Management of atrial fibrillation following cardiac surgery: Observational study and development of a standardised protocol

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Abstract

Rationale, aims and objectives: Postoperative atrial fibrillation (POAF) is the most common complication occurring after cardiac surgery. Guidelines for the management of this complication are scarce, often resulting in differences in treatment strategy use among patients. The aims of this study were to evaluate the management of POAF in a cardiac surgery department, characterise the extent of its variability and develop a standardised protocol. Methods: Data from patients who underwent cardiac surgeries with subsequent POAF between 1 January 2017 and 1 June 2018 were analysed in this single-centre observational retrospective study. The primary outcome was the difference in the proportions of patients whose first POAF episodes were treated with a rate control (RaC) strategy, a rhythm control (RhC) strategy and both among hospital units (intensive care unit [ICU], intermediate care unit [IMCU] and general ward [GW]). Secondary outcomes included the mean duration of POAF episodes, POAF recurrences, and the management of anticoagulation. Results: Data from 97 patients were included in this study. The POAF management strategy differed significantly among hospital units (ICU: RhC 75.0%, RhC and RaC 19.4%, RaC 0.0%; IMCU: RhC 40.4%, RhC and RaC 34.6%, RaC 13.5%; GW: RhC 22.2%, RhC and RaC 33.3%, RaC 44.4%; p = 0.001). Ninety-five (97.9%) patients converted to sinus rhythm after the first POAF episode; 51.2% of these conversions occurred within 8 h after onset. POAF recurred in 56.7% of patients. Considering all POAF episodes, 83 (85.6%) patients received amiodarone as part of the RhC strategy. Based on these results, a hospital working group developed a standardised protocol for POAF management. Conclusions: POAF management was heterogeneous at our institution. This paper highlights the need for clear practice guidelines based on large prospective studies to provide care according to best practices for all patients undergoing cardiac surgery.

1 INTRODUCTION

Atrial fibrillation (AF) is the most commonly occurring complication after cardiac surgery, with incidences of 16–33% after coronary artery bypass grafting (CABG),[1,2] 37–50% after valve surgery[1,3,4] and up to 60% after valve replacement with CABG.[1,3] Postoperative atrial fibrillation (POAF) occurs 24–48 h after cardiac surgery, and 43% of patients with this complication experience more than one episode.[5] POAF is transient in most patients; spontaneous conversion to sinus rhythm (SR) occurs within 2 h in 15–30% of cases and within 24 h in up to 80% of cases.[3] Despite this transience and hemodynamic tolerance in most cases, POAF has been related to increased in-hospital and long-term mortality rates in multiple studies.[5-7] It has also been related to the prolongation of hospitalisation, increased cost of care and increased risk of perioperative stroke.[8]

Strategies for POAF prevention with the preoperative use of beta blockers, anti-arrhythmic drugs, calcium channel blockers, colchicine, statins and antioxidants have been tested extensively, but whether they affect

the incidence of POAF remains controversial.[9-16] Only beta blockers, amiodarone and sotalol have been shown to effectively reduce the incidence of POAF, and they have only moderate effects.[17,18] In everyday clinical practice, the efficacy of these drugs should be weighed against their side effects.[19]

POAF management has not been studied extensively, and no evidence-supported consensus on the best strategy has been reached.[20,21] POAF management has three main goals: the maintenance of hemodynamic stability with the reduction of symptoms, the prevention of thromboembolic events and the reduction of recurrence risk.[22] It can be achieved by rate control (RaC) or rhythm control (RhC), using anti-arrhythmic drugs or direct-current (DC) cardioversion. Recent studies have found no significant difference in the risks and benefits of these two strategies.[23] RaC is achieved with drugs (mainly beta blockers) that have fewer side effects of long-term use than do the drugs used for RhC (e.g. amiodarone), but amiodarone is easier to use in the acute phase because it acts rapidly and is less likely to provoke hemodynamic instability than are intravenously administered beta blockers. Despite the lack of strong evidence, most experts recommend RaC as the first-line strategy for POAF management in hemodynamically stable patients.[22,24]

No clinical study has examined stroke prevention in patients with POAF; the currently used strategy has been extrapolated from the guidelines for classic AF. The risk of stroke is considered to be significant when the POAF duration exceeds 48 h or multiple episodes occur.[24] For classic AF, the CHA_2DS_2-VASc score was developed to estimate the risk of thromboembolism, with anticoagulation recommended when the score is [?]2.[25]This score has not been validated for POAF, but it is used in some postoperative settings. The European Society of Cardiology's guidelines recommend the initiation of anticoagulation in all patients with POAF in the absence of contraindication (e.g., major bleeding).[20]

We observed that POAF management was highly variable among the intensive care unit (ICU), intermediate care unit (IMCU) and general ward (GW) of our institution, a Swiss university hospital. This variability may be explained partly by differences in medical practices deriving from the physicians' different backgrounds. We also observed that amiodarone was used most commonly for POAF management. We thus conducted this study to examine POAF management among patients admitted to the hospital for cardiac surgery. The primary outcome was the management of the first PAOF episode (RhC or RaC), according to the units in which patients were hospitalised. Secondary outcomes were the rate of return to SR, POAF recurrence rate and anticoagulation management. In addition, we present a standardised POAF management protocol that was developed at our institution based on the literature, expert advice and the findings of this study.

2 METHODS

2.1 Study design and population

This single-centre observational retrospective study was conducted with data from patients who underwent cardiac surgery at our institution between 1 January 2017 and 1 June 2018 and subsequently developed POAF. It was approved by the local ethics committee (*Commission d'Ethique de la Recherche du Canton de Vaud* ; no. 2018-01038) and complied with the principles of good clinical practice and the Declaration of Helsinki. The patients were identified via coding for cardiac surgery and POAF as a complication in the hospital's billing database. The following types of surgery were included: CABG, all valvular surgeries (i.e. valve replacement and repair), aortic surgeries with and without valvular surgery (i.e. Bentall surgery, Tirone David surgery, ascending aorta replacement). POAF was detected by cardiac monitoring during hospitalisation and diagnosed by the physician in charge at the time of onset. At our institution, patients are usually hospitalised first in the ICU after cardiac surgery, and then in the IMCU and finally in the GW. In the ICU and IMCU, all patients are under continuous cardiac monitoring and arrythmia detection. Thus, POAF could be diagnosed in any of these units. Patients for whom informed consent was not obtained, those aged < 18 years, those with known AF at baseline and patients who underwent other cardiac surgeries (i.e. extracorporeal membrane oxygenation placement, pacemaker placement, pericardiectomy, left ventricular assist device implantation and cardiac transplantation) were excluded.

2.2 Data collection

Data were collected from patients' electronic medical records (Soarian®/Metavision®) and entered into a database (Filemaker Pro®, Clarivate International Inc.) stored on a secure server. The following data were collected: patient age and sex, diagnoses, surgical data (date, type of surgery, duration of heart-lung bypass, complications), post-surgical left ventricular ejection fraction (determined by transthoracic echocardiography), date of POAF onset, duration of POAF, type of POAF (slow [ventricular rate $<$ 60 bpm], controlled [ventricular rate 60–100 bpm] or rapid [ventricular rate [?] 110 bpm]), hemodynamic instability (severe hypotension with systolic blood pressure $<$ 90 mmHg, signs of peripheral hypoperfusion or pulmonary oedema) during POAF, acute management strategy (RaC or RhC), anti-arrhythmic drug used when cardioversion was chosen (amiodarone, propafenone or flecainide), drug dose and duration of administration, date of SR conversion, assessment of relapse, acute management of relapse and use of oral and intravenous (IV) anticoagulants.

2.3 Primary outcome

The primary outcome was the difference in the proportions of patients whose first POAF episodes were managed using RaC and RhC strategies among hospital units (ICU, IMCU or GW). We considered the use of anti-arrhythmic drugs or DC cardioversion to comprise RhC strategies, and the use of beta blockers or non-dihydropyridine calcium channel blockers (i.e. diltiazem, verapamil) to comprise RaC strategies. We also recorded cases in which both strategies were employed, and those in which neither strategy was used (i.e. no antiarrhythmic or bradycardic drug administration).

2.4 Secondary outcomes

Secondary outcomes were the duration of the first POAF episode, the number of recurrences according to the management strategy (RhC and RaC) used at the time of recurrence, the total amount of amiodarone used during hospitalisation (including oral administration, IV boluses and infusions) and the performance of anticoagulation management. We considered that an anticoagulant should have been administered when the CHA_2DS_2-VASc score was [?]2 and when a POAF lasted [?]48 h or multiple episodes occurred within 48 h.

2.6 Statistical analysis

Basic descriptive statistics were used to determine proportions for categorical variables and medians with interquartile range (IQRs) for continuous variables. We used the χ^2 test to assess differences in the proportions of management strategies applied among hospital units. All tests were two tailed, and the significance level was set to $p < 0.05$. The statistical analysis was performed using the STATA software (version 14; Stata Corporation, College Station, TX, USA).

3 RESULTS

3.1 Baseline characteristics of the study population

In total, 175 patients who underwent cardiac surgery and developed POAF at our hospital during the study period were identified. After the exclusion of patients who did not provide informed consent, the medical records of 159 patients were examined. As computer-assisted prescription was initiated in February 2017, 17 additional patients were excluded due to missing data. The application of the remaining exclusion criteria resulted in a final sample of 97 patients (Figure 1).

Most (85.5%) patients were male, and the median patient age was 69 (IQR, 63–75) years. CABG was the most frequently performed type of surgery (83.0%), and the median duration of hospitalisation was 15 (IQR, 12–20) days (Table 1).

POAF occurred 1–3 days after surgery in 79 (81.4%) patients and later in the remaining patients. At the time of POAF onset, 52 (53.6%) patients were in the ICU, 36 (37.1%) were in the IMCU and 9 (9.3%) patients were in the GW. Most (81 [83.5%]) patients developed rapid POAF; 14 (14.4%) patients had controlled POAF and 2 (2.1%) had slow POAF. Only 5 (5.2%) patients had documented hemodynamic instability.

3.2 Management of first POAF episodes

Patients' first POAF episodes were managed with the RhC strategy alone in 50 (51.5%) cases (47 with chemical cardioversion and 3 with chemical and DC cardioversion), with the RaC strategy alone in 11 (11.3%) cases and with RhC and RaC strategies combined in 28 (28.9%) cases (26 with chemical and 2 with chemical and DC cardioversion). Chemical cardioversion was performed with amiodarone in all 78 cases; 39 (50.0%) patients received IV boluses (150–300 mg, one to three boluses) followed by continuous perfusion at doses of 600–900 mg over 24 h, 38 (48.7%) patients received IV boluses with no continuous perfusion, and 1 patient received continuous perfusion only. RaC was performed with beta blockers in all 39 cases; IV metoprolol infusion (5 mg) with a relay to oral metoprolol (12.5–50 mg) was used in 7 (17.9%) cases, oral metoprolol alone was used in 31 (79.5%) cases and oral nadolol was used in one case.

The proportions of cases in which the different POAF management strategies were applied differed significantly among hospital units ($p = 0.001$). POAF management consisted primarily of RhC in the ICU, was more heterogeneous in the IMCU and even more in the GW (Figure 2).

3.3 POAF duration and return to SR

Conversion to SR after the first POAF episode occurred in 95 (97.9%) cases; two patients had POAF until discharge (1 persistent and 1 paroxysmal). As presented in Figure 3, most (51.2%) patients returned to SR in <8 h; six patients had episodes lasting >48 h.

3.4 POAF recurrence

POAF recurred in 55 (56.7%) of the 95 patients with conversion to SR; 24 (43.6%) patients had one recurrence, 11 (20.0%) had two recurrences and 20 (36.4%) had three or more recurrences. The management of POAF recurrence was heterogeneous and depended on the management of the first episode. Among the 11 patients whose first POAF episodes were managed with an RaC strategy, recurrence was managed using an RhC strategy in two cases, the beta blocker dose was up-titrated or an IV bolus of metoprolol was administered in three cases, 2 g IV magnesium was administered in two cases, and DC cardioversion was performed in one case. Among the eight patients whose first episodes were not managed using an RaC or RhC strategy, second episodes were managed using an RhC strategy with amiodarone in two cases, an RaC strategy with beta blockers in two cases, 2 g IV magnesium in two cases and DC cardioversion in one case.

3.5 Overall management of all POAF episodes during hospitalisation

Overall, POAF occurring during hospitalisation was managed using the RaC strategy alone in 10 (10.3%) patients, the RhC strategy alone in 41 (42.3%) patients, both strategies in 42 (43.3%) patients and neither strategy in 4 (4.1%) patients. Eighty-three (85.6%) patients received amiodarone for POAF. The cumulative amiodarone doses were 0.15–2.9 g for 25 (30.1%) patients, 3.0–5.9 g for 34 (41.0%) patients and 6.0–12.0 g for 24 (28.9%) patients.

3.6 Anticoagulation management

Anticoagulation was performed in 58 (59.8%) patients. Acenocoumarol was used in 46 (79.3%) cases, a direct oral anticoagulant (DOAC) was used in 7 (12.1%) cases and a subcutaneous therapeutic dose of enoxaparin was used in 5 (8.6%) cases (Figure 4).

Twenty-one (21.6%) patients in the total sample had anticoagulation indications other than the prevention of thromboembolism due to POAF; 13 (61.9%) patients had undergone mitral valve repair or replacement, 6 (28.6%) had undergone aortic valve replacement (one of the surgeons performing biologic aortic valve replacement prescribed a vitamin K antagonist [VKA] for 3 months postoperatively), 1 (4.8%) had heparin-induced thrombocytopenia and 1 (4.8%) had upper-limb thrombosis. All of these patients received acenocoumarol, in some cases after bridging with parenteral anticoagulant (IV heparin or low-molecular-weight heparin).

Anticoagulation management was suboptimal in 23 (29.5%) of the 78 patients with POAF and no other anticoagulation indication (Figure 4). Of 38 patients with indications for anticoagulation (POAF duration [?] 48 h and CHA_2DS_2VASc score [?] 2), 12 (31.6%) did not receive an anticoagulant. Of 38 patients with no anticoagulation indication (POAF duration $<$ 48 h, or POAF duration [?] 48 h and CHA_2DS_2VASc score $<$ 2), 11 (28.9%) received an anticoagulant with therapeutic dosing.

3.7 Status and prescriptions at discharge

At discharge, 5 patients were still in AF rhythm (1 persistent and 4 paroxysmal) and 71 were in SR. Cardiac rhythm was unknown for 20 patients because it was not mentioned in the discharge letters and no electrocardiographic data from the time of discharge were available. The discharge letters for 36 (37.1%) patients recommended cardiac rhythm assessment.

Forty-five (46.4%) patients were discharged with prescriptions for amiodarone (38 with maintenance doses, 7 with 200 mg t.i.d. or b.i.d. to complete the loading doses), 72 (74.2%) patients were discharged with prescriptions for beta blockers, 39 (40.2%) were discharged with prescriptions for VKAs and 8 (8.2%) were discharged with prescriptions for DOACs. Only six (6.2%) patients did not receive any of these medications.

4 DISCUSSION

This study confirmed the heterogeneity of POAF management at our hospital. In addition, we identified suboptimal management of POAF in some cases, particularly concerning the use of amiodarone and the initiation of anticoagulation. These problems may be related in part to the lack of consensus about the best management strategy and highlights the need for practice guidelines.

Our results are in line with international findings. Experts from the Society of Cardiovascular Anesthesiologists and European Association of Cardiothoracic Anaesthetists have identified wide practice variability in POAF prevention and management, with less than one-third of survey respondents in North America and Europe reporting the use of beta blockers for these purposes.[26] These experts also identified differences in practice between academic centres and private practices, and among practice providers.[26] The heterogeneity of POAF management at our hospital is probably due partly to the patient's journey through the hospital after surgery. Any one of various physicians may be in charge of a patient at the time of POAF onset. In the ICU, intensive care physicians make PAOF management decisions and are more likely to implement an

RhC strategy. In the IMCU and GW, cardiac surgery teams make such decisions. Thus, the establishment of consensus among these medical professionals is essential.

Amiodarone was used largely as part of the RhC strategy, but its use was suboptimal in many cases in our sample. The cumulative amiodarone dose was [?] 6 g in only one-third of the patients. Due to its pharmacokinetic properties and very long half-life, amiodarone should be initiated with loading IV doses to be effective. Multiple dosing schemes exist, but most practice guidelines recommend a loading dose of 6–10 g amiodarone before switching to a once-daily oral dose of 100–200 mg.[20,21,27]

Suboptimal management of anticoagulation was observed in approximately one in three patients in our sample. This finding demonstrates the difficulty of the decision to initiate anticoagulation for POAF, as it is not addressed well in guidelines. For example, no clear POAF duration threshold has been established; some experts recommend the initiation of anticoagulation in patients with POAF durations $>$ 48 h and in those with multiple episodes, due to the risk of stroke,[24] whereas the European Society of Cardiology (ESC) recommends the systematic use of anticoagulants at the time of POAF onset, considering the risks of stroke and postoperative bleeding, without specifying the timing of initiation[20]. Anticoagulation initiation in the post–cardiac surgery setting is more complex than that in the classic AF setting because it can increase the risks of pericardial effusion and tamponade, especially in the early postoperative period.[28] These complications occur predominantly in patients with supratherapeutic international normalised ratios (INRs) and [?]1 week after surgery; in most cases, the risk of bleeding is low and stroke prevention should be considered.[24] Patient monitoring during the first weeks after surgery is particularly important to avoid supratherapeutic INRs. We recommend the initiation of anticoagulation in every patient with POAF who has a low bleeding risk. When POAF occurs several hours after surgery, the bleeding risk is high and the decision to start anticoagulation is always difficult. The CHA_2DS_2-VASc[29] and HAS-BLED[30] scores, which have not been used extensively in the post-surgery setting, are probably the most useful tools for the identification of patients in need of anticoagulation over the long term, at least several weeks after surgery.

Our results show that the best care strategy in hemodynamically patients is still unclear. We found that RhC was used commonly, and RaC alone was used rarely, at our institution. As most patients in our sample were not hemodynamically unstable and POAF is known to be transient, the treatment of almost all patients with amiodarone for cardioversion is questionable. Moreover, we do not know whether these patients would have converted spontaneously to SR without treatment. Although it is considered to be a highly effective anti-arrhythmic drug, amiodarone has a wide range of significant side effects, including dysthyroidism, bradycardia, QT interval prolongation, and ocular, pulmonary and hepatic toxicity, which affect up to 19% of patients after 1 year of treatment[31-33]. It also has the potential for pharmacokinetic interaction due to its inhibitory effects on the cytochrome P450, which may lead to an increased effect of VKA with risks of supratherapeutic INR and bleeding. Amiodarone is even more dangerous when combined with DOACs, as the anticoagulant effect of the latter cannot be monitored. Nevertheless, amiodarone can be used in patients with structural heart disease and in those with renal failure, which makes it the first-choice agent for chemical cardioversion after cardiac surgery.[20] In other words, amiodarone is highly effective, should be used for only short periods of time due to its toxicity. We detected no side effect of amiodarone, in our sample, but we did not follow patients after discharge and most such effects occur over the long term. However, because of recent data showing no benefit of RhC over RaC in stable patients[23] and because guidelines advocate the use of RaC as the first choice in these patients,[20] we believe that more patients in our sample could have been treated safely with an RaC strategy.

As we found that POAF management in our institution was variable and no internal protocol had been established, we formed a working group including cardiologists, cardiac surgeons and intensivists, who developed and agreed on a standardised protocol for the management of POAF after cardiac surgery (Figure 5). This protocol promotes the use of an RaC strategy instead of an RhC strategy in hemodynamically stable patients. As guidelines on this topic remain very scarce, this protocol could also be useful to other centres.

4.1 Limitations

The major limitation of this study is related to its observational and retrospective nature. Retrospective data collection can involve missing information and uncertainty. The quality of our data depended on the quality of the reporting of every event in the patients' medical records. However, questions about the ability to use unclear event records were resolved by the data-collecting master's student's consultation with the principal investigator. In addition, as this study was conducted at a single tertiary hospital, the findings cannot be generalised to all centres worldwide.

4.2 Conclusions

POAF management remains very variable at our institution, and likely in many centres worldwide. Despite previously published evidence that the RaC and RhC strategies are equivalently effective in hemodynamically stable patients, we found that 85.6% of patients received amiodarone as part of an RhC strategy. Moreover, when amiodarone was used, it dosage was not always adequate; many cumulative doses were below the recommended dose. Lastly, we found that anticoagulation management was not optimal. Our results show the impacts of the lack of clear guidelines about POAF management and highlight the need for larger prospective studies to fill this gap in the literature. In the meantime, we developed our own protocol, presented here; we now face the challenge of implementing it to offer care based on best practices to patients undergoing cardiac surgery.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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FIGURE LEGENDS

FIGURE 1 Flow of inclusion of patients hospitalised for cardiac surgery between 1 January 2017 and 1 June 2018. AF, atrial fibrillation; CABG, coronary artery bypass grafting

FIGURE 2 Acute management of postoperative atrial fibrillation according to hospital unit at the time of onset ($n = 97$). ICU, intensive care unit; IMCU, intermediate care unit

FIGURE 3 Duration of first POAF episode in patients who returned to normal sinus rhythm, stratified by the strategy employed at episode onset ($n = 82$; 13 POAF durations were unknown and 2 POAFs were persistent). POAF, postoperative atrial fibrillation

FIGURE 4 Anticoagulation management in patients with POAF ($n = 97$). Red squares indicate suboptimal management and green squares indicate optimal management. POAF, postoperative atrial fibrillation, VKA, vitamin K antagonist; $CHA_2DS_2VAS_c$; DOAC, direct oral anticoagulant

FIGURE 5 Algorithm for POAF management. POAF, postoperative atrial fibrillation; ECG, electrocardiogram; IV, intravenous; LVEF, left ventricular ejection fraction; ICU, intensive care unit; IMCU, intermediate care unit; DC, direct current; UFH, unfractionated heparin; LMWH, low-molecular-weight heparin; VKA, vitamin K antagonist; DOAC, direct oral anticoagulant; HD, hemodynamically; TEE, trans-oesophageal echography; SBP, systolic blood pressure; aPTT, activated partial thromboplastin time; TP, prothrombin time; INR, international normalised ratio; AV, atrio-ventricular block; GFR, glomerular filtration ratio;

HR, heart rate; COPD, chronic obstructive pulmonary disease; WpW, Wolff Parkinson White; AF, atrial fibrillation.

TABLE 1 Characteristics of patients and procedures during index hospitalisation according to the strategy employed at the time of POAF onset

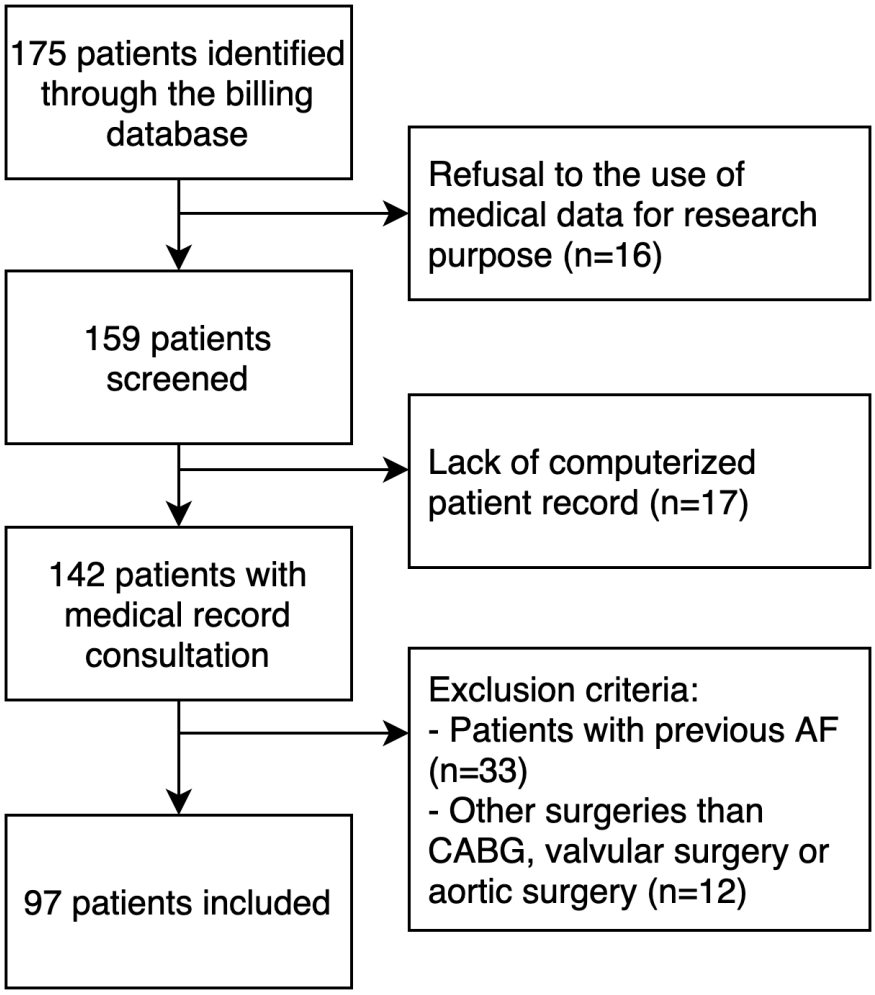
Characteristic	**Characteristic**	**Characteristic**
Demographic characteristics	Demographic characteristics	Demographic characteristic
Sex, male, *n* (%)	Sex, male, *n* (%)	Sex, male, *n* (%)
Age, years, median (IQR)	Age, years, median (IQR)	Age, years, median (IQR)
Medical history, *n* (%)	Medical history, *n* (%)	Medical history, *n* (%)
Co-morbidities	Co-morbidities	Co-morbidities
	Hypertension	Hypertension
	Diabetes	Diabetes
	Vascular disease^{+}	Vascular disease^{+}
ACS	ACS	ACS
Index surgical procedure, *n* (%)	Index surgical procedure, *n* (%)	Index surgical procedure, *n*
	CABG only	CABG only
	Valve replacement only	Valve replacement only
		Aortic valve only
		Mitral valve only
		Aortic and mitral valves
	Valve repair only	Valve repair only
		Aortic valve only
		Mitral valve only
		Aortic and mitral valves
	Valve replacement and valve repair	Valve replacement and valv
	Ascending aorta replacement	Ascending aorta replaceme
	Bentall surgery	Bentall surgery
	CABG and ascending aorta replacement	CABG and ascending aorta
	CABG and valve replacement	CABG and valve replaceme
		Aortic valve replacement
		Mitral valve replacement
	CABG and mitral valve repair	CABG and mitral valve rep
	Other mixed surgeries^{++}	Other mixed surgeries^{++}
Bypass time, median (IQR)	Bypass time, median (IQR)	Bypass time, median (IQR)
Postoperative complications, *n* (%)	Postoperative complications, *n* (%)	Postoperative complication
Postoperative LVEF function, median (IQR)§	Postoperative LVEF function, median (IQR)§	Postoperative LVEF functi
	<40%	<40%
	40–49%	40–49%
	[?]50%	[?]50%
Length of hospital stay, days, median (IQR)	Length of hospital stay, days, median (IQR)	Length of hospital stay, day

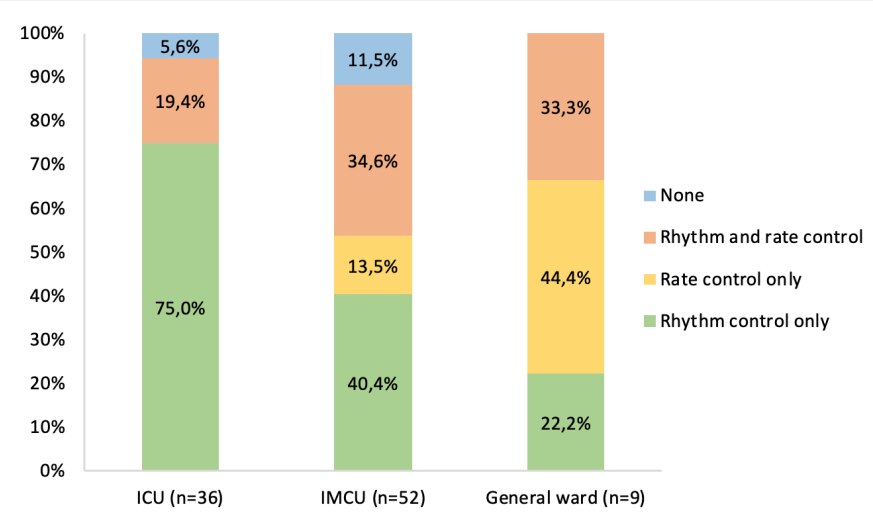
$^{+}$Coronary artery disease, stroke, deep vein thrombosis, peripheral artery disease or atherosclerosis.

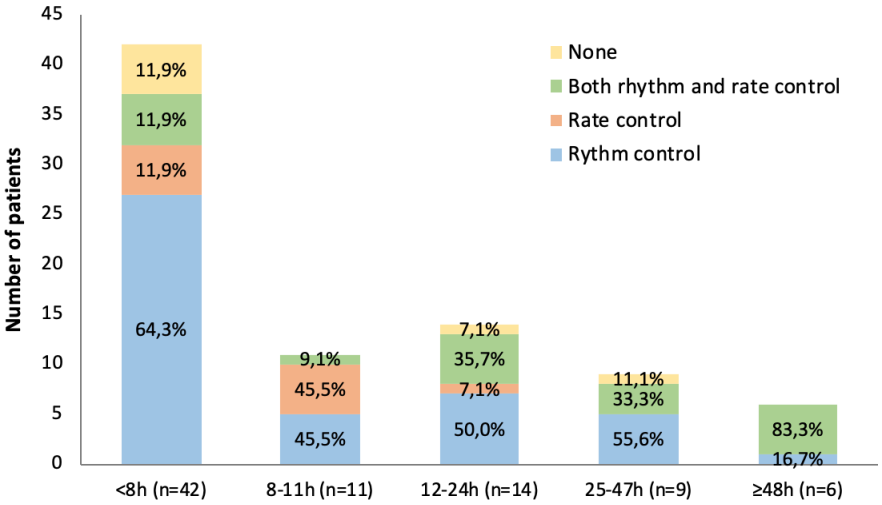
$^{++}$Ascending aorta replacement with mitral and aortic valve replacement, CABG with mitral valve repair and ascending aorta replacement.

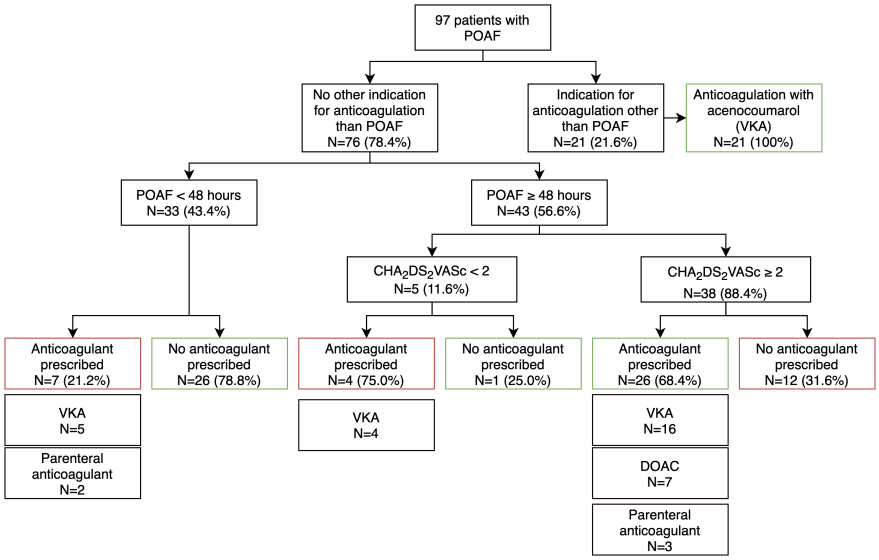
§ Data missing for 15 patients (7 in the rhythm control group, 7 in the rhythm and rate control group, 1 in the rate control group).

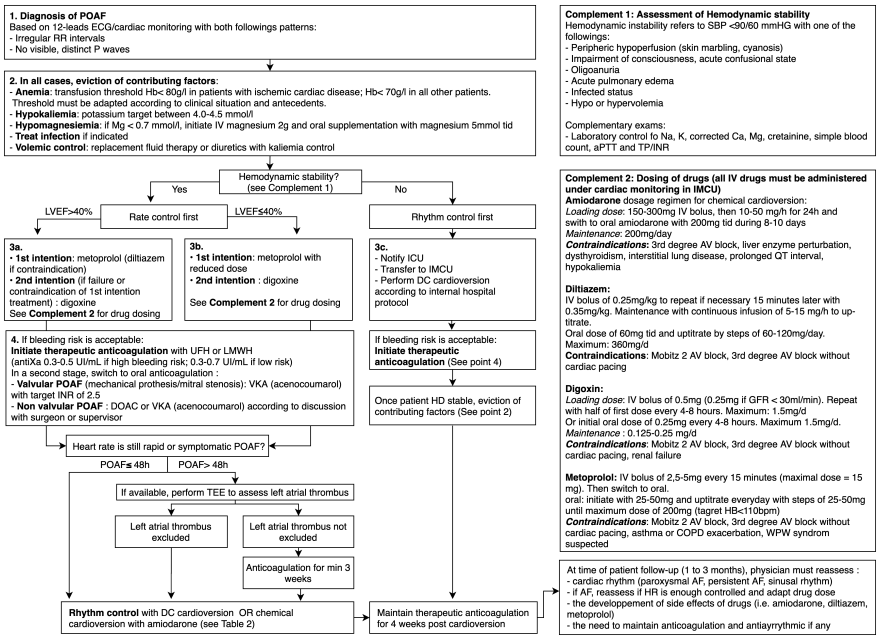
POAF, postoperative atrial fibrillation; IQR, interquartile ratio; ACS, acute coronary syndrome; CABG, coronary artery bypass grafting; LVEF, left ventricular ejection fraction.











Complement 1: Assessment of Hemodynamic stability
Hemodynamic instability refers to SBP <90/60 mmHG with one of the followings:
- Peripheric hypoperfusion (skin marbling, cyanosis)
- Impairment of consciousness, acute confusional state
- Oligoanuria
- Acute pulmonary edema
- Infected status
- Hypo or hypervolemia

Complementary exams:
- Laboratory control fo Na, K, corrected Ca, Mg, cretainine, simple blood count, aPTT and TP/INR

Complement 2: Dosing of drugs (all IV drugs must be administered under cardiac monitoring in IMCU)
Amiodarone dosage regimen for chemical cardioversion:
Loading dose: 150-300mg IV bolus, then 10-50 mg/h for 24h and swith to oral amiodarone with 200mg tid during 8-10 days
Maintenance: 200mg/day
Contraindications: 3rd degree AV block, liver enzyme perturbation, dysthyroidism, interstitial lung disease, prolonged QT interval, hypokaliemia

Diltiazem:
IV bolus of 0.25mg/kg to repeat if necessary 15 minutes later with 0.35mg/kg. Maintenance with continuous infusion of 5-15 mg/h to up-titrate.
Oral dose of 60mg tid and uptitrate by steps of 60-120mg/day.
Maximum: 360mg/d
Contraindications: Mobitz 2 AV block, 3rd degree AV block without cardiac pacing

Digoxin:
Loading dose: IV bolus of 0.5mg (0.25mg if GFR < 30ml/min). Repeat with half of first dose every 4-8 hours. Maximum: 1.5mg/d
Or initial oral dose of 0.25mg every 4-8 hours. Maximum 1.5mg/d.
Maintenance : 0.125-0.25 mg/d
Contraindications: Mobitz 2 AV block, 3rd degree AV block without cardiac pacing, renal failure

Metoprolol: IV bolus of 2,5-5mg every 15 minutes (maximal dose = 15 mg). Then switch to oral.
oral: initiate with 25-50mg and uptitrate everyday with steps of 25-50mg until maximum dose of 200mg (tagret HB<110bpm)
Contraindications: Mobitz 2 AV block, 3rd degree AV block without cardiac pacing, asthma or COPD exacerbation, WPW syndrom suspected

At time of patient follow-up (1 to 3 months), physician must reassess :
- cardiac rhythm (paroxysmal AF, persistent AF, sinusal rhythm)
- if AF, reassess if HR is enough controlled and adapt drug dose
- the developpement of side effects of drugs (i.e. amiodarone, diltiazem, metoprolol)
- the need to maintain anticoagulation and antiayrrythmic if any