Impact of Standardizing Management of Atrial Fibrillation with Rapid Heart Rate in the Emergency Department

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ABSTRACT

Context: There is substantial variation in the emergency treatment of atrial fibrillation with tachycardia. A standardized treatment approach at an academic center decreased admissions without adverse outcomes, but this approach has not been evaluated in a community Emergency Department (ED).

Objective: To evaluate the implementation of a standardized treatment guideline for patients with atrial fibrillation and a rapid heart rate in a community ED.

Design: An observational pre-/postimplementation (August 2013 to July 2014 and August 2014 to July 2015, respectively) study at a community ED. The standardized treatment guideline encouraged early oral treatment with rate control medication, outpatient echocardiogram, and early follow-up. A multiple logistic regression model adjusting for patient characteristics was generated to investigate the association between the intervention and ED discharge rate.

Main Outcome Measures: The primary measure was ED discharge. Secondary measures included stroke or death, ED return visit, hospital readmission, length of stay, and use of oral rate control medications.

Results: A total of 199 (104 pre/95 post) ED encounters were evaluated. The ED discharge rate increased 14% after intervention (57.7% to 71.6%, p = 0.04), and use of rate control medications increased by 19.4% (p < 0.01). Adjusted multivariate results showed a nearly 2-fold likelihood of ED discharge after guideline implementation (odds ratio = 1.97, 95% confidence interval = 1.07-3.63). Length of stay, return visits, and hospital readmissions were similar.

Conclusion: A standardized approach to ED patients with atrial fibrillation and tachycardia is associated with a decrease in hospital admissions without adversely affecting patient safety.

INTRODUCTION

Atrial fibrillation currently affects 2.3 million Americans and is the most common arrhythmia treated in in the Emergency Department (ED).[1,2] Because of the association of atrial fibrillation with increasing age,[2] the number of persons affected by atrial fibrillation is expected to reach 5.6 million by the year 2050.[2] Despite the rising prevalence, there is currently no consensus on the optimal management of atrial fibrillation in the acute care ED setting.[2-6] Multiple reports have shown a great deal of variation in ED treatment strategies for atrial fibrillation with a rapid heart rate above 100/min.[1,6-8]

Of importance to patients, clinicians, and policy makers is the decision whether to admit the patient to the hospital or to refer the patient for outpatient management. Patients prefer outpatient care when possible,[9] and hospitalizing patients without a clear benefit incurs unnecessary costs.[10] A standardized ED guideline emphasizing early oral use of rate control medication and 48-hour follow-up at a dedicated atrial fibrillation clinic in an academic teaching hospital resulted in a significant reduction in hospital admissions without compromising patient outcomes.[11] The translation or implementation of this approach into other EDs has not been reported among different patient populations or different practice settings, most of whom lack routine 48-hour follow-up at a dedicated atrial fibrillation clinic. We lack the understanding of whether this process can be safely translated into a community ED setting, and it will be important to understand if these results are generalizable to an integrated health care system.

The primary objective of our study was to evaluate the impact of a standardized practice guideline on the hospitalization rate of patients presenting to the ED with atrial fibrillation and a rapid heart rate. The secondary objectives were to describe the use of oral medications for these patients, incidence of stroke or death at 30 days, 14-day ED return visit or hospital admission, and length of stay (LOS) before and after initiation of the practice guideline.

METHODS

Study Design and Setting

This observational pre-/postimplementation study evaluated encounters with patients presenting with a rapid heart rate to the ED at Kaiser Permanente (KP) Panorama City Hospital in Panorama City, CA, who received a diagnosis of atrial fibrillation. The cohorts were divided into a preintervention group (August 1, 2013, to July 31, 2014) and an intervention group (August 1, 2014, to July 31, 2015). Retrospective data were collected for the preintervention group using information from our electronic health record, as well as claims data for visits outside our health system. Data after the intervention were prospectively collected from our electronic health record and claims information. Extensive chart review using standard methods

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recommended for emergency medicine research was employed, including a standard chart abstraction form to validate information collected for all encounters included in the study.[12]

The intervention was the implementation of a practice guideline aimed at standardizing the treatment of atrial fibrillation with a rapid heart rate. The practice guideline (Figure 1) was rolled out beginning in August 2014 at KP Panorama City Hospital's ED, a community ED that sees a volume of 60,000 patients per year. The guideline was based on a previously published guideline and is in concordance with current American College of Cardiology/American Heart Association recommendations.[11,13] The essential components of the guideline are early oral use of rate control medication, moderate heart rate control, outpatient echocardiogram, and early follow-up with the primary care physician. The rate control protocol consists of a series of rate control medication administrations (β-blocker or calcium channel blocker), with hourly rechecks (see Sidebar: Protocols for Rate Control Medications). If rate control was achieved, the patient was deemed eligible for discharge from the ED. In the event rate control failed, the patient would be placed on a regimen of continuous intravenous rate control medication and admitted to the hospital.

The protocol was presented to the hospital's emergency physician group in August 2014 as part of a regularly scheduled

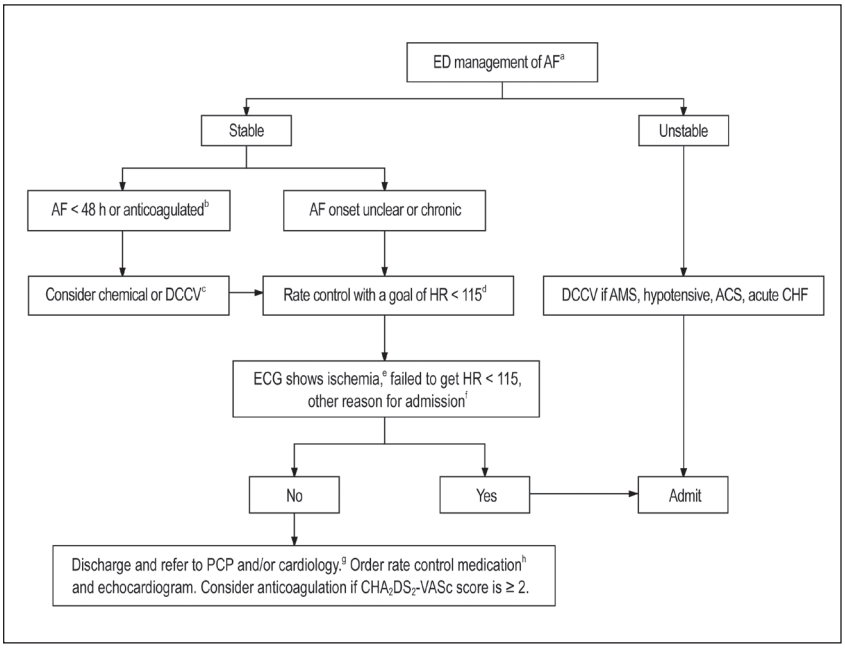

Figure 1. Practice Guideline for Emergency Department Management of Atrial Fibrillation.

[a] This clinical reference is for the care of the patient with a primary diagnosis of atrial fibrillation and no other diagnosis that requires emergency care.
[b] If the patient has an electrocardiogram showing sinus rhythm in the last 48 hours or has had an international normalized ratio > 2.0 for at least 3 weeks, then the patient may be cardioverted. If atrial fibrillation onset is unclear, then rate control only.
[c] Consider consultation with a cardiologist. For electrical cardioversion, consider administering at least 100 J (biphasic) of electricity. Rate control may be attempted before cardioversion, although not required.
[d] Intravenous and oral rate control medications should be ordered at the same time, and the oral medication should be given as soon as possible. See Sidebar: Protocols for Rate Control Medications for recommendations of medication and dosing.
[e] Greater than 2 mm of ST-elevation or depression.
[f] Positive troponin, symptoms consistent with acute coronary syndrome, patient has another reason for admission such as exacerbation of either congestive heart failure or chronic obstructive pulmonary disease.
[g] Referral to primary care physician within 3 days for discussion of anticoagulation, vital signs check, and medication adjustments. Follow-up with cardiologist as per local practice.
[h] See Sidebar: Protocols for Rate Control Medications for recommendations of discharge medication.
ACS = acute coronary syndrome; AF = atrial fibrillation; AMS = altered mental status; CHF = congestive heart failure; DCCV = direct current cardioversion; ECG = electrocardiogram; ED = Emergency Department; HR = heart rate (/min); PCP = primary care physician.

Protocols for Rate Control Medications

Intravenous medications

Diltiazem, 0.25 mg/kg, intravenous bolus over 2 minutes. May repeat diltiazem at 0.35 mg/kg intravenous bolus over 2 minutes, 15 minutes after the prior dose. Caution with doses over 25 mg.

Metoprolol, 2.5 mg to 5.0 mg, slow intravenous bolus. May repeat every 5 minutes for a total of 15 mg.

Oral medications

During initial orders select *either* atenolol, 25 to 50 mg orally, or diltiazem extended release (Diltia XT, Watson Laboratories, Inc, Corona, CA), 120 mg orally, and administer once as soon as it is feasible. Recheck patient 1 hour after oral medication administration.

First heart rate assessment: Heart rate > 115/min at rest: Consider repeating atenolol dose at 25 mg or diltiazem extended release, 120 mg orally once. Recheck patient in 1 hour.

Second heart rate assessment: Heart rate > 115/min at rest: Consider intravenous drip infusion and admission to the hospital.

Maximum atenolol dose is 100 mg/d.

Maximum diltiazem extended release dose is 480 mg/d.

Holding parameters are systolic blood pressure < 100 mmHg and heart rate < 60/min.

On discharge, the patient may be placed on a regimen of atenolol, 25 mg daily, or diltiazem extended release, 120 mg daily, until seen by his/her primary care physician. Start warfarin therapy at your discretion if CHA_2DS_2-VASc score is ≥ 2. Contact pharmacist for bedside education about warfarin and order a 30-day supply. Clerks can direct-book an appointment with the primary physician within 3 days. Refer for urgent echocardiogram as an outpatient. Primary care physician can refer to cardiology if needed, or refer to cardiology if the patient or the cardiologist desires elective cardioversion.

meeting that most physicians attended. A detailed explanation of the protocol, including education regarding the CHA_2DS_2-VASc score[14] (Table 1) and the recommendations for anticoagulation with aspirin or warfarin, was provided and discussed. In addition to reviewing details of the protocol, pharmacologic therapies were discussed, and the expedited direct booking for an echocardiogram and primary care follow-up was explained. Early oral dosing of the rate control medication of the physician's choice was strongly encouraged; however, the guideline is voluntary and patient dependent. Thus, the implementation of the protocol, the type of medication, number of doses of medication, and the decision to discharge the patient were ultimately up to the physician. Follow-up after discharge included a primary care appointment within three days, a cardiology referral as needed, and an outpatient echocardiogram within one week. A physical copy of the protocol was given to each physician, and the protocol was made available for reference on every computer in the ED.

Table 1. CHA_2DS_2-VASc scoring[14]

Risk factor	Points
Age 65-74 y	1
Age ≥ 75 y	2
Women	1
Congestive heart failure	1
Hypertension	1
Stroke/transient ischemic attack/ thromboembolism	2
Vascular disease	1
Diabetes	1

Selection of Participants

To find all potentially eligible encounters, we identified all ED visits with a diagnosis of atrial fibrillation, chronic atrial fibrillation, paroxysmal atrial fibrillation, permanent atrial fibrillation, or atrial fibrillation with rapid ventricular response from the ED or hospital discharge diagnosis (International Classification of Diseases, Ninth Revision, Code 427.31). Next, the investigators manually reviewed all charts to apply the inclusion and exclusion criteria and fill out data sheets. To meet the inclusion criteria, patients had to be at least age 18 years, have presented for treatment/evaluation of stable nonvalvular atrial fibrillation with a rapid heart rate, and be KP Health Plan members. We included only Health Plan members to ensure accurate patient information and because of the recommended early follow-up that could not be coordinated or tracked for nonmembers. Encounters without atrial fibrillation as the primary emergent complaint were excluded (eg, myocardial infarction, congestive heart failure exacerbation), as were patients with known valvular disease or cardiomyopathy. Unstable patients requiring emergency cardioversion because of chest pain, shortness of breath, or altered mental status were also excluded. A single patient was allowed multiple eligible encounters for emergency treatment of atrial fibrillation if 15 or more days had passed between encounters.

We performed chart review for all patients who met the inclusion criteria to determine whether the patient was still alive 30 days after his/her ED encounter. KP members have encounters placed in their medical record when they receive medical care at an outside facility, ensuring accurate follow-up information.

The KP pharmacy data captured all medications dispensed, and that record was compared with the medication administration record to accurately track the type of treatment the patient received while in the ED (oral vs intravenous medication, calcium channel blocker vs β-blocker, etc).

Table 2. Patient characteristics

Variable	Preintervention (n = 104)	Postintervention (n = 95)	p value
Age, mean y (SD)	69.5 (13.43)	70.4 (12.79)	0.5833
Women, no. (%)	61 (58.7)	59 (62.1)	0.6192
Arrival vital signs			
Arrival heart rate, mean beats/min (SD)	133.7 (19.67)	127.5 (18.07)	0.0283
Arrival systolic blood pressure, mean mmHg (SD)	136.8 (20.95)	132.3 (20.22)	0.1982
Arrival oxygen saturation, mean % (SD)	97.6 (2.11)	97.8 (1.68)	0.8324
Comorbidities, no. (%)			
Diabetes	30 (28.8)	33 (34.7)	0.3722
Hypertension	74 (71.2)	69 (72.6)	0.8169
Congestive heart failure	9 (8.7)	11 (11.6)	0.4930
Myocardial infarction	4 (3.8)	10 (10.5)	0.0657
Coronary artery disease	5 (4.8)	16 (16.8)	0.0058
Stroke	6 (5.8)	6 (6.3)	0.8715
Transient ischemic attack	2 (1.9)	3 (3.2)	0.5783
Chronic atrial fibrillation	55 (52.9)	49 (51.6)	0.7839
CHA_2DS_2-VASc score, mean (SD)	3.2 (1.84)	3.7 (1.95)	0.1280
Medication history, no. (%)			
β-blocker	48 (46.2)	40 (42.1)	0.5657
Calcium channel blocker	24 (23.1)	28 (29.5)	0.3049
Digoxin	11 (10.6)	5 (5.3)	0.1685
Warfarin	23 (22.1)	21 (22.1)	0.9986
Presenting symptoms, no. (%)			
Shortness of breath	31 (29.8)	33 (34.7)	0.4571
Chest pain	25 (24)	18 (18.9)	0.3824
Palpitation	68 (65.4)	53 (55.8)	0.1661
Dizziness	28 (26.9)	17 (17.9)	0.1283
Syncope	2 (1.9)	1 (1.1)	0.6147
No symptom or other	17 (16.3)	23 (24.2)	0.1667
Symptom onset < 48 h	59 (56.7)	46 (48.4)	0.3286

SD = standard deviation.

Similar to other atrial fibrillation studies in the ED, we included the following patient variables: Chief complaint, vital signs from triage documentation, chronic atrial fibrillation diagnosis, pharmacy data to assess medication use, disease burden, age, sex, and comorbidities.[1,3,7,11,15] Beyond building on the learning from previous research, these patient characteristics reflect both the risk of stroke in patients with atrial fibrillation and the risk factors for nonvalvular atrial fibrillation.[2,14,16]

Statistical Analysis

A comparison of patient characteristics before and after the intervention was examined by *t*-test for continuous variables and by the χ^2 test for categorical variables. To investigate the association between the intervention and hospital discharge rate, we generated a multiple logistic regression model that adjusted for key patient characteristics. Relevant confounders for this model were selected by their significance in the univariate association test or their clinical relevance as mentioned in Selection of Participants.

All statistical tests were 2-sided. P values less than 0.05 were considered statistically significant. All analyses were performed with SAS EG (Version 9.3, SAS Institute, Cary, NC).

RESULTS

A total of 199 ED encounters were included in the study (104 patients preintervention and 95 postintervention; Table 2). The mean heart rate on arrival to the ED was higher for the preintervention cohort than the intervention cohort: 133.7/min (standard deviation [SD] = 19.67/min) and 127.5/min (SD = 18.07/min), respectively (p = 0.03). Additionally, coronary artery disease was found at a higher rate in the intervention cohort (16.8% vs 4.8%, p < 0.01). Patient characteristics were otherwise similar between groups. Medication use and presenting symptoms were similar in both groups. No statistically significant difference in CHA_2DS_2-VASc score was found between the preintervention (3.2, SD = 1.84) and the postintervention groups (3.7, SD = 1.95).

There was a significant decrease in hospitalization after the intervention was implemented. The discharge rate increased from 57.7% in the preimplementation period to 71.6% after intervention (13.9% change, p = 0.04; Table 3). The increase in the discharge rate was primarily related to a decrease in observation unit admissions demonstrated by a 34.4% reduction (45.5% to 11.1%, p < 0.01), whereas admission to telemetry was the same in both groups. Of note, admission to the intensive care unit increased 29.2% (22.7% to 51.9%, p = 0.01) but the actual numbers show only 4 more admissions to the intensive care unit during the intervention year. Oral rate control increased in the intervention cohort by 19.4% (p < 0.01). The preintervention cohort received calcium channel blockers at a higher rate, 66.3% vs 48.8% (p = 0.01). Cardioversion was the same in both groups (9.6% vs 9.5%, p < 0.99). Adjusted multivariate results showed that patients given the intervention are almost twice as likely to be discharged (OR = 1.97, 95% CI = 1.07-3.63; Table 4).

Return visits to the ED and readmission to the hospital at 14 days were

Table 3. Discharge rate, disposition, and treatment of the cohorts

Variable, no. (%)	Preintervention (n = 104)	Postintervention (n = 95)	p value
Discharged	60 (57.7)	68 (71.6)	0.0411
Hospitalized			
Direct observation unit	10 (22.7)	14 (51.9)	0.0118
Telemetry	11 (25)	10 (37)	0.2807
Observation	20 (45.5)	3 (11.1)	0.0027
Medical-surgical ward	1 (2.3)	0 (0)	0.4302
Treatment[a]			
Oral rate control medication given in the ED	40 (38.5)	55 (57.9)	0.0061
IV rate control medication given in the ED	83 (79.8)	71 (74.7)	0.3930
Received β-blocker	49 (47.1)	40 (42.1)	0.4777
Received calcium channel blocker	69 (66.3)	46 (48.4)	0.0105
Received digoxin	11 (10.6)	5 (5.3)	0.1685
Cardioversion: direct current or chemical	10 (9.6)	9 (9.5)	> 0.99

[a] Patients may have received more than 1 class of medication.
ED = Emergency Department; IV = intravenous.

Table 4. Odds ratio adjusted for vital signs and CHA_2DS_2-VASc score[14]

Effect	Point estimate	95% Wald confidence limits
Intervention, pre vs post	1.967	**(1.067-3.627)**[a]
CHA_2DS_2-VASc	0.965	(0.822-1.133)
Systolic blood pressure	1.013	(0.995-1.031)
Diastolic blood pressure	1	(0.976-1.025)
Heart rate	0.557	(0.254-1.218)

[a] Bold indicates statistical significance

Table 5. Outcomes for preintervention and postintervention cohorts

Outcome	Preintervention (n = 104)	Postintervention (n = 95)	p value
30-d mortality, no. (%)	0 (0)	5 (5.3)	0.0184
30-d ischemic stroke, no. (%)	2 (1.9)	0 (0)	0.1743
14-d return visit to ED, no. (%)	14 (13.5)	11 (11.6)	0.6890
14-d hospital readmission, no. (%)	8 (7.7)	8 (8.4)	0.8502
ED length of stay, mean d (SD)	4.6 (2.55)	4.7 (2.32)	0.6843
Hospital length of stay, mean d (SD)	45.7 (76.43)	45.9 (49.34)	0.6062

ED = Emergency Department; SD = standard deviation.

similar in the pre- and postintervention groups (Table 5). The protocol did not affect LOS in the ED or the hospital (mean ED LOS of 4.6 hours and hospital LOS of 46 hours for both groups). There were 2 strokes in the preintervention group within 30 days of the encounter and none in the intervention group. There were no deaths in the preintervention group and 5 deaths in the intervention group within 30 days. However, on chart review of the deaths, none appeared attributable to the atrial fibrillation protocol. Three deaths were caused by sepsis, 1 was a patient receiving hospice care, and 1 patient died presumably because of a dysrhythmia from propafenone. Further details of the deaths appear in the Sidebar: Details of Patient Deaths.

DISCUSSION

Implementing a recommended guideline to standardize the ED treatment of atrial fibrillation with a rapid heart rate was associated with a 14% decrease in hospitalization. It appears that this effect was specifically related to a 19.4% increase in the use of oral rate control medications, a cardinal component of the guideline. The study ED had a low admission rate to begin with, 42.3% in the preintervention year compared with 64% across the US,[17] which may indicate that EDs with a higher admission rate could experience a greater effect. Additionally, no increase in the LOS in the ED was observed during the intervention year, showing that the practice guideline did not adversely affect the departmental flow. We also found that discharging more patients did not lead to worse outcomes related to atrial fibrillation, nor did it result in higher return visits to the ED or readmissions to the hospital.

The study does have limitations inherent to all retrospective studies, specifically with causation. The Hawthorne effect, which is a change in behavior because the participants in the study know they are being observed, may have influenced the study. That may have led to improved rate control during the intervention year, leading to more patients getting discharged home. Another inherent limitation is that only KP enrollees were used in the study. About 20% of the patients who came into the ED were not included because of nonmembership with the KP Health Plan. The reader should also be aware that the heart rate on arrival showed that there was a statistically significant difference between the preintervention and the intervention groups, 133.7/min and 127.5/min, respectively. This may have led to a greater chance of rate control in the intervention group with a subsequent increase in the discharge rate, but we do not believe that this statistical difference has much clinical meaning to the emergency physician treating someone with rapid atrial fibrillation.

The study from which our guideline was based[11] yielded a 36% decrease in hospital admission rate compared with our modest 14% decrease, but there are several important factors to consider when drawing a comparison between the studies. First, the other authors' preintervention admission rate was 78% compared with the preintervention admission rate of 42% in our study, which shows that our ED was already more aggressive in treating atrial fibrillation at baseline and offered less room for improvement. Second, the patients in the study by Zimetbaum et al[11] were almost exclusively patients with new-onset or paroxysmal atrial fibrillation, whereas only half the population in our study had new-onset or paroxysmal atrial fibrillation. This difference may explain why their cardioversion rate was more than double ours, as their study had more likely candidates for cardioversion. It is known that patients who are cardioverted are much more likely to be discharged from the ED.[15] Last, our study had much higher rates of hypertension and diabetes, a higher heart rate on arrival, and significantly higher rates of calcium channel or β-blocker use at baseline, showing our cohort to be somewhat "sicker." Our study also demonstrates that primary care follow-up may be sufficient for these patients when a dedicated atrial fibrillation cardiology clinic is not available.

Details of Patient Deaths

Patient 1: This patient, who had a history of falling because of a gait problem, fell 4 days after discharge and broke 2 ribs. About 11 days later, sepsis caused by pneumonia developed, and the patient died of sepsis.

Patient 2: The patient was admitted because of rapid atrial fibrillation. After discharge severe *Clostridium difficile* diarrhea developed, and she died of sepsis.

Patient 3: After treatment of rapid atrial fibrillation, a consult was made for admission to the hospital. The admitting team administered propafenone, and the patient died during dialysis several hours later, presumably because of dysrhythmia.

Patient 4: This patient was admitted to control the rate of her atrial fibrillation. Two weeks after discharge sepsis developed because of peritoneal catheter site infection. Shock ensued, and she died of sepsis.

Patient 5: This patient was treated for rapid atrial fibrillation and discharged home. He had a history of refractory chronic lymphoid leukemia. After 3 weeks of continued worsening of the chronic lymphoid leukemia, treatments were stopped, he was placed on hospice care, and he died a week later.

CONCLUSION

Our findings confirm that standardizing acute treatment of primary atrial fibrillation with a rapid heart rate in the ED is associated with a decrease in hospitalization and similar patient outcomes. The paramount element in our treatment guideline was increasing the use of oral medications, but doing rechecks with repeated administration of medications, expedited primary care follow-up, and outpatient echocardiography are also important. As with any clinical guideline, exceptions to the rules can always be found, and decision making should adapt accordingly to treat the individual patient. Because ED physicians will be seeing many more patients with atrial fibrillation in the future, it behooves us to implement proven guidelines to improve care and efficiency. We will also benefit from future research assessing the role of observation units, increased

use of cardioversion, and comparative effectiveness studies evaluating medication regimens for rate control. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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