 (64.3%, $n = 7,487$) mitral valve operations were performed via a minimally invasive access (►Table V2). The isolated transvascular TAVI, mitral and tricuspid valve procedures show a continuous increase, whereas the rate of transapical TAVI decreased. Concerning the surgical aortic valve replacements (sAVR) an increase of 0.5% in 2024 could be observed (►Fig. 1). The sAVR unadjusted mortality was 2.9%, nearly consistent over the last 3 years. With regard to interpretation of this and every other reported mortality rate in this report, it is important to note that all mortality rates are nonrisk-adjusted and not clustered by indication. As a result, groups are inhomogeneous and contain all emergency procedures, all valve pathologies including endocarditis. Concerning the TAVI, it must be considered that the included data are transferred only by the heart surgery departments in Germany and therefore are largely incomplete (►Table V2).

In 7,804 (89.5%) isolated sAVR under ECC conditions, xenograft prostheses were implanted, also a consistent distribution over the last 5 years (►Table V3, ►Fig. 2). A total of 63.8% (4,773) of the isolated mitral valve operations for primary and secondary mitral valve insufficiency, mitral stenosis, and endocarditis were mitral valve repairs (►Fig. 3). In a total of 2,464 combined mitral valve repair

procedures, 1,038 (42.1%) simultaneous CABG procedures, 834 tricuspid valve repairs (33.8%), 446 (18.1%) aortic valve procedures, and 146 (5.9%) concomitant CABG and sAVR were performed (►Table V4). It is important to note that the registry does not allow a stratification of results based on mitral valve pathology, and hence, the data do not reflect the outcomes of mitral valve repair for isolated degenerative mitral valve insufficiency.

The subgroup of 3,454 multiple heart valve procedures includes 2,836 (82.1%) double heart valve operations as a combination of mitral + tricuspid ($n = 1,515$) or mitral + aortic ($n = 1,321$) valve procedures (►Table V5). With regard to the 21,299 TAVIs reported in this registry, and in line with international developments an increase of procedures performed by transvascular access (20,676 [97.1%]) and a decrease for transapical access (623 [2.9%]) were observed. For the very rare TAVI procedures under ECC conditions, probably related to severe complications during the initial procedure, 78 were performed by transvascular and 8 by transapical access (►Table V7).

A total of 78.0% of 36,968 CABG operations were performed as isolated procedures ($n = 28,843$), 11.7% ($n = 4,321$) combined with sAVR and 5.0% ($n = 1,839$) with simultaneous mitral valve operations (►Table C1). These numbers are in the range of previous years. ►Table C2 provides an overview of the isolated CABG operations focused on the number of bypass grafts and subdivided by on- and off-pump CABG. The total number of isolated CABG procedures decreased by 0.5% and the subgroup without ECC increased to 8,185 (2023: 7,598). Conversions from off- to on-pump CABG are not captured in the registry. The unadjusted mortality rate of all isolated CABG procedures was 2.2% in 2024 and therefore reached the best result within the past 10 years (►Fig. 4).

►Tables Con1 + Con2 show data for congenital heart surgery procedures. In this subcategory the total number ($n = 5,394$) shows a slight decrease. ►Table Tx shows an increase of orthotopic heart transplantations by 7.4% from 324 in 2023 to 348 in 2024 (►Fig. 5). An increase in organ donation can only be expected if the legal framework for organ donation in Germany would change from the consent to the objection regulation. ►Table AD summarizes 4,879 temporary and 809 permanent mechanical circulatory support devices. In the temporary AD-subgroup 3,168 extracorporeal life support/extracorporeal membrane oxygenation, 1,333 extracorporeal pumps without oxygenator and 378 intra-aortic balloon pump were accounted while the permanent AD-subgroup comprised 780 L-/right ventricular assist device, 9 biventricular assist device, and 20 total artificial heart implantations (►Fig. 6). As shown in ►Table CIED, the number of permanent pacemaker and implantable cardioverter defibrillator (ICD) procedures rose to 20,114, an increase of 2.1% (2023: 19,699) (►Fig. 7). ►Tables Aort and Abl demonstrate further compiled registry data under different aspects and for various categories.

Compared with the data of previous years some expected changes can be seen on one hand, whereas several developments remained almost unchanged in 2024 on the other hand. The number of CABG procedures, isolated or combined,

show comparable levels after a decline during the coronavirus disease pandemic 2019. The number of isolated heart valve procedures increased to 45,422 procedures (+4.4%) and thus continues the upward trend that has been observed for years (►Fig. 8). However, unadjusted mortality rates for CABG, sAVR, and mitral valve procedures vary slightly over the last decade, although CABG reached the best result in 2024 (►Fig. 4). The age distribution of patients over the years continued to evolve toward a higher percentage of elderly patients (≥ 80 years) as well as a slight decrease of adults ≤ 69 years, this trend continued in 2024 and remained quite consistent compared with 2023 (►Fig. 9). Presently, 31.1% of the cardiac procedures are performed in patients from 70 to 79 years of age, and 21.1% in octo-/nonagenarians. The relative amount of isolated off-pump CABG increased to 28.4% in 2024 (2023: 26.2%) (►Fig. 10).

With regard to aortic valve prostheses distribution in 90.9% ($n = 7,804$) sAVR was performed using a xenograft (►Fig. 2), whereas in 9.1% ($n = 778$) a mechanical prosthesis was implanted: a consistent proportion over the past years. The unchanged development of transcatheter heart valve procedures in Germany lead to a total of 24,983 reported procedures in 2024 (►Table V7). Focusing on the distribution of aortic valve procedures for 2024, 21,299 (71.2%) TAVI and 8,596 (28.8%) sAVR were reported to the registry (►Fig. 1). Since data were reported exclusively by departments for cardiac surgery the registry cannot reach completeness for all TAVI procedures performed in Germany. On the basis of and in addition to the recommendations of international scientific guidelines on the management of valvular heart disease,^{8–10} the German Federal Joint Committee (G-BA) implemented a quality assurance directive¹¹ for “minimally invasive heart valve interventions (TAVI, transcatheter mitral clip reconstruction)” in 2015. Further surveys for selected procedures, such as the legally compulsory quality assurance (§135a SGB V) or the voluntary nationwide German Aortic Valve Registry (GARY),^{12–34} provide important findings on top of this registry and thus also contribute to an exceptional patient benefit. From January 1, 2025 the German Aortic Valve Registry became part of the mandatory German Implant Registry (IRD).

In 2024, the rate of isolated mitral valve repairs remains almost unchanged on a level of 63.8% (2023: 63.5%) (►Fig. 3). Based on the fact that all isolated mitral valve procedures regardless of the underlying mitral valve pathology or urgency of the operation are included results cannot be compared with registry data published for isolated pathologies (such as degenerative mitral valve insufficiency).³⁵

In 2024 almost half (43.1%; $n = 2,274$) of cardiac operations for congenital heart disease (CHD) were performed in neonates/infants < 1 year, 37.8% in children between 1 and 17 years and 19.1% in patients at least 18 years of age (►Fig. 11). These numbers show a relatively steady level over the past decade. In this context, a potential bias cannot be excluded due to the fact that the survey systematics do not allow the clear assignment of all relevant procedures to the CHD category (e.g., aortic valve disease in patients > 18 years).

As shown in ►Fig. 6 the permanent ventricular assist device implantations increased by 4.8% compared with 2023. In addition, the total number of temporary circulatory support also increased by 10.6%, mainly attributed by implantations of extracorporeal pumps without oxygenator (►Table AD). The number of heart transplantations increased to 348, an increase of 7.4% compared with the previous year (►Fig. 5).

The distribution of pacemaker and ICD procedures remained on a nearly stable level (►Fig. 7, ►Table CIED).

Discussion

The registry of the German Society for Thoracic and Cardiovascular Surgery enables a comprehensive overview of all heart surgical procedures performed in German cardiac surgery departments. The accuracy of this registry remains high due to the implemented compilation algorithm using standardized operation coding as a relevant criterion for reimbursement purposes. This is supported by other authors who could demonstrate a high accuracy for major outcome parameters in unaudited registries.³⁶ Considering the background of demographic evolvments, the population to be treated changes to patients at increased age combined with a higher proportion of related comorbidities and an accordingly complex perioperative risk profile.

Compared with 2023, the number of cardiac surgery procedures showed a steady state for isolated/combined CABG and a slight increase of sAVR. Despite the demographic development of the German population, the rapid deployment of transcatheter procedures and more restrictive recommendations for surgery in scientific guidelines^{10,37,38} a large volume increase is rather unlikely. The continuously low level of heart transplantations as a result of donor shortage has recently once again triggered a political discussion with regard to an objection regulation for organ transplantation in Germany.

Further improvements of the registry would be needed to allow for risk-adjusted data analyses and to inform about quality outcome data. An improved database should also allow for longitudinal follow-up.

Completeness, validity, and further progress depend on continued efforts and a close collaboration of the German Society for Thoracic and Cardiovascular Surgery and all German cardiac surgical departments. This will be of utmost importance to ensure patient safety and provide evidence for the high quality of heart surgery in Germany.

Conflict of Interest

None declared.

Acknowledgment

The German Society for Thoracic and Cardiovascular Surgery would like to thank all heads of the German cardiac surgical departments and their employees for their continued cooperation and support to realize the annual update of this registry.

Tables and Figures

Table 1 German federal states/heart surgery procedures

Federal states	Population ^a	Procedures ^b	Procedures/100,000 inhabitants
Baden-Württemberg	11,245,898	12,083	107.4
Bavaria	13,248,928	14,099	106.4
Berlin	3,685,265	4,285	116.3
Brandenburg	2,556,747	3,779	147.8
Bremen	704,881	760	107.8
Hamburg	1,862,565	2,457	131.9
Hesse	6,280,793	8,168	130.0
Mecklenburg-Vorpommern	1,573,597	2,359	149.9
Lower Saxony	8,004,489	10,767	134.5
North Rhine-Westfalia	18,034,454	21,876	121.3
Rhineland-Palatinate	4,129,569	5,368	130.0
Saarland	1,012,141	1,362	134.6
Saxony	4,042,422	5,277	130.5
Saxony-Anhalt	2,135,597	3,606	168.9
Schleswig-Holstein	2,959,517	3,701	125.1
Thuringia	2,100,277	2,934	139.7
Germany	83,577,140	102,881	123.1

^aFederal Office for Statistics of German: Population; due date December 31, 2024.

^bn = 736, foreign residences excluded.

Table 2 Department categorization by number of cardiac surgery procedures (Σ^a [n = 103,617])

Procedures/department	<500	500–999	1,000–1,499	1,500–1,999	2,000–5,500
Departments	7	25	21	12	12
Range	160–436	560–999	1,009–1,475	1,513–1,918	2,035–5,319
Average	307	824	1,205	1,644	2,986

^aCIED and extracardiac procedures without ECC excluded.

Table 3 Departments categorized by type of cardiac surgery procedures

Category	Departments
Coronary artery bypass grafting (CABG)	75
Heart valve surgery	75
Pacemaker/ICD procedures	74/70
Congenital heart disease procedures (p < 1 y with ECC)	22 ^a
Heart transplantation	19 ^b
Heart–lung transplantation	1

^aN = 1,682 thereof: 2 operations in 1 unit, 15–46 operations in 5 units, 52–83 operations in 8 units, 101–171 operations in 8 units.

^bN = 348: thereof: 1–4 HtX in 6 units, 5 HtX in 1 unit, 10–20 HtX in 5 units, 22–78 HtX in 7 units.

Table 4 Cardiac surgery procedures with extracorporeal circulation (2015–2024)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Procedures	81,527	79,082	76,696	72,331	71,759	63,720	61,272	61,696	63,683	64,602
Departments	78	78	78	78	78	78	78	78	77	77
Average	1,045	1,014	983	927	920	817	786	791	827	839

Table 5 Number of heart surgery procedures/gender distribution

Category	ECC application				Gender				Total	Diff. 2023 (%)
	With ECC		Without ECC		Female		Male			
	n	%	n	%	n	%	n	%		
CABG - isolated	20,658 ^a	(72)	8,185 ^a	(28)	7,750	(21)	29,218	(79)	28,843	- 0,5
-Combined	8,001 ^a	(98)	124 ^a	(2)					8,125	+ 3,2
Heart valve procedures	20,599 ^a	(45)	24,823 ^a	(55)	18,962	(42)	26,460	(58)	45,422	+ 4,4
Surgery of thoracic aorta	8,505 ^a	(91)	862 ^a	(09)	3,205	(34)	6,162	(66)	9,367	+ 6,3
Congenital heart surgery procedures	4,419 ^a	(84)	851 ^a	(16)	2,348	(45)	2,922	(55)	5,270	+ 1,8
Cardiac surgery, other	1,172 ^a	(45)	1,408 ^a	(55)	1,010	(39)	1,570	(61)	2,580	+ 4,1
Assist device procedures	681 ^a	(20)	2,762 ^a	(80)	942	(27)	2,501	(73)	3,443	+ 7,9
Extracardiac surgery	428 ^a	(01)	54,955	(99)	20,167	(36)	35,216	(64)	55,383	- 13,3
CIED procedures	139 ^a	(01)	19,975	(99)	7,244	(36)	12,870	(64)	20,114	+ 2,1
Total	64,602	(36)	113,945	(64)	61,628	(35)	116,919	(65)	178,547	+ 5,7

^aSum: n = 103,617 (heart surgery procedures).

Table 6 Emergency and redo procedures with extracorporeal circulation

Procedures	2024 n (%)		2023 n (%)	
	Emergency	11,856	(11)	11,319
Redo	7,056	(07)	7,037	(7.0)

Table V1 Isolated heart valve procedures

Procedure	n
Single	16,803
Double	3,126
Triple	328
Transcatheter (single) ^a	24,944
Transcatheter (double) ^a	13
Unspecified	208
Total	45,422

^a21,299 TAVI; 277 TMVI; 2,455 MV-TEER.

58 TTVI; 854 TV-TEER; 13 double aortic and mitral valve procedure; 1 TPVI.

Table V2 Single heart valve procedures

Access path	n
Aortic	
Sternotomy	4,797
Partial sternotomy	3,926
Transvascular	20,676
Transapical	623
Mitral	
Sternotomy	2,673
Minimal invasive	4,814
Transcatheter	2,732
Tricuspid	
Sternotomy	298
Minimal invasive	225
Transcatheter	912
Pulmonary	
Sternotomy	67
Minimal invasive	0
Transcatheter	1
Total ^a	41,744

^aApical aortic conduits procedures excluded (n = 3).

Table V3 Isolated aortic/mitral valve surgery: prostheses

Prosthesis/native heart valve	Aortic <i>n</i>	Mitral <i>n</i>
Xenograft	7,804	2,269
Allograft	778	437
Repair	127	4,773
Homograft	14	8
Total	8,723	7,487

Note: Transcatheter procedures and apical aortic conduits procedures (*n* = 3) excluded.

Table V4 Isolated/combined mitral valve procedures - implantation/replacement vs repair

Mitral valve procedures	Repair <i>n</i>	Implantation/ replacement <i>n</i>	Total <i>n</i>
Isolated	4,773	2,714	7,487
+ CABG	1,038	801	1,839
+ Tricuspid valve repair ^a	834	618	1,452
+ sAVR	446	875	1,321
+ CABG + sAVR	146	244	390
Total	7,237	5,252	12,489

^a63 procedures (not specified mitral valve + tricuspid valve surgery) excluded.

Table V5 Multiple heart valve procedures

Combination	<i>n</i>
MV + TV	1,515
AV + MV	1,321
AV + MV + TV	327
AV + TV	170
AV + PV ^a	103
TV + PV	17
AV + MV + PV	1
Total ^b	3,454

^aIncluding Ross procedures.

^bTranscatheter procedures excluded.

Table V6 Ross procedures—autologous sAVR and PVR (2015–2024)

Age (y)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
<18	28	38	38	29	32	35	25	39	37	44
≥18	64	72	52	61	104	70	124	136	151	138
Total	92	110	90	90	136	105	149	175	188	182

Table V7 Transcatheter heart valve procedures

	Without ECC <i>n</i>	With ECC <i>n</i>	Total <i>n</i>
TAVI	21,212	87	21,299
Transvascular	20,598	78	20,676
Transapical	614	9	623
Mitral valve	2,685	47	2,732
TEER	2,415	40	2,455
TMVI	270	7	277
Tricuspid valve	912	0	912
TEER	854	0	854
TTVI	58	0	58
TAVI + TMVI	13	0	13
TAVI ^a + CABG	16	10	26
TMVI ^b + CABG	0	1	1
Total ^c	24,838	145	24,983

^aFemoral, subclavian, or transaortic access.

^bTransvascular and transapical access.

^cTPVI for CHD excluded.

Table C1 Isolated and combined coronary artery bypass grafting procedures

CABG	<i>n</i>
Isolated CABG	28,843
+ sAVR	4,321
+ Other	1,454
+ Mitral valve repair	1,038
+ Mitral valve replacement	801
+ sAVR + mitral valve repair	146
+ sAVR + mitral valve replacement	244
+ Aneurysmal resection	94
+ Transcatheter aortic valve implantation	26
+ Transcatheter mitral valve procedure	1
Total	36,968

Table C2 Isolated coronary artery bypass grafting with/ without extracorporeal circulation

Grafts	On-pump <i>n</i>	Off-pump <i>n</i>	Total <i>n</i>
Single	595	1,705	2,300
Double	4,512	2,240	6,752
Triple	9,810	3,048	12,858
Quadruple	4,508	944	5,452
Quintuple + more	1,233	248	1,481
Total	20,658	8,185	28,843

Table Con1 Congenital heart surgery with/without extracorporeal circulation

Age (y)	With ECC <i>n</i>	Without ECC <i>n</i>	Total <i>n</i>
<1	1,711	592	2,303
1–17	1,861	216	2,077
≥18	971	43	1,014
Total	4,543	851	5,394

Table Con2 Age categorization congenital heart disease/procedures

Congenital heart defect/procedures	<1 y <i>n</i>	1–17 y <i>n</i>	≥18 y <i>n</i>
ASD	44	257	200
Complete AV canal	145	115	21
VSD	266	126	13
Fallot's tetralogy	170	45	2
DORV	46	11	2
TGA	125	9	1
TGA + VSD	52	9	0
Truncus arteriosus	28	4	0
Fontan circulation	6	226	5
Norwood	79	2	0
Pulmonary valve	63	234	65
TPVI	0	1	9
sAVR	38	188	371
Ross procedure	5	39	39
Mitral valve	33	94	93
Tricuspid valve	81	90	51
PDA	80	19	2
Coarctation	233	26	4
Others	805	539	136
HTx	3	33	0
HLTx	0	1	0
LTx	1	9	0
Total	2,303	2,077	1,014

Table Tx Heart/Lung transplantation

Transplant	<i>n</i>
HTx	348
HLTx	2
LTx ^a	287

Note: Pediatric transplantations (demonstrated in Table Con2) included.

^a269 LTx without ECC included.

Eurotransplant (ET) report 2024: 348 HTx, 2 HLTx, 283 DLTx, 25 SLTx, and 1 LTx + liverTx..

Table AD Assist device (temporary versus permanent)

Temporary	<i>n</i>
ECLS/ECMO	3,168
Extracorporeal pump without oxygenator	1,333
IABP	378
Total	4,879
Permanent	<i>n</i>
L-/RVAD	780
BVAD	9
TAH	20
Total	809

Table Aort Aortic surgery

Procedures ^a	With ECC, <i>n</i>	Without ECC, <i>n</i>
Supracoronary ascending aorta replacement	1,286	
Supracoronary ascending + aortic valve replacement	1,639	
Infracoronary ascending aorta replacement		
Mechanical aortic valve conduits	291	
Biological aortic valve conduits	1,115	
David procedure	512	
Yacoub procedure	80	
Other	409	
Aortic arch replacement ^b	3,097	
Replacement of descending aorta	42	10
Thoraco-abdominal aortic replacement	34	22
Endostent descending aorta	0	830
Total ^c	8,505	862

^aAbdominal aortic diseases excluded: 329 abdominal procedures and 47 endovascular abdominal stents.

^bAll combined procedures included; the only common denominator is aortic arch surgery.

^cAll isolated and combined procedures involving aortic surgery.

Table CIED Pacemaker and implantable cardioverter defibrillator procedures

CIED	With ECC, <i>n</i>	Without ECC, <i>n</i>	Total, <i>n</i>
Pacemaker	82	13,390	13,472
Implantation	56	8,780	8,836
Battery exchange	7	2,032	2,039
Revision	19	2,578	2,597
ICD	22	5,822	5,844
Implantation	6	2,477	2,483
Battery exchange	4	1,257	1,261
Revision	12	2,088	2,100
Miscellaneous	35	763	798
Total	139	19,975	20,114

Table Abl Surgical procedures for tachyarrhythmia

	Endocardiac <i>n</i>	Epicardiac <i>n</i>	Total
Unipolar radio frequency	11	108	119
Unipolar cooled radio frequency	31	82	113
Bipolar radiofrequency	159	1,618	1,777
Cryotherapy	1,853	385	2,238
Microwave	0	1	1
Focused ultrasound	6	41	47
Laser	0	0	0
Other	3	4	7
Total	2,063	2,239	4,302

Note: 163 procedures unspecified concerning endo-/epicardiac ablation.

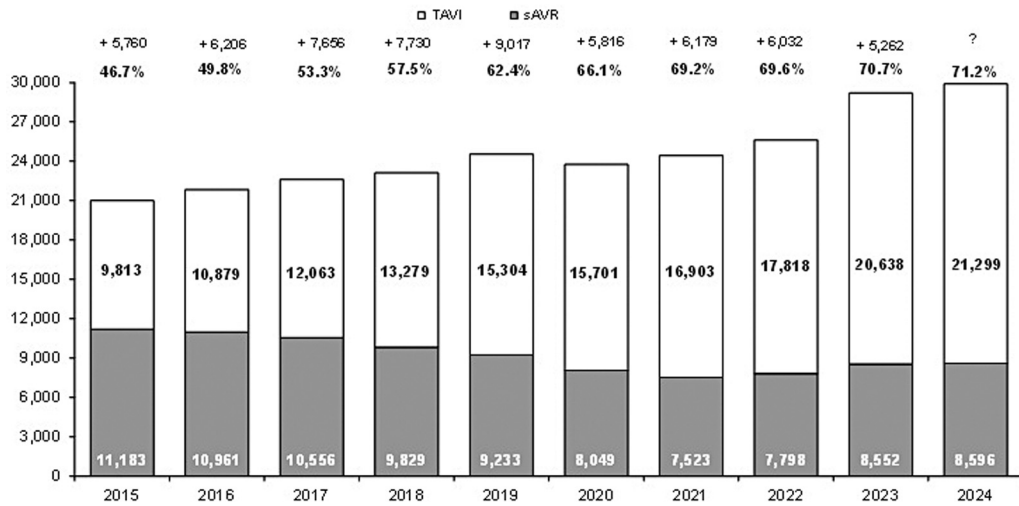


Fig. 1 Isolated sAVR and TAVI (2015–2024) + Additional patients (TAVI) calculated from the German legal quality assurance program, §§ 135a/ 136/ 137 SGB V.

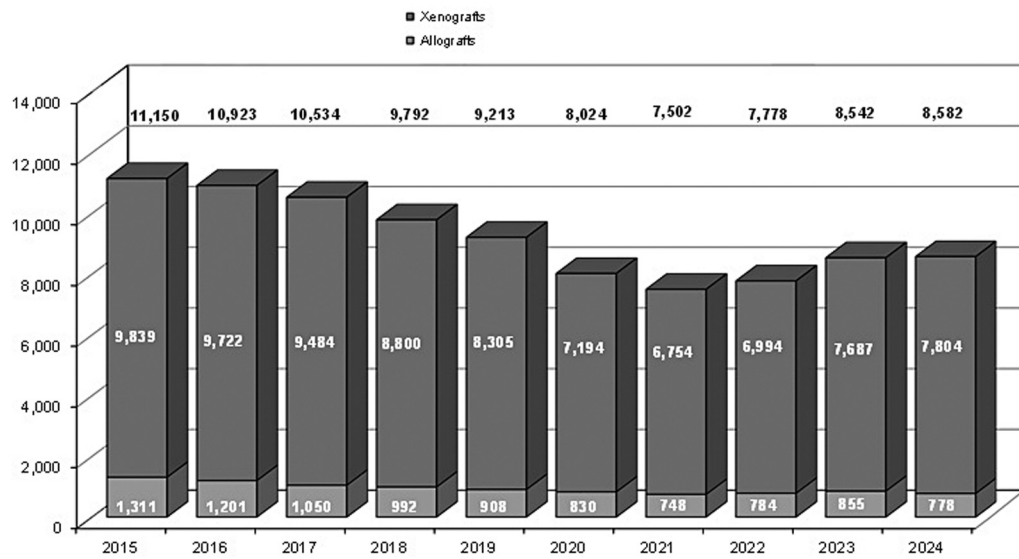


Fig. 2 Isolated sAVR (2015–2024). Ross procedures, homograft implantations, and transcatheter heart valve interventions excluded.

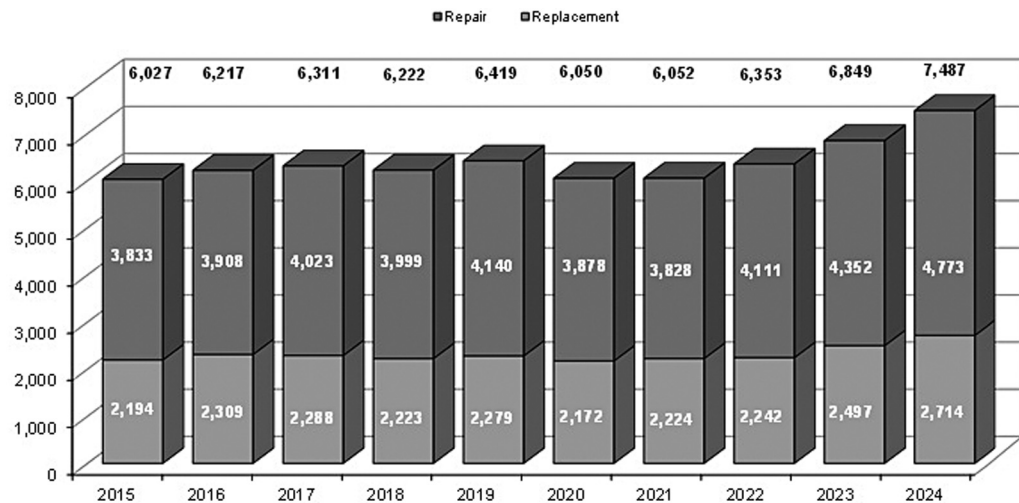


Fig. 3 Isolated MV surgery (2015–2024).

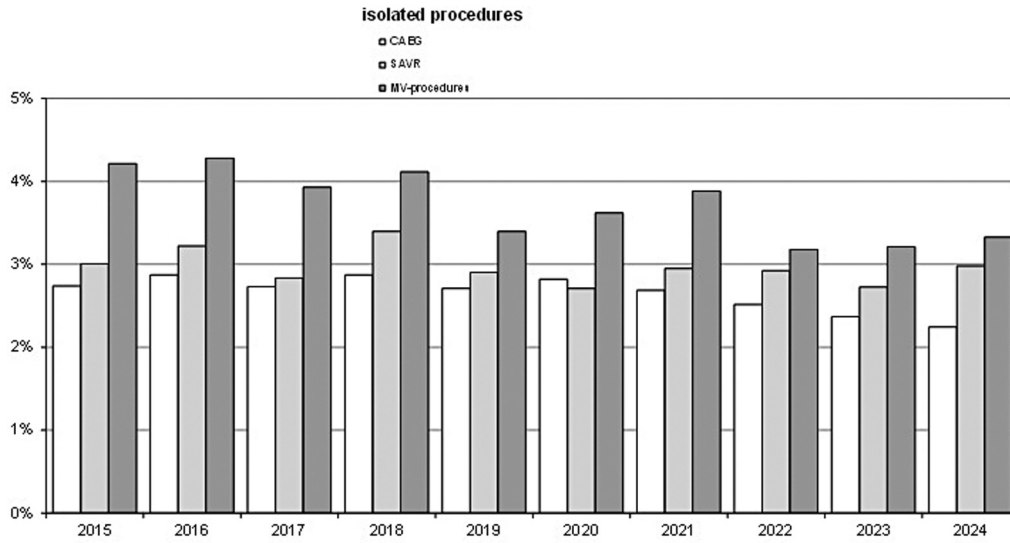


Fig. 4 Unadjusted mortality: CABG, sAVR, MV procedures (2015–2024).

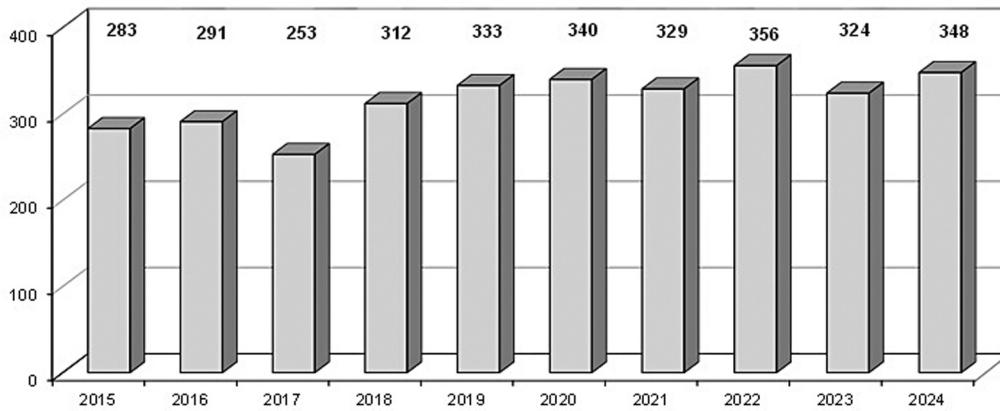


Fig. 5 Heart transplantation (2015–2024).

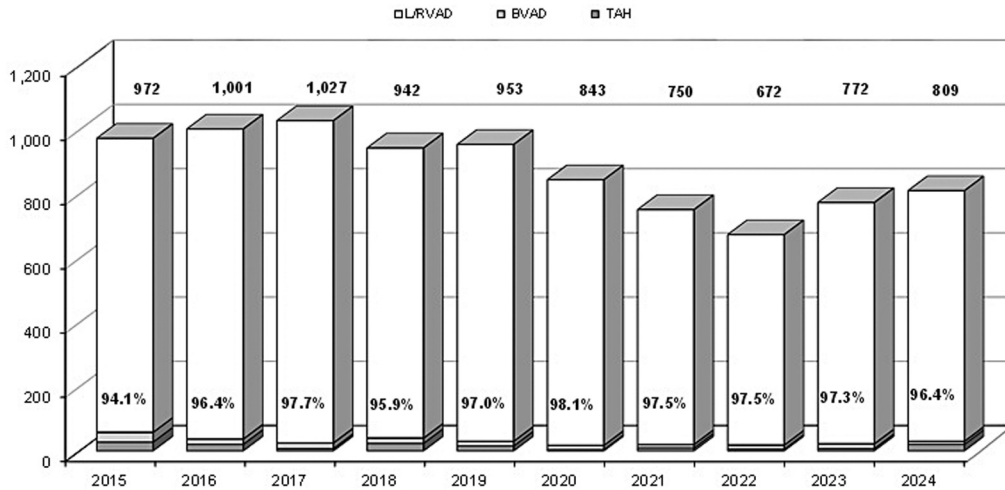


Fig. 6 VAD/TAH (2015–2024).

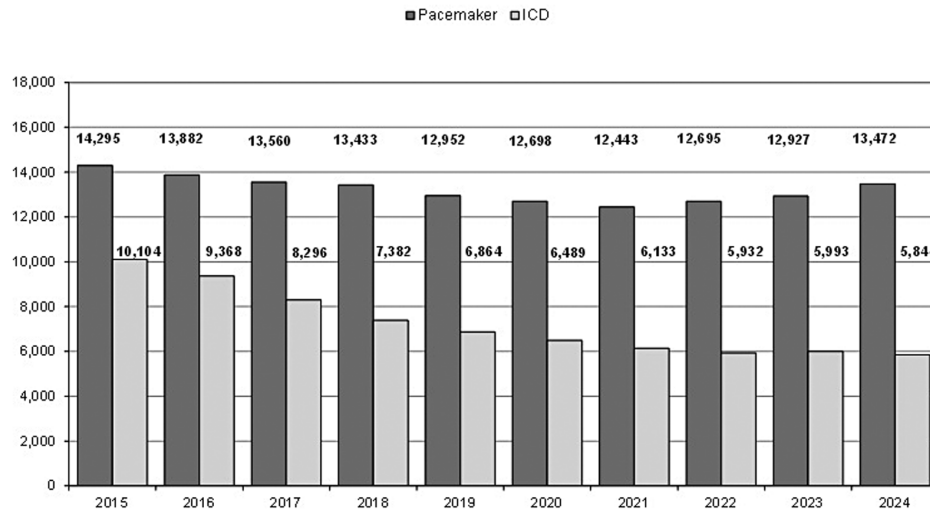


Fig. 7 Pacemaker and ICD procedures (2015–2024).

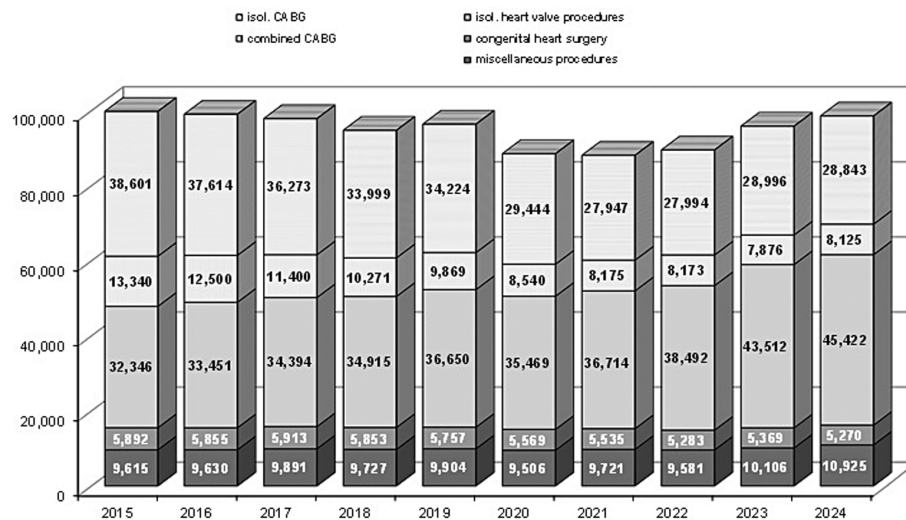


Fig. 8 Selected heart surgical categories (2015–2024). Congenital heart surgery: atrial septal defect repairs in adults or in combination with coronary artery bypass grafting (CABG) or heart valve procedures are summarized in the CABG or heart valve procedure groups; miscellaneous procedures: all other types of procedures with extracorporeal circulation.

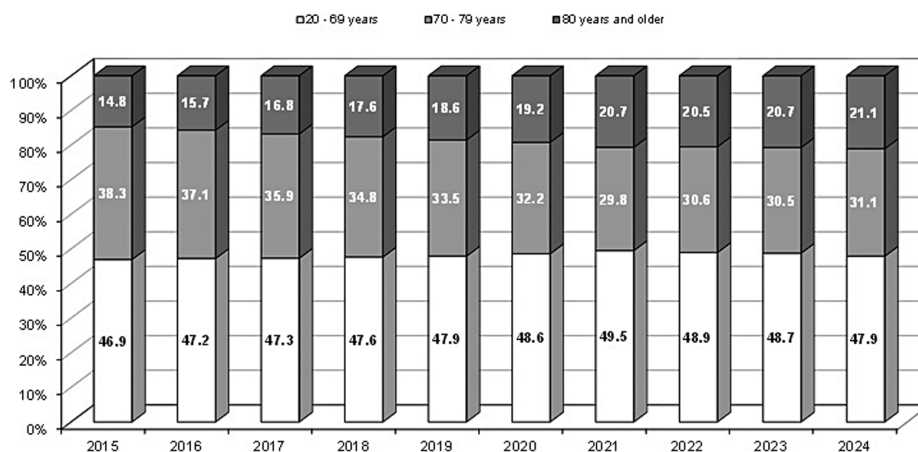


Fig. 9 Age distribution of cardiac procedures (2015–2024). Patients < 20 years and CIED procedures excluded.

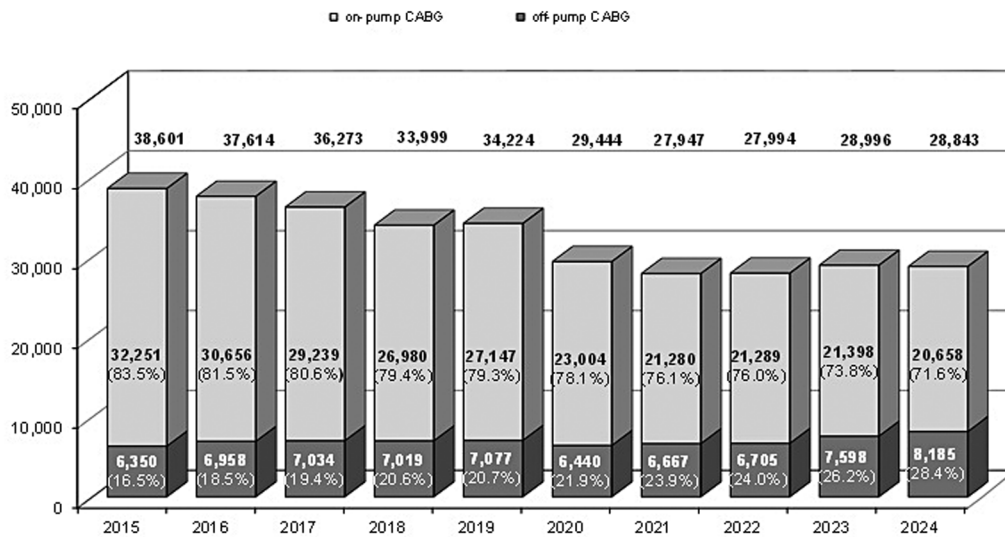


Fig. 10 Isolated CABG (2015–2024).

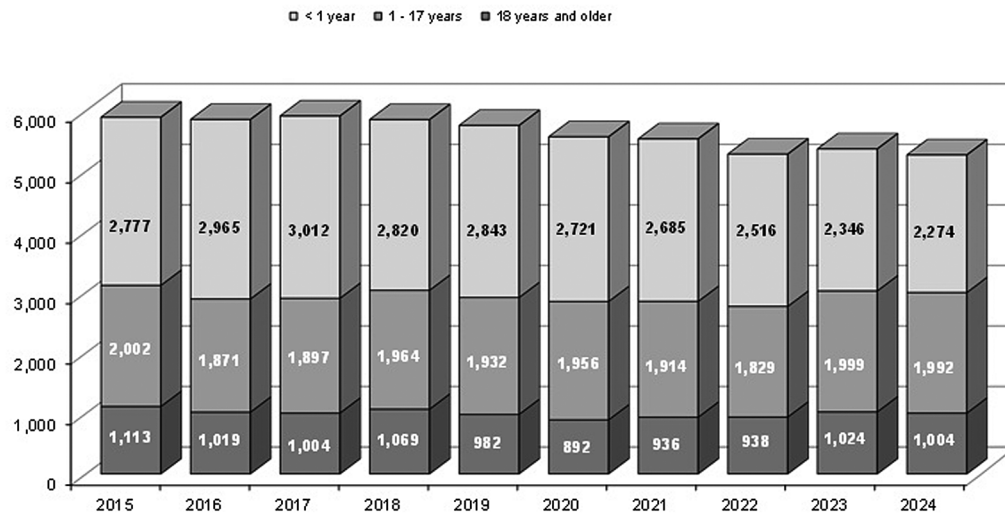


Fig. 11 Age distribution of congenital heart surgery (2015–2024).

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