Original Article

Clinical analysis of hospital acquired mycoplasma pneumoniae infection after cardiac surgery: a case series

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Background: *Mycoplasma pneumoniae* (MP) is a common pathogen of community-acquired respiratory infections. The clinical characteristics hospital-acquired MP infections are rarely reported in the literature. Our ward is mainly responsible for the management of patients during the perioperative period of cardiac surgery. Several patients had fever during the improvement of their condition after cardiac surgery, and the effect of upgrading antibiotics and increasing the antibacterial spectrum was not good.

Methods: Using inpatient data of Guangdong Provincial People's Hospital, we conducted a retrospective case series study of hospital-acquired MP infection after cardiac surgery from January 2015 to December 2020 to investigate the clinical characteristics. Clinical data was extracted from patients with a confirmed diagnosis of MP infection after >48 hours of hospitalization. All analyses for this study were descriptive. Data were expressed as mean ± standard deviation (SD), median with range or number with percentage as appropriate.

Results: We totally included 22 patients. The time of onset of hospital-acquired MP infection after surgery was 23.32±12.57 days, and the duration of antibiotic use before the onset of infection was 4–40 days. Both fever and sore throat were the main symptoms of nosocomial MP infection, and the rash was the most common physical sign. Laboratory tests were normal for peripheral blood leukocyte count and procalcitonin in most patients (17 cases), while the lymphocyte count was decreased in 10 cases. A single serum anti-MP antibody titer ≥1:160 combined with clinical manifestations and imaging helped confirm nosocomial MP infection, although a double serum anti-MP antibody (four-fold change in titer) wasn't seen. With quinolone therapy, such as levofloxacin, all the patients' temperature gradually returned to normal and were discharged uneventfully.

Conclusions: Patients after cardiac surgery should be aware of the presence of hospital-acquired MP infection when they develop new fever accompanied by atypical bacterial infection signs such as sore throat and rash during treatment. In such cases, changes in MP antibody titers need to be monitored and anti-MP therapy is required.

Keywords: *Mycoplasma pneumoniae* (MP); hospital-acquired; cardiac surgery

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Introduction

Hospital-acquired infections include those occurring during hospitalization and after discharge, but not those commencing prior to admission (1). Hospital-acquired infections not only increase morbidity and mortality, increase patient suffering and medical staff workload, and reduce bed turnover, but cause significant economic losses to patients and society. Most nosocomial infections are caused by opportunistic pathogens (2,3), the majority of which are drug resistant. Studies evaluating hospital-acquired *Mycoplasma pneumoniae* (MP) infections are rare (4). MP is a common pathogen of community-acquired respiratory infections in children and adults, and causes a variety of respiratory diseases such as pharyngitis, bronchitis, and pneumonia (5).

Our ward is mainly responsible for the management of cardiac patients during the perioperative period. Initially, we found that several patients developed fever during the course of improvement after cardiac surgery, with varying degrees of fever. The presence of bacterial or fungal infection was considered, and the patients' temperature weren't relieved after upgrading antibiotics and increasing the antimicrobial spectrum (e.g., carbapenem plus vancomycin). Drug fever was also considered, and antibiotics that might cause fever were discontinued. However, for the poor prognosis of patients after macrovascular surgery and the insufficient antimicrobial treatment with infective endocarditis patients, quinolone therapy (e.g., levofloxacin) was used as maintenance anti-infective therapy. Unexpectedly, the patients' temperature quickly returned to normal. We considered that levofloxacin had the advantage of covering atypical pathogenic bacteria and that the patients did have clinical manifestations of non-bacterial infection such as sore throat and rash during the course of the disease.

Previous studies on MP mainly focused on community-acquired MP or several scattered case reports (6-9), with few studies on hospital-acquired MP infection. Therefore, the clinical characteristics of infection in such patients are lacking. We present the following article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1491/rc).

Highlight box

Key findings

- Patients after cardiac surgery should be aware of the presence of hospital-acquired *Mycoplasma pneumoniae* infection when they develop new fever accompanied by atypical bacterial infection signs such as sore throat and rash during treatment.

What is known and what is new?

- *Mycoplasma pneumoniae* infection is a common pathogen of community-acquired respiratory infections;
- Patients after cardiac surgery should be aware of the presence of hospital-acquired *Mycoplasma pneumoniae* infection.

What is the implication, and what should change now?

- In patients after cardiac surgery, changes in *Mycoplasma pneumoniae* antibody titers need to be monitored and anti-*Mycoplasma pneumoniae* therapy is required.

Methods

Preoperative basic heart disease, cardiac function, postoperative cardiac complications, basic nutrition, imaging manifestations, range of MP antibodies were retrospectively collected from the records of 22 patients with hospital-acquired MP infection after cardiac surgery. White blood cells (WBC), granulocyte (GRAN), lymphocyte (LYMPH), procalcitonin (PCT), C-reactive protein (CRP), alanine transaminase (ALT), aspartate transaminase (AST), B-type natriuretic peptide (BNP) were analyzed.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of Guangdong People's Hospital [No. GDREC2016222H(R2)]. Individual consent for this retrospective analysis was waived.

Clinical data

Data obtained from visits to the authors' hospitals between January 2015 and December 2020 was conducted. Patients with a confirmed diagnosis of MP infection after >48 hours of hospitalization according to national and international expert consensus on the diagnosis and treatment of MP in adults and children were included (10-12).

Laboratory tests and serum MP-specific antibody detection

Following cardiac surgery, all patients received non-MP-directed anti-infection treatment. Following infective endocarditis, 10 patients required continued anti-infective therapy, one for a postoperative urinary infection, three for postoperative pulmonary infection, five for high haemogram values and high inflammatory indexes with or without fever a week after surgery, and three for postoperative bloodstream infection.

During treatment, patients were considered stabilized, but new onsets of fever, sore throat, dry cough and other symptoms reappeared, and blood was collected for anti-MP antibody, routine blood test, blood culture, liver and renal function test, CRP, PCT, and G test. After 3 days, blood tests, liver and renal function tests, PCT, and CRP were reviewed, and the change in anti-MP antibody titer was monitored every 7 days. The anti-MP test reagent SERODIA-MYCO II agglutination test kit was manufactured by RIBIO Co., Ltd.

Imaging

When the cause of respiratory symptoms such as new-onset fever and dry cough could not be identified after 3 days of treatment, all patients were routinely subjected to a plain computed tomography (CT) scan of the lungs to rule out pulmonary conditions.

Statistical analysis

SPSS 13.0 statistical software was applied for data processing. All analyses for this study were descriptive and mean ± standard deviation or median were used to express measurement data. The mean ± standard deviation was used to express measurement data that conformed to or approximated a normal distribution, and the median was used to express measurement data not conforming to a normal distribution.

Results

Epidemiological data

This study included 22 patients, 12 males and 10 females, ranging in age from 15 to 62 years old (median 32.5 years old). Of these, nine were diagnosed in 2015, eight in 2016, one in 2017, two in 2018, one in 2019, and one in 2020. All enrolled patients were affected at different time points so the possibility of nosocomial cross infection could be ruled out. As shown in *Table 1*, the time from hospitalization to the onset of MP infection ranged from 5 to 58 days, with a median of 24 days, and the time from surgery to the onset of MP infection was 12 days, with a mean of 14.47±6.38 days.

Cardiac disease and combined underlying disease

As shown in *Table 1*, the major cardiac diseases were heart valve disorders and macrovascular disorders, with infective endocarditis being the most common. The cardiac function of 13 of the 22 patients was classified as New York Heart Association (NYHA) classes II, and only two patients had an immune deficiency (intravenous drug addiction and leukoaraiosis).

Surgery

As seen in *Table 2*, all patients had undergone open-heart surgery with significant surgical trauma and a lengthy surgical procedure. The median anesthesia time was 300 minutes, the median cardiopulmonary bypass time was 142.5 minutes, and the median aortic clamping time was 88 minutes.

Nutritional status of patients before the occurrence of nosocomial MP infection

Table 3 shows almost all postoperative patients had varying degrees of anemia and hypoproteinemia.

Antibiotic use before hospital-acquired MP infection

Tables 4,5 show all patients had used multiple antibiotics prior to the occurrence of MP infection, with enzyme inhibitors and glycopeptide antibiotics being the most common, with a mean of three types, and a duration of use of 4–40 days, median 13.5 days, and 15.8±9.1 days. Among these, 13 patients had used vancomycin, with a median cumulative dose of 17 g, while lymphopenia combined with taking vancomycin was observed in eight cases, with a LYMPH count of (0.86±0.17) $\times 10^9$/L.

Clinical manifestations

Symptoms and signs

As shown in *Table 6*, the symptoms of patients with nosocomial MP infection were mainly febrile. There was one case with no fever, seven cases with low fever, nine cases with moderate fever, and five cases with high fever, with body temperatures ranging from 36 to >39.0 ℃. The most common respiratory symptoms were a sore throat and a dry cough, and the most noticeable signs were pharyngeal congestion, lymph node enlargement, and rash.

Laboratory examination

As shown in *Table 7*, most patients with hospital-acquired

Table 1 Basic information of patients

Basic information	Values (n=22)
Age (years), median [range]	32.5 [15–62]
Gender (male), n	12
Time from surgery to onset (days), median	12
Time from hospitalization to onset (days), median [range]	24 [5–58]
Time from onset to MP diagnosis (days), median	7.5
Major diseases, n	
Infective endocarditis	10
Vegetations with or without perforation	6
Perivalvular abscess	2
Prosthetic valve infection	2
Type A aortic dissection	2
Marfan syndrome	1
Rheumatic heart valvular disease	5
Behcet's disease with aortic regurgitation,	1
Mitral valve prolapse with severe regurgitation	1
Atrial septal defect	1
Atrial myxoma	1
With underlying diseases (incorrect number of cases)	6
Hypertension	1
HBsAg, HBeAb, and HBcAb test positive	1
Intravenous drug addiction with hepatitis C and lung abscess (WBC and lymphocyte counts are normal)	1
Postoperative endometrial cancer	1
Hypothyroidism	1
Behcet's disease (WBC and lymphocyte counts are normal, never treated with immunosuppressive agents)	1
NYHA class, n	22
I	4
II	13
III	3
IV	2
EF (%), n	
>50	19
≤50	3
40–50	3
30–39	0
<30	0

MP, *Mycoplasma pneumoniae*; HBsAg, hepatitis B surface antigen; HBeAb, hepatitis B e antibody; HBcAb, hepatitis B core antibody; WBC, white blood cell; NYHA, New York Heart Association; EF, ejection fraction.

Table 2 Surgical conditions of the patients

Surgical conditions	Values
Surgical mode, n	
Sternotomy	22
Valve replacement (sing/double)	13
Valve replacement combined with coronary artery bypass graft	1
Bentall/Cabrol	3
VSD repair	2
Bicuspid aortic valve replacement with aortic root distributary	1
Atrial septal defect closure	1
Atrial myxoma resection	1
Anesthesia time (min), mean ± SD	335.45±114.50
Cardiopulmonary bypass time (min), median	142.5
Aortic clamping time (min), median, mean ± SD	99.25±48.38
Ventilator support time (h), median	18
Thoracic drainage tube duration (days), median	3
ICU indwelling time (h), median	36.5
Use of temporary pacemaker, n	19

VSD, ventricular septal defect; SD, standard deviation; ICU, intensive care unit.

Table 3 Nutritional indexes of 22 cases

Nutritional indexes	Postoperative
Hb (g/L)	101.5 (median)
Normal, n	1
Hb >90, n	17
60< Hb <90, n	4
BMI (kg/m^2)	19.28 (median)
BMI <18.5, n	4
18.5< BMI <24.9, n	17
25.0< BMI <29.9, n	1
ALB (g/L)	34.9 (median)

The normal range in our hospital laboratory is Hb, male <130 g/L, female <115 g/L; ALB, 40–55 g/L. Hb, hemoglobin; BMI, body mass index; ALB, albumin.

MP infection had normal peripheral blood leukocytes and neutrophil counts, and a mild increase in PCT, while 10/22 of the patients had decreased LYMPH counts. In addition, some patients had abnormal liver function, and one had poor basal renal function.

Imaging

As shown in *Table 8*, seventeen patients had no abnormalities on imaging, while new lung lesions were seen in five.

Diagnosis of MP antibodies and MP infection

As shown in *Table 9*, 17 patients had a four-fold increase or decrease in the potency of serum anti-MP antibodies, and the anti-MP antibody titer of five did not meet the standard of recovery. However, the clinical diagnosis was analyzed based on a combination of a continuous ≥1:160 combined with the medical history, laboratory results, pulmonary imaging, and effective treatment with macrolides and quinolone antibiotics.

Treatment and outcome

Moxifloxacin injections were given to 14 patients, three received levofloxacin injections, and five received macrolides (azithromycin, clarithromycin). After completing their treatment, all patients were discharged.

Discussion

In this study we examined the clinical characteristics and diagnostic challenges for disease in 22 patients with hospital-acquired MP infection after cardiac surgery to improve the diagnosis rate.

Clinical features

According to the statistical results of this study, the symptoms of hospital-acquired MP infection were primarily fever and cough, and its signs were mainly pharyngeal congestion, lymph node enlargement and rash, while most lungs had no significant imaging abnormalities. These results suggest there is no significant difference between hospital-acquired MP infection and community-acquired MP infection in terms of symptoms, signs, laboratory tests, and imaging (13). However, the incidence of rash

Table 4 Antibiotic use conditions of 22 cases before onset

Patient number	Duration of antibiotic use before onset of disease (days)	Antibiotic varieties (in order of use)
1	16	Vancomycin, imipenem/cilastatin sodium; cefoperazone sodium/tazobactam sodium
2	25	Imipenem/cilastatin sodium, vancomycin, cefoperazone sodium/tazobactam sodium, teicoplanin
3	12	Cefuroxime sodium, cefoperazone sodium/tazobactam sodium, imipenem/cilastatin sodium, vancomycin
4	10	Ceftriaxone sodium, amikacin, vancomycin, imipenem/cilastatin sodium
5	17	Cefoperazone sodium/sulbactam sodium, vancomycin
6	30	Cefoperazone sodium/sulbactam sodium, vancomycin, panipenem betamipron, fluconazole, linezolid, cefoperazone sodium/tazobactam sodium
7	4	Amoxicillin/clavulanic acid potassium
8	12	Cefoperazone sodium/sulbactam sodium, cefoperazone sodium/tazobactam sodium, vancomycin
9	22	Cefuroxime sodium, cefotaxime sodium/sulbactam sodium
10	31	Cefoperazone sodium/sulbactam sodium, vancomycin, imipenem/cilastatin sodium, cefotaxime sodium/sulbactam sodium, teicoplanin
11	11	Cefuroxime sodium, cefoperazone sodium/tazobactam sodium, isopalmitic
12	11	Cefoperazone sodium/tazobactam sodium, teicoplanin
13	11	Cefoperazone sodium/sulbactam sodium, cefotaxime sodium/sulbactam sodium
14	40	Teicoplanin, imipenem/cilastatin sodium, cefoperazone sodium/sulbactam sodium
15	8	Cefuroxime sodium, cefotaxime sodium/sulbactam sodium
16	10	Cefoperazone sodium/tazobactam sodium, teicoplanin
17	15	Meropenem, teicoplanin
18	21	Vancomycin, cefoperazone sodium/tazobactam sodium, piperacillin sodium/tazobactam sodium
19	22	Cefoperazone sodium/sulbactam sodium, imipenem/cilastatin sodium, cefoperazone sodium/tazobactam sodium, vancomycin, fluconazole
20	17	Cefoperazone sodium/sulbactam sodium, vancomycin, cefoperazone sodium/tazobactam sodium, teicoplanin, amikacin
21	16	Imipenem/cilastatin sodium, vancomycin, ceftriaxone sodium
22	22	Penicillin, amikacin, imipenem/cilastatin sodium, vancomycin, cefotaxime sodium/sulbactam, cefodizime

was higher, with six cases of rash and three of combined LYMPH reduction in absolute value, although as patients were polymedicated, it was difficult to differentiate the rash (14,15). Furthermore, the immunopathogenesis of CD4 T-cell redistribution may contribute to the development of Stevens-Johnson syndrome (16).

There are two points worth noting regarding difficulties in the pathogenic diagnosis of hospital-acquired MP infections. Firstly, the complexities of the patient's underlying disease, as well as the non-specificity of clinical manifestations and imaging of hospital-acquired MP infections make diagnosis difficult. The main manifestation of this condition is fever, which is accompanied by pharyngeal congestion and rash. However, as these patients have been taking antibiotics for extensive periods, when fever and rash appear, it is necessary to determine whether this is due to drug fever, drug rash, or disease, and as fever and rash can also be caused by many other bacterial

Table 5 Relationship between antibiotic use and lymphocytes

Antibiotics	N	Lymphocytopenia in 10 cases
Glycopeptide antibiotic use	17	
Vancomycin	13	
Vancomycin combined with lymphocytopenia	8	8
Teicoplanin	3	0
Linezolid	1	0
β-lactam	22	2
Penicillin	1	0
Cephalosporin	7	0
Enzyme inhibitors	19	2
Carbapenems	11	0
Aminoglycosides	3	0
Triazoles (Fluconazole)	2	0

Table 6 Symptoms and signs of 22 patients

Symptoms, signs	N
Fever (℃)	
36.0–37.2 (no fever)	1
37.3–38.0 (low fever)	7
38.1–39.0 (moderate fever)	9
>39.0 (high fever)	5
Irritating dry cough	5
Cough with sputum	2
Pharyngalgia	6
Arthralgia	1
Headache	1
Swollen neck and submandibular lymph nodes	3
Enlarged tonsils with pus	2
Rash	6
Oral ulcers	1
Moist rales	1

nosocomial infections, identification is difficult. In addition, most patients have no abnormalities on imaging, while those who do mainly show increased pulmonary exudate. Given these patients are postoperative cardiac patients with underlying pulmonary exudate, it is necessary to determine whether this is the result of a new pulmonary infection, cardiac insufficiency, or surgery-related pulmonary exudate. Secondly, temporal requirements render an early pathogenic diagnosis difficult, and there is little clinical value in traditional MP pathogen isolation and culture, as this takes 3 weeks or more, the culture conditions are strict, and the positive detection rate is low (17). The serum MP antibody test requires two serum specimens collected at 7–14 days intervals demonstrating a 4-fold or greater increase or decrease in antibody potency and is currently an internationally accepted criterion for the diagnosis of MP, although it too is difficult to practice clinically (18). In summary, postoperative cardiac patients are difficult to identify clinically due to severe underlying disease, complex medications, and atypical symptoms and signs. Additionally, laboratory tests in some patients with antibody titer changes that do not meet the standard have led to difficulties in diagnosis.

In this study, MP infection in 10 of 22 patients was clinically considered based on early clinical features combined with an initial MP antibody titer ≥1:40, followed by anti-MP treatment and continued monitoring of MP antibody titer. Therefore, once the diagnosis of MP infection was confirmed, patients with clinical symptoms consistent with it following major cardiac surgery and long-term antibiotic use combined with MP antibody ≥1:40 were given anti-MP therapy immediately.

The cause of hospital-acquired MP infections in

Table 7 Laboratory examination

Laboratory indicators	Absence of fever (preoperative)		Presence of fever	
	N	Mean ± SD or median	N	Mean ± SD or median
Routine blood	0	–	22	–
WBC, $\times10^9$/L				
<3.9	1	3.24	2	3.30
3.9–9.8	13	7.90±1.57	17	6.78±1.40
>9.8	8	13.58±2.42	3	13.47±1.46
GRAN, $\times10^9$/L				
<1.8	2	1.57	1	1.37
1.8–6.3	14	4.97±0.87	17	4.34±1.12
>6.3	6	10.15±2.03	4	9.03±1.30
LYMPH, $\times10^9$/L				
<1.1	1	0.80	10	0.86±0.17
1.1–3.2	18	1.98±0.59	11	1.88±0.61
>3.2	3	3.80±0.53	1	3.41
PCT, ng/mL				
≤0.05	8	–	7	0.047±0.0048
>0.05, ≤0.2	10	–	11	0.11±0.05
>0.2, ≤0.5	4	–	4	0.385±0.100
CRP, mg/L	–	70.69±59.14	–	63.81±53.14
Blood culture (positive)	0	–	0	–
G test (increase)	0	–	0	–
ALT (abnormal)	2	–	4	–
AST (abnormal)	2	–	2	–
Urea (abnormal)	2	–	0	–
Cr (abnormal)	3	–	1	–
BNP (pg/mL)	–	279.5	–	566.5

SD, standard deviation; WBC, white blood cell; GRAN, granulocyte; LYMPH, lymphocyte; PCT, procalcitonin; CRP, C-reactive protein; ALT, alanine transaminase; AST, aspartate transaminase; Cr, creatinine; BNP, B-type natriuretic peptide.

the 22 patients in this study varied and occurred at different times and in different wards. Accordingly, cross-acquired infections were not considered. The main pathogenesis associated with MP infection includes both immunosuppression and autoimmunity. MP will elicit a rapid, yet effective immune response, allowing the body to clear antigenic foreign bodies without damaging its own tissues, and takes place under conditions of a relatively constant immune cell ratio (19). MP has a similar antigenic composition to the host cell membrane and can evade immunosurveillance to form a prolonged parasitic state that allows the host to exist in a carrier state (20). Based on the current pathogenesis of MP infection, we hypothesize it is related to impaired immune function in these patients.

Several factors may have contributed to the impaired immune function of patients in this study. Firstly, most had undergone long-term antibiotic use and combined drug use, and long-term antibiotic use has been shown to

Table 8 Imaging manifestations

Imaging manifestations	N
Lesion site	
Bilateral-lung	4
Unilateral-lung	1
Imaging appearance	
Ground glass	3
Cavity consolidation	2
Hilar or mediastinal lymphadenopathy	1
Pleural	1

Table 9 Range of MP antibodies

MP-Ab	N	Titer
4-fold dynamic change	17	1:40–1:1,280
Continuous ≥1:160	5	1:160–1:320

MP, *Mycoplasma pneumoniae*; Ab, antibody.

impair human immune function (21). Secondly, studies have shown vancomycin use can arouse immunosuppression (22). Glycopeptide antibiotics were used by 13 of the 22 patients in this study prior to fever, with a median cumulative dose of 17 g of vancomycin, while 10 of the 22 had lymphopenia at the time of fever, eight of whom had used vancomycin. Glycopeptide antibiotics are mostly used to treat methicillin-resistant staphylococci and are more commonly used after cardiac surgery. Overall, almost all the postoperative cardiac patients in this study were treated with antibiotics, and the long-term and combination use of these drugs, particularly vancomycin, may disrupt immune balance, allowing latent pathogens to cause immune damage and MP reinfection. Furthermore, due to surgical reasons or underlying diseases, postoperative cardiac patients have poor dietary intake and absorption, resulting in poor nutritional status. A study has confirmed that patients with poor nutritional status are more susceptible to infection (23). Correspondingly, all patients in our study had anemia and hypoproteinemia, and most had lower weight and nutritional indicators after surgery compared to pre-surgery.

Conclusions

Physicians should raise awareness about the occurrence of in-hospital MP infections in post-operative cardiac patients and be alert to its extrapulmonary manifestations as the initial symptoms. Early anti-infection treatment against MP is highly recommended for patients on long-term anti-infective therapy after cardiac surgery who develop new fever, typical clinical symptoms of MP infection, and positive anti-MP antibody titers ≥1:40 during treatment. Changes in MP antibody titers should also be monitored. Limitations of this study: this study is a retrospective observational study on mechanisms for the development of hospital-acquired MP infection in postoperative cardiac patients, and further prospective research on the specific mechanism is warranted.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1491/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1491/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1491/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of Guangdong People's Hospital [No. GDREC2016222H(R2)]. Individual consent for this retrospective analysis was waived.

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