Incidence and recurrence of new-onset atrial fibrillation detected during hospitalization for non-cardiac surgery: a systematic review and meta-analysis

Incidence et récurrence de nouvelle fibrillation auriculaire détectée pendant l'hospitalisation pour une chirurgie non cardiaque : revue systématique et méta-analyse

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Abstract

Purpose This systematic review aimed to summarize reports of the incidence and long-term recurrence of new-onset atrial fibrillation (AF) associated with non-cardiac surgery.

Sources We searched CENTRAL, MEDLINE and EMBASE

from inception to November 2019. We included studies that reported on the incidence of new-onset perioperative AF during hospitalization for non-cardiac surgery and/or AF recurrence in such patients following discharge. Reviewers screened articles and abstracted data independently and in duplicate. We assessed study quality by appraising methodology for collecting AF history, incident AF during hospitalization, and AF recurrence after discharge.

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Principal findings From 39,233 citations screened, 346 studies that enrolled a total of 5,829,758 patients met eligibility criteria. Only 27 studies used prospective, continuous inpatient electrocardiographic (ECG) monitoring to detect incident AF. Overall, the incidence of postoperative AF during hospitalization ranged from 0.004 to 50.3%, with a median [interquartile range] of 8.7 [3.8–15.0]%. Atrial fibrillation incidence varied with type of surgery. Prospective studies using continuous ECG monitoring reported significantly higher incidences of AF than those that did not (13.9% vs 1.9%, respectively; $P < 0.001$). A total of 13 studies (25,726 patients) with follow-up up to 5.4 years reported on AF recurrence following hospital discharge; only one study used a prospective systematic monitoring protocol. Recurrence rates ranged from 0 to 37.3%.

Conclusions Rates of AF incidence first detected following non-cardiac surgery and long-term AF recurrence vary markedly. Differences in the intensity of ECG monitoring and type of surgery may account for this variation.

Trial registration PROSPERO (CRD42017068055); registered 1 September 2017.

Résumé

Objectif Cette revue systématique visait à résumer les comptes rendus sur l'incidence et la récurrence à long terme de la fibrillation auriculaire (FA) de novo associée à une chirurgie non cardiaque.

Sources Nous avons effectué des recherches dans les bases de données CENTRAL, MEDLINE et EMBASE de leur création à novembre 2019. Nous avons inclus les études ayant examiné l'incidence de nouvelle FA périopératoire pendant l'hospitalisation pour une chirurgie non cardiaque et/ou la récurrence de la FA

chez de tels patients après leur congé. Les chercheurs ont passé en revue les articles et les données extraites de manière indépendante et en double. Nous avons estimé la qualité des études en évaluant la méthodologie de collecte des antécédents de FA, de l'incident de FA pendant l'hospitalisation et de la récurrence de FA après le congé.

Constatactions principales Sur les 39 233 citations examinées, 346 études portant sur un total de 5 829 758 patients ont répondu à nos critères d'admissibilité. Seulement 27 études ont utilisé un monitoring électrocardiographique (ECG) continu prospectif et des patients hospitalisés pour détecter les incidents de FA. Dans l'ensemble, l'incidence de FA postopératoire pendant l'hospitalisation allait de 0,004 à 50,3 %, avec une médiane [écart interquartile] de 8,7 [3,8-15,0] %. L'incidence de fibrillation auriculaire variait en fonction du type de chirurgie. Des études prospectives utilisant un monitoring continu par ECG ont fait état d'incidences significativement plus élevées de FA que celles sans monitoring continu (13,9 % vs 1,9 %, respectivement; $P < 0,001$). Au total, 13 études (25 726 patients) avec un suivi allant jusqu'à 5,4 ans ont rapporté leurs données sur la récurrence de FA après le congé de l'hôpital; seule une étude a utilisé un protocole de monitoring prospectif systématique. Les taux de récurrence allaient de 0 à 37,3 %.

Conclusion Les taux d'incidence de nouvelle FA détectés après une chirurgie non cardiaque et la récurrence à long terme de FA varient considérablement. Les différences du degré de monitoring par ECG et le type de chirurgie pourraient expliquer cette variation.

Enregistrement de l'étude PROSPERO (CRD42017068055); enregistrée le 1er septembre 2017.

Keywords atrial fibrillation · secondary · reversible · stroke · perioperative · telemetry

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Atrial fibrillation (AF) is the most common serious heart rhythm disorder and is frequently detected for the first time after surgery.^{1–3} Published articles report a wide range in the incidence of new-onset perioperative AF,^{2,4} which may also vary according to the type of surgery, the baseline risk in the population under study, the approach to electrocardiography (ECG) monitoring, and the definition used for perioperative AF (e.g., ≥ 30 seconds AF duration, AF detected on a monitor, or AF that results in symptoms or requires treatment).^{2,4} New-onset perioperative AF has been associated with higher rates of adverse outcomes and mortality as well as longer length of hospital stay after non-cardiac surgery.^{5–7} In the perioperative setting, AF often resolves before hospital discharge, and the long-term prognosis of patients with AF occurring transiently with

stress (AFOTS) is not well-defined.^{2,8–10} The occurrence of AFOTS could be secondary to physiologic stressors associated with surgery with no long-term consequences; but it may also be newly detected paroxysmal AF.² Understanding whether AFOTS is a short-term problem or the first presentation of a chronic disease (i.e., paroxysmal AF) is critical because the risk of ischemic stroke associated with paroxysmal AF can be reduced with oral anticoagulants (OAC).² Clinical practice guidelines and position statements have reinforced this position.^{11–16} Variation in the incidence estimates and the risk of recurrence of perioperative AF may contribute to the uncertainty in how to manage these patients.

The objective of this study was to systematically review the published literature to estimate: 1) the proportion of patients in whom new-onset AF is detected during hospitalization for non-cardiac surgery, and 2) the proportion of such patients in whom a recurrence of AF is detected over long-term follow-up. We also hypothesized that prospective studies with continuous ECG monitoring would have higher rates of AF detection than those that did not.

Methods

Protocol

The original review protocol was pre-registered (PROSPERO CRD42017068055; 1 September 2017). The differences between the original and final protocol are as follows. We initially planned to include observational and interventional studies including more than ten participants. Nevertheless, to make the number of eligible studies manageable, we changed this threshold to those with more than one hundred participants. As for the secondary outcomes, we initially planned to collect data on risk factors for the development of AF during hospitalization for non-cardiac surgery. To make the review manageable, and because these data are not readily combinable, we elected to forego collection of these data.

Eligibility criteria

This systematic review included prospective and retrospective observational studies of patients hospitalized for non-cardiac surgery. Included studies reported the incidence of new-onset AF during hospital admission for non-cardiac surgery, and/or the rate of AF recurrence following discharge from hospital in patients who had new-onset perioperative AF. We only included studies with > 100 participants. We excluded data from patients with a history of AF before hospital admission and from patients who underwent cardiac surgery.

Search strategy

We created the search strategy (available in the Electronic Supplementary Material [ESM] as eAppendix 1) with input from a medical librarian. We searched Ovid EMBASE (1974–November 2019), Ovid MEDLINE (1946–November 2019), and The Cochrane CENTRAL Library (Wiley) (November 2019). We did not impose language restrictions. The references of eligible papers were screened and experts were consulted to identify additional studies. We did not systematically hand-search conference abstracts or grey literature, but we did include conference abstracts that were captured by our database searches. Search results were imported into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia; available at www.covidence.org). Pairs of reviewers independently screened study titles and abstracts for eligibility using a pre-piloted template. If either reviewer thought the citation could be eligible, the full-text article was evaluated for eligibility. Full texts of the potentially eligible studies were retrieved and screened by pairs of reviewers. Reviewers recorded the principal reason for exclusion. Disagreements were resolved through discussion. Reviewers recorded the principal reason for exclusion.

Data extraction and outcomes

Independently, pairs of reviewers extracted data pertaining to study and participant characteristics, AF incidence, and AF recurrence into a pre-piloted database. Disagreements were resolved through discussion. Reviewers recorded type of surgery, methods for AF diagnosis, approach used to rule out a prior history of AF, and whether studies used continuous ECG monitoring. Standard error (SE) for each study was calculated using the following formula: $SE = \sqrt{((\text{new-onset AF}/\text{total population}) * (1 - (\text{new-onset AF}/\text{total population}))/\text{total population})}$. We grouped studies according to the major organ system under operation. We included studies that combined multiple types of surgeries under the heading “non-cardiac”. Reviewers extracted the number of patients with AF and at risk, excluding those with a prior history of AF when this was reported. Reviewers contacted study authors to clarify ambiguities.

Methodological quality of included studies

Pairs of reviewers appraised the methodological quality of included studies using a pre-piloted tool based on the Newcastle-Ottawa Scale (Table 1).^{4,17} The three domains evaluated in each study were: exclusion of patients with a history of AF, detection of AF in hospital, and detection of AF recurrence following the initial hospitalization. A score was allotted for each domain in each study. We considered

TABLE 1 Quality assessment framework

Domain	Methods for exclusion of a history of AF	Methods for detection of AF in hospital	Methods for detection of AF following hospital discharge
Applicable studies	<i>Incidence and recurrence studies</i>	<i>Incidence and recurrence studies</i>	<i>Recurrence studies only</i>
1	⊕ Searched a prior source (e.g., medical records)	⊕ Continuous monitoring and systematic ECG review	⊕ Systematic ECG monitoring protocol
2	⊕ Reported as no history of AF	Routine ECGs or prospective, continuous monitoring without systematic review	Systematic search for collected ECGs
3	Terms like “new-onset” are used without meeting selections 1 or 2	Retrospective review of ECGs collected non-systematically	Systematic review of diagnoses or non-systematic search for collected ECGs
4	No description	No description	No description

⊕ Denotes item identified as “high quality” in this domain.

AF = atrial fibrillation; ECG = electrocardiography.

studies to be of high quality if they searched medical records to exclude patients with a history of AF, used prospective, continuous, and systematic ECG review to detect AF in hospital, and employed a systematic monitoring protocol to detect AF recurrence.

Meta-analysis and subgroup tests

We used CMA software (Biostat Inc, Englewood, NJ, USA) to perform analyses. For each study, we inputted the incidence of perioperative AF as binomial proportions and calculated the accompanying standard errors.¹⁸ For the overall group of studies and for each type of surgery, we performed meta-analysis using a DerSimonian–Laird random effects model.¹⁹ We assessed between-study heterogeneity quantitatively with the I^2 test and we planned to present a pooled estimate only if $I^2 < 50\%$.¹⁹ We hypothesized that prospective studies with continuous ECG monitoring (i.e., quality score of 1 as defined in Table 1) would detect higher AF rates than those that did not, both in the overall population and in each different type of surgery. We tested this by creating a DerSimonian–Laird random effects model that pool studies based on quality score and compared subgroup effects with an interaction test. To estimate of the proportion of variance explained by continuous monitoring, we created a binary logistic meta-regression model and calculated a goodness-of-fit statistic and accompanying R^2 analogue.²⁰

Results

Screening process

The electronic search generated 39,233 unique citations (Fig. 1). After reference and full-text screening, 346

studies met eligibility criteria, including 345 that reported AF incidence and one that exclusively reported AF recurrence after hospital discharge. Twelve reported data on both incidence and recurrence.

Incidence studies

Study Characteristics

Three hundred and forty-five studies published between 1973 and 2019 reported the incidence of new-onset AF associated with non-cardiac surgery (Table 2; eAppendix 2, ESM). Five studies were published in Mandarin, four studies in Spanish, two studies in French, two studies in Japanese, and one study each in Hungarian, Russian, Icelandic, Romanian and Italian (eAppendix 3, ESM). The remaining studies were published in English. The intensive care unit (ICU) was the primary setting in 55 studies. Seventy studies were prospective cohort studies and 275 were retrospective. One hundred and fifty-three studies included patients who underwent pulmonary surgery, 32 studies included patients who underwent esophagectomy, 20 studies included patients who underwent thoracic surgery not otherwise specified, 60 studies included patients who underwent abdominal or digestive surgery, ten studies included patients who underwent vascular surgery, 26 studies included patients who underwent orthopedic surgery, and 44 studies reported aggregate data from patients who had undergone different types of non-cardiac surgery. The mean age of patients in the included studies ranged from 32 to 80 yr.

The methodologic quality of included studies varied greatly (eAppendix 2, ESM). One hundred and sixty-two studies (47.0%) reported AF incidence after ruling out a

Fig. 1 Study selection diagram (PRISMA Format) **TABLE 2** Median incidence of new-onset atrial fibrillation according to type of surgery

Surgery type	Continuous monitoring <i>n</i> =27 Studies			No continuous monitoring <i>n</i> =318 studies		
	Number of studies	Total number of patients	Median (range) of AF incidence by study (%)	Number of studies	Total number of patients	Median (range) of AF incidence by study (%)
Pulmonary resection/transplant	15	3300	19.1 (7.3–33.7)	138	432,661	11.9 (0.1–50.3)
Esophagectomy	2	242	13.9 (7.8–20.0)	30	13,421	13.4 (1.1–27.7)
Thoracic surgery NOS	5	2280	12.5 (8.7–25.2)	15	19,706	16.0 (1.1–29.0)
Abdominal surgery	-	-	-	60	194,498	3.3 (0.004–16.9)
Vascular surgery	2	917	5.7 (3.7–7.7)	8	29,135	5.4 (3.7–22.6)
Orthopedic surgery	-	-	-	26	585,613	3.0 (0.1–9.3)
Other	3	1705	10.2 (5.3–12.0)	41	4,546,280	3.6 (0.3–17.2)
Total	27	8444	16.2 (3.7–33.7)	318	5,821,314	8.1 (0.004–50.3)

AF = atrial fibrillation; NOS = not otherwise specified.

prior history of AF based on high-quality methods; 74 (21.4%) described explicit searching of medical records to rule out a prior history of AF (quality score 1), and 88

(25.5%) reported that patients in the study did not have a history of AF but did not mention searching medical records (quality score 2). Only 27 (7.8%) studies monitored

for AF using high-quality methods (prospective design with continuous ECG monitoring, quality score 1); five (1.4%) of these studies used high-quality methods in both domains.

The incidence of new-onset AF during hospitalization for non-cardiac surgery reported in 345 studies ($n = 5,829,758$) ranged from $< 0.01\%$ to 50.3% . Table 2 reports the ranges of AF incidences according to type of surgery performed and whether continuous monitoring was used. Figure 2 summarizes the estimates of the incidence of new-onset AF in studies that used continuous, prospective monitoring. Heterogeneity was substantial ($I^2 > 90\%$) both overall and by surgical subgroup (eAppendices 4 and 5, ESM); therefore, we did not pool results to generate a summary estimate. We tested the hypothesis that prospective studies with continuous ECG monitoring would find higher incidences of AF. To do this, we created a random effects binary logistic meta-regression model that compared the incidence of AF in studies with AF ascertainment quality scores of 1 with those with AF ascertainment quality scores of 2,3, or 4 as defined in Table 1. Reported AF incidences were significantly higher in studies with continuous monitoring compared with those without (test of model $P < 0.001$) according to the

goodness-of-fit test ($P < 0.001$) and R^2 analogue 0.02 (eAppendix 5, ESM). Nevertheless, it suggested that only a small amount of variance (2%) was explained by differences in monitoring intensity. We found no evidence of a subgroup effect when comparing studies using continuous monitoring with those that did not across surgical subtypes (eAppendix 4, ESM).

Studies of long-term recurrence of AF

Thirteen studies ($n = 25,726$) reported the long-term recurrence of AF following the index hospitalization (Table 3). Follow-up ranged from one month to 5.4 years after discharge. Four studies were prospective cohort studies and nine were retrospective. Follow-up duration and the methods used for AF detection varied markedly (Table 3). Only one study was assessed as having high-quality methods for AF detection—Higuchi *et al.*²¹ used a systematic 12-month protocol for the surveillance of AF recurrence in cancer surgery patients with postoperative AF. Seventy-seven patients with confirmed postoperative AF wore either a two-week event-triggered recorder or a 24-hr Holter monitor at one month and 12 months postoperatively. Atrial fibrillation recurrence of at least

Fig. 2 Incidence of new-onset atrial fibrillation after non-cardiac surgery in prospective studies that used continuous electrocardiography.

TABLE 3 Characteristics of included studies on AF recurrence for atrial fibrillation after non-cardiac surgery

Study ID	Condition	Design	Setting	Age (yr)	History of AF	New-onset AF		AF recurrence	New-onset AF (N)	Recurrent AF (N)	Recurrence rate	Follow-up time		
					Ascertainment and quality score*	Ascertainment and quality score*	Ascertainment and quality score*							
Cardinale 1999 ⁴¹	Pulmonary thoracotomy	Prospective cohort study	ICU	59 (11)	Patients with history of AF were excluded	2	Continuous ECG monitoring daily; 12-lead ECG	1	Monthly follow-up questionnaire for symptoms related to AF	3	26	1	3.8%	18 (8) mo
Ciriaco 2000 ⁴²	Pneumonectomy	Retrospective cohort study	Hospital	64 (10)	Patients with history of AF were excluded after medical records review	1	Continuous ECG until postop day 3	2	Patients seen in clinic and assessed for symptoms of AF	4	22	0	0%	7–21 mo
Curtis 1998 ⁴³	Pneumonectomy	Prospective cohort study	ICU	60	Mentions AF as postoperative complication	3	Holter monitor with continuous ECG monitoring	1	Patients were assessed for AF after discharge in clinic, not all patients received ECG	3	24	0	0%	1–1.5 mo
Garner 2017 ⁴⁴	Pneumonectomy	Retrospective review	Hospital	67	Patients were excluded if they had an arrhythmia history, or if were on any antiarrhythmics	2	Routine ECG with ECG prior to discharge	2	ECG at follow-up visit	2	43	3	7%	At 1 mo
Gialdini 2014 ²⁴	Non-cardiac surgery	Retrospective review	Hospital	72 (12)	Review of medical records	1	ICD diagnosis	3	According to ICD-9 codes, Follow-up visit with ECG monitoring	3	12,874	4799	37.3%	Up to 12 mo
Henri 2012 ⁴⁵	Pulmonary transplantation	Retrospective cohort study	Hospital	47	Patients with history of AF excluded through medical record review	1	12-lead ECG, telemetry monitoring performed during the postoperative period	2	Postoperative clinic follow-up and chart review at 1 year postop	3	221	8	3.6%	Up to 12 mo

TABLE 3 continued

Study ID	Condition	Design	Setting	Age (yr)	History of AF Ascertainment and quality score*	New-onset AF Ascertainment and quality score*	AF recurrence Ascertainment and quality score*	New-onset AF (N)	Recurrent AF (N)	Recurrence rate	Follow-up time
Higuchi 2019 ²¹	Oncological non-cardiac surgery	Prospective cohort study	Hospital	68 (11)	Review of medical records	1 Patients medical records, ICD codes	3 Continuous recorder used for AF surveillance for approximately 2 weeks at postoperative months 1 and 12	1 77	24	31.3%	Up to 12 mo
Hyun 2018 ⁴⁶	Pneumonectomy	Retrospective review	Hospital	67	Review of medical records	1 No description	4 No description	4 449	60	13.4%	Up to 24 mo
Sacher 2018 ⁴⁷	Pulmonary transplantation	Prospective cohort study	ICU	49 (14)	Mentions patients with history of AF as separate subgroups	1 Continuous ECG monitoring daily; 12-lead ECG	1 AF documented via 12-lead, ambulatory ECG monitoring	2 79	13	16.5%	2.9 (2.4) yr
Kim 2019 ²⁵	Non-cardiac surgery	Retrospective cohort study	National health insurance service	66 [57–73]	No description	4 No description	4 According to ICD-10 code 148. ECGs reviewed on hospitalization or outpatient visits	3 11, 347	2,289	20.2%	3.9 [2.0–6.2] yr
Lee 2010 ⁴⁸	Thoracic surgery	Retrospective cohort study	ICU	52 (16)	Patients with history of AF excluded through medical record review	1 Retrospective routine 12-lead ECG, continuous ECG monitoring in ICU	2 Follow-up phone call with patients to determine new symptoms, medications or diagnoses for AF. Charts were reviewed	3 508	40	7.9%	5.4 (2.9) yr
Rachwan 2020 ²³	Liver transplantation	Retrospective cohort study	Hospital	57 (11)	Patients with history of AF were excluded	2 ECG done	2 12-lead ECGs done on select patients	2 42	10	24%	Up to 90 days

TABLE 3 continued

Study ID	Condition	Design	Setting	Age (yr)	History of AF Ascertainment and quality score*	New-onset AF		AF recurrence		New-onset AF (N)	Recurrent AF (N)	Recurrence rate	Follow-up time
						Ascertainment and quality score*	AF confirmed by 12-lead ECG	Ascertainment and quality score*	Patients were followed up in clinic. No other description				

Turaga 2009⁴⁹ Abdominal surgery Retrospective review University hospital 67 (9) Mentions AF as postoperative complication 2 AF confirmed by 12-lead ECG 3 Patients were followed up in clinic. No other description 4 14 0 0% Not specified

*High quality = 1 and low quality = quality scores 2,3 or 4 for methods for detection of AF in hospital, as defined in Table 1 of the main paper

Values are mean (standard deviation) or median [interquartile range]

AF = atrial fibrillation; ECG = electrocardiogram; ICD = International Classification of Disease; ICU = intensive care unit; mo = months; yr = years

30 sec, as confirmed by a cardiologist, was documented in 24 (31.1%) patients. Four other studies reported AF recurrence rates of greater than 15%. Jesel *et al.* followed patients with postoperative AF following lung transplantation for a mean (standard deviation) of 2.9 (2.4) years.²² Patients were assessed weekly for three months, then monthly until one year, and every three months thereafter. Atrial fibrillation was documented by 12-lead ECG or ambulatory ECG monitoring, as reviewed by two cardiologists. The rate of AF recurrence was 16.5%. Rachwan *et al.* followed patients who developed postoperative AF following liver transplantation.²³ All were discharged from hospital in sinus rhythm. Of the 42 that had a 12-lead ECG in follow-up, ten (24%) were in AF. Gialdini *et al.* used administrative claims data to identify Californian patients with new-onset perioperative AF.²⁴ Among 12,874 patients with no prior history of AF who developed new-onset perioperative AF, 4,799 (37.3%) had another healthcare encounter for AF in the ensuing 12 months. Kim *et al.* used a similar approach with 11,347 patients in South Korea, finding that 2289 (20.2%) had another encounter for AF over a median 47 months of follow-up.²⁵

Discussion

In this systematic review, we found that among 345 published articles, the reported incidence of new-onset AF during hospitalization for non-cardiac surgery ranged from very rare (< 0.01%) to extremely common (~ 50%). This variability prohibited pooling data, even when reports of the same type of surgery were considered. Consistent with our hypothesis, prospective studies that used continuous ECG monitoring found higher incidences of AF than those that did not. Although some of the variability in study results was explained by detection methods and different surgical populations, much remains unexplained. There was similar variability in the 13 articles reporting on the long-term rate of AF recurrence in this population. Several studies, however, reported recurrence rates upwards of 20%. Rigorously designed studies with continuous and prospective monitoring are required to more accurately estimate the incidence and long-term recurrence of new-onset postoperative AF in patients who have undergone non-cardiac surgery.

To the best of our knowledge, this is the first systematic review to broadly assess the incidence and recurrence of new-onset perioperative AF following non-cardiac surgery. Most reviews to date have focused on cardiac surgery.^{26,27} Reviews in non-cardiac surgery have assessed surgical sub-populations and did not systematically assess study methodology for detection.^{28,29} This review has two

important strengths. First, when possible, we excluded data from patients with a prior history of AF to isolate the population for whom the long-term prognosis is in question. Second, our methodological appraisal focused on methods used for AF detection and specifically tested the hypothesis that prospective studies with continuous ECG monitoring reported higher incidences of AF. As AF is often an intermittent arrhythmia, the probability of detecting AF increases with the intensity of ECG monitoring.^{30–32} As in our previous review of medical patients, studies with continuous monitoring found a significantly higher incidence of AF, although meta-regression modelling suggested significant unexplained variance.³³ These findings have informed the design of the AFOTS incidence study (clinicaltrials.org: NCT03552588) which is enrolling consecutive at-risk patients admitted to an ICU and continuously monitoring them with a continuous ECG monitor for up to 14 days.³⁴

Accurate estimates of the incidence of new-onset perioperative AF are critical to guide future research in this patient population. There is interest in preventing new-onset perioperative AF and in optimizing outcomes for affected patients.^{11–16} New-onset perioperative AF has been associated with adverse outcomes during the index hospital stay in at least two large, multi-centre studies.^{5,6} Nevertheless, the incidences of new-onset AF in these two studies (2.5 and 3.0%) are at the lower end of what we found in this review.^{5,6} Confounding may explain these findings; AF may be noticed more frequently in patients who are more acutely ill with closer monitoring and in patients who stay longer with longer monitoring. In addition, worse outcomes for patients with AF could be explained by a higher burden of co-morbidities.^{35–37} This review underscores the need for standardized AF detection to minimize detection bias using prospective designs with continuous ECG monitoring. Continuous monitoring will also help estimate the minimum burden of AF that is associated with adverse outcomes.

Evidence is lacking to guide the long-term management of patients with new-onset perioperative AF. The majority of patients are discharged from hospital in sinus rhythm, whether it is due to spontaneous, pharmacologic, or electrical cardioversion.^{9,10} Nevertheless, clinicians are faced with the decision as to whether these patients should be treated for AF, with the most pressing question being whether to start them on long-term OAC treatment. New-onset perioperative AF has been associated with an increased long-term risk of stroke in large observational studies.^{23,38,39} Nevertheless, the incidences of AF in these studies is again at the lower end of what was seen in our review (0.4%, 0.8%, 2.2%), raising the question of selection bias.

We assessed long-term rates of AF recurrence in this population. This interest was driven by the hypothesis that patients who have a recurrence of AF following an initial presentation of AF perioperatively could be more likely to have paroxysmal AF and might therefore benefit from OAC.^{2,8,40} Nevertheless, we found very wide ranges in the long-term recurrence of AF. Only one 77-patient study systematically re-assessed patients using long-term ECG monitoring and found a cumulative recurrence rate of 31.1% over one year.^{21,40} Long-term ambulatory ECG monitoring may identify patients with recurrent AF who might benefit from OAC treatment as we await the results of randomized clinical trials. Ongoing studies are attempting to better define the long-term prognosis and management of this population. The AFOTS follow-up study attempts to overcome some of the limitations of prior studies.⁸ This study identifies patients with new-onset AF during hospitalization for medical illness or non-cardiac surgery who have returned to sinus rhythm at the time of hospital discharge. Cases and matched controls wear two 14-day Holter monitors over the ensuing 12 months. At least one randomized trial is being conducted in this population: Anticoagulation for Stroke Prevention In Patients With Recent Episodes of Perioperative Atrial Fibrillation After Noncardiac Surgery ASPIRE-AF is a pilot trial (clinicaltrials.org; NCT03968393) assessing the feasibility of a full study of OAC vs no OAC in this population.

Limitations of review

This review is principally limited by the design and methodologic descriptions of the included studies. Most studies were either single centre or combined heterogeneous types of surgery. A small number of studies defined the minimum length of AF episodes they considered to be relevant. We did not collect data on the long-term risk of stroke associated with new-onset AF following non-cardiac surgery in this review. We are, however, assessing this in a separate, dedicated review (PROSPERO; CRD42017054309).

Conclusions

Rates of AF incidence and long-term recurrence of AF first detected following non-cardiac surgery vary markedly. Differences in the intensity of ECG monitoring and type of surgery may account for this variation. Atrial fibrillation recurs after hospital discharge in up to 37% of patients.

Author contributions William F. McIntyre takes responsibility for the integrity of the data. William F. McIntyre, Jeff S. Healey, Richard P. Whitlock, and Emilie P. Belley-Côté contributed to study concept and design. William F. McIntyre, Maria E. Vadakken, Anand S. Rai, Terry Thach, Wajahat Syed, Kevin J. Um, Omar Ibrahim, Shreyash Dalmia, Akash Bhatnagar, Pablo A. Mendoza, Graham R. McClure, Toru Inami, Tianyi Zhang, and Jessica T. Huynh contributed to acquisition of data. William F. McIntyre, Emilie P. Belley-Côté, Maria E. Vadakken, Anand S. Rai, Richard P. Whitlock, Jeff S. Healey, Jessica Spence, Shrikant I. Bangdiwala, David Conen, and P.J. Devereaux contributed to analysis and interpretation of data. William F. McIntyre, Emilie P. Belley-Côté, and Maria E. Vadakken contributed to drafting of the manuscript. William F. McIntyre, Maria E. Vadakken, Anand S. Rai, and Shrikant I. Bangdiwala contributed to statistical analysis. Emilie P. Belley-Côté, Richard P. Whitlock, and Jeff S. Healey contributed to study supervision. All authors contributed to critical revision of the manuscript for important intellectual content.

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