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Original Article

Ventricular Tachycardia and Hospital Readmission in Patients Discharged From the Hospital After an Acute Myocardial Infarction

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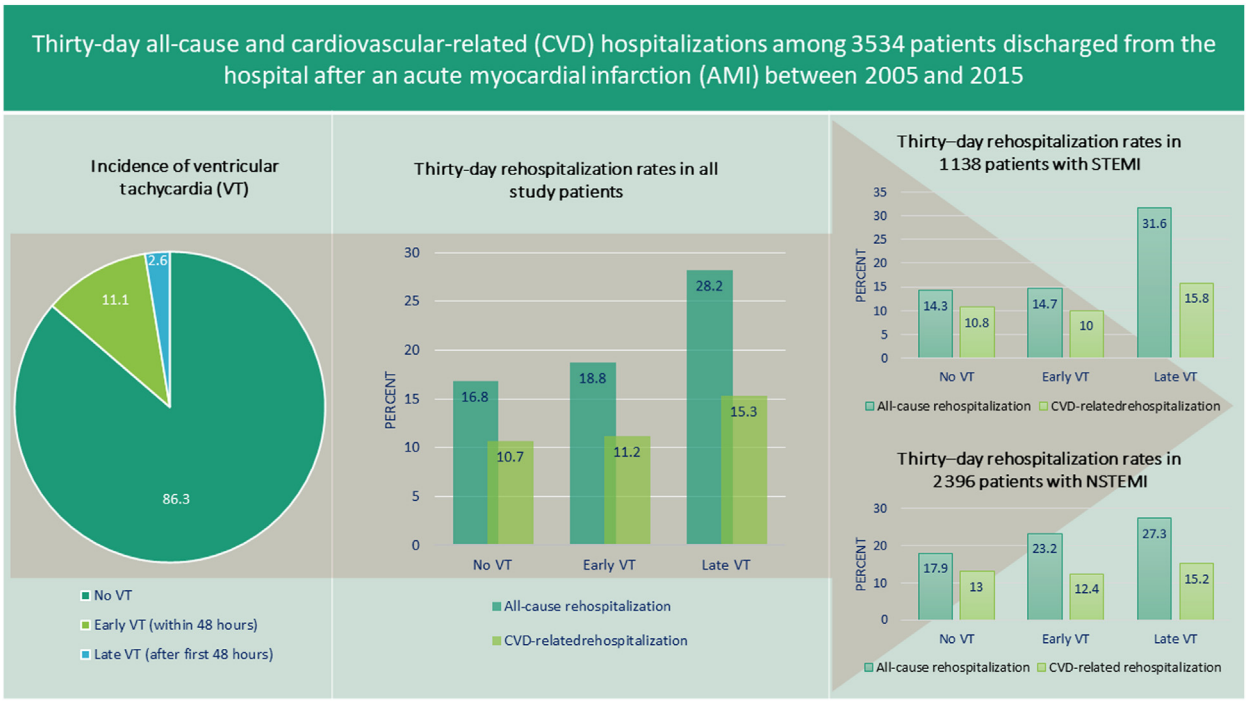

ABSTRACT

Background: Although ventricular tachycardia (VT) occurring during hospitalization for an acute myocardial infarction (AMI) increases mortality risk, its relationship with 30-day postdischarge rehospitalization has not been examined.

RÉSUMÉ

Contexte : Bien qu'une tachycardie ventriculaire (TV) survenant pendant une hospitalisation pour un infarctus aigu du myocarde (IAM) augmente le risque de décès, son lien avec une réhospitalisation dans les 30 jours suivant le congé n'a pas fait l'objet d'étude.

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Methods: Using data from the Worcester Heart Attack Study, we examined the association between early (during the first 48 hours of admission) and late (after 48 hours from admission) VT with 30-day postdischarge all-cause and cardiovascular disease (CVD)-related rehospitalization while analytically controlling for several demographic and clinical factors.

Results: The study population consisted of 3534 patients who were hospitalized with an AMI between 2005 and 2015 (average age, 67.2 years; 40.7% women); VT occurred in 452 patients (13.7%), with the majority of instances (81.2%) occurring within 48 hours of admission. The 30-day all-cause rehospitalization rate was 17.3%, with 70.9% of the hospitalizations related to CVD. The odds of rehospitalization were 1.63 times (95% confidence interval [CI] = 0.99-2.69) and 1.12 times (95% CI = 0.83-1.51) higher for patients with AMI who developed late VT and early VT, respectively, compared to patients who did not develop VT. The risk of rehospitalization among patients with late VT was higher (odds ratio = 2.22 (95% CI = 0.79-6.26) in those with ST-segment-elevation AMI, compared to those with non-ST-segment-elevation AMI (odds ratio = 1.45 (95% CI = 0.81-2.57); early VT was not associated with rehospitalization in patients with either AMI subtype. No significant association was present between the occurrence of VT and CVD-related rehospitalization.

Conclusions: Patients who develop late VT may experience a higher risk of 30-day rehospitalization following hospital discharge for AMI, especially among those with ST-segment-elevation AMI. Larger studies are needed to confirm our findings.

Méthodologie : À partir des données de l'étude Worcester Heart Attack Study, nous avons étudié le lien entre les TV précoces (dans les 48 heures de l'hospitalisation) et tardives (après 48 heures d'hospitalisation) et les réhospitalisations liées à une maladie cardiovasculaire et toutes causes confondues 30 jours après le congé, tout en tenant compte de manière analytique de plusieurs facteurs démographiques et cliniques.

Résultats : La population de l'étude était composée de 3 534 patients qui ont été hospitalisés pour un IAM entre 2005 et 2015 (âge moyen, 67,2 ans; 40,7 % de femmes). Une TV est survenue chez 452 patients (13,7 %), la majorité des cas (81,2 %) dans les 48 heures de l'hospitalisation. Le taux de réhospitalisations toutes causes confondues à 30 jours était de 17,3 %, 70,9 % des cas étant liés à une maladie cardiovasculaire. Chez les patients ayant eu un IAM et ayant subi une TV tardive ou précoce, les risques de réhospitalisation étaient respectivement 1,63 fois (intervalle de confiance [IC] à 95 % = 0,99-2,69) et 1,12 fois (IC à 95 % = 0,83-1,51) plus élevés que chez ceux qui n'avaient pas développé de TV. Le risque de réhospitalisation chez les patients ayant subi une TV tardive était plus élevé (risque relatif approché = 2,22 [IC à 95 % = 0,79-6,26]) chez ceux ayant eu un IAM avec élévation du segment ST que chez ceux ayant eu un IAM sans élévation du segment ST (risque relatif approché = 1,45 [IC à 95 % = 0,81-2,57]). La TV précoce n'a pas été associée à la réhospitalisation chez les patients dans l'un ou l'autre des sous-types d'IAM. Aucun lien important n'a été observé entre la survenue d'une TV et la réhospitalisation pour une maladie cardiovasculaire.

Conclusions : Chez les patients qui développent une TV tardive, le risque de réhospitalisation 30 jours après le congé de l'hôpital pour un IAM peut être augmenté, particulièrement lorsque l'IAM s'accompagne d'une élévation du segment ST. De vastes études sont nécessaires pour confirmer nos observations.

Despite advances in the diagnosis and treatment of coronary heart disease during the past several decades, cardiovascular disease (CVD) remains the leading cause of morbidity and mortality in the US.[1] Ventricular tachycardia (VT) is a relatively common serious cardiac arrhythmia, developing in approximately 10% of patients following an acute myocardial infarction (AMI),[2,3] and it is an important risk factor for sudden cardiac death.[2]

The frequency of VT following hospitalization for an AMI differs according to the subtype of AMI, as patients who develop an ST-segment elevation AMI have a greater risk of developing VT than do patients with a non-ST-segment elevation AMI.[4,5] Data from both the pre-coronary reperfusion era, and from more recent periods when percutaneous coronary intervention was the standard of care, showed that the majority of ventricular arrhythmias occur early during the first 48 hours of hospitalization for an AMI.[3,6,7] Prior studies have shown that VT occurring at any time after an AMI is associated with a substantially higher risk of dying at 30 days.[7,8] On the other hand, data from the **G**ruppo **I**taliano per lo **S**tudio della **S**treptochinasi nell'**I**nfarto Miocardico (GISSI) and **G**lobal **U**tilization of **S**treptokinase and **T**issue-Plasminogen Activator for **O**ccluded Coronary Arteries (GUSTO-III) trials suggest that VT that develops after the first 48 hours of hospitalization for an AMI is associated with particularly poorer outcomes, compared to VT that occurs earlier.[9-11]

To the best of our knowledge, the association between VT and rehospitalization following hospital discharge for an AMI has not been examined. In the present study, we examined the association between the occurrence of any VT and 30-day rehospitalization following hospital discharge for an AMI, using data from the **W**orcester **H**eart **A**ttack **S**tudy (WHAS).[12,13] We examined this relationship separately for patients who developed either early (within 48 hours of admission) or late (after 48 hours from admission) VT, as well as according to the subtype of AMI.

Methods

Study design

We used data from the WHAS for this study. In brief, the WHAS is a population-based investigation of AMI among residents of the Worcester (MA) metropolitan area who were hospitalized at all medical centres in central Massachusetts.[13,14] The medical records of hospitalized patients were individually reviewed and validated with the use of predefined diagnostic criteria for AMI. To be included in this study, at

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See page 788 for disclosure information.

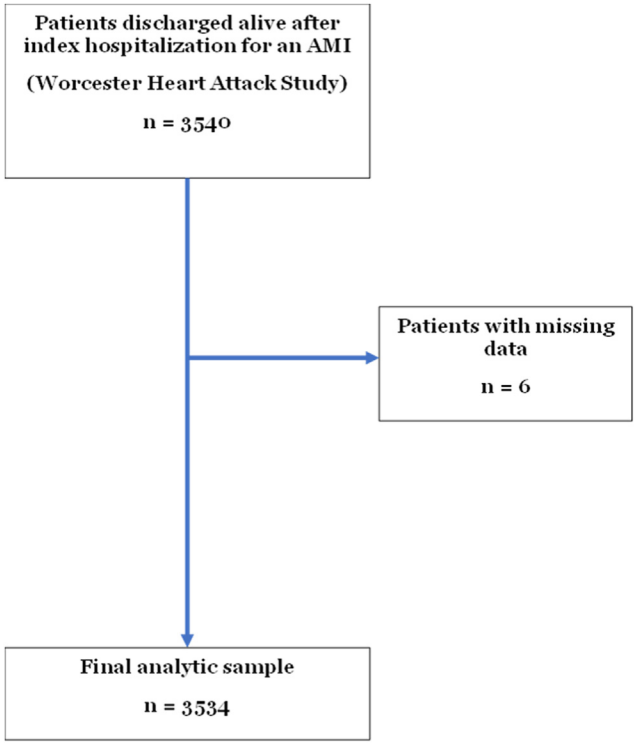

Figure 1. Patient selection flow chart. AMI, acute myocardial infarction.

least 2 of the following 3 criteria were required to be met: (i) elevated serum cardiac enzyme levels; (ii) suggestive clinical findings; and (iii) serial electrocardiographic findings consistent with the diagnosis of AMI. The Institutional Review Board at the University of Massachusetts Medical School approved this study.

Informed consent

The authors confirm that patient consent is not applicable, as this was a retrospective observational study using de-identified data routinely collected in hospital medical records.

Data collection

Patients' sociodemographic and clinical characteristics were abstracted from hospital medical records by trained physicians and nurses. Data were collected about the patient's age, sex, race/ethnicity, medical history, clinical features, receipt of cardiac medications and diagnostic and interventional cardiac procedures, and the in-hospital occurrence of heart failure, cardiogenic shock, atrial fibrillation, severe hemorrhage, and death. The patient's AMI was further classified as being either ST-segment elevation (STEMI) or non-ST-segment elevation (NSTEMI)[15] in nature.

For the present study, we included data on patients who were discharged from the hospital after an independently validated AMI in 5 annual study periods between 2005 and 2015 when information about the timing of VT and subtype of AMI were systematically collected. We excluded 6 patients who had missing data on key study variables. The patient selection process is shown in Figure 1.

VT

VT was defined as a cardiac arrhythmia of 3 or more consecutive complexes originating from the ventricles at a rate of greater than 100 beats per minute.[6] We included both monomorphic and polymorphic VT, and sustained (more than 30 seconds or that resulted in hemodynamic instability) and nonsustained VT.[6,16] The occurrence of VT was recorded based on physicians' progress notes. Research physicians also reviewed all patients' hospital electrocardiogram strips to identify electrocardiogram changes consistent with the development of VT otherwise not reported in the progress notes. For patients with multiple episodes of VT, only the first episode was considered. This cardiac dysrhythmia was further classified as occurring either early (during the first 48 hours of hospital admission) or late (occurring after 48 hours from admission). Details about the ascertainment of VT in our study population have been described previously.[17,18]

Rehospitalization

Subsequent hospital admission for any reason within 30 days after discharge from the patient's index hospitalization for their AMI was classified as a 30-day readmission. Trained study staff searched subsequent hospital medical records from the 3 major teaching and community hospitals in the city of Worcester to identify any subsequent hospital readmissions to these major medical centres among discharged study patients.[14,19] Our internal quality-control measures showed that the 3 major hospitals in the city of Worcester captured more than 90% of all rehospitalizations in central Massachusetts,

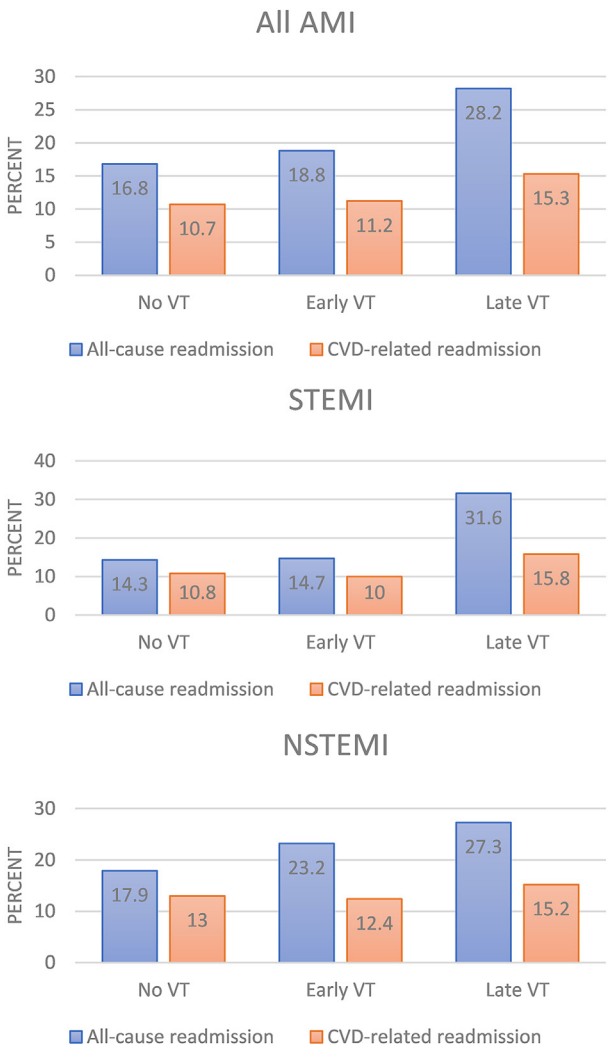

Figure 2. Distribution of 30-day all-cause readmissions and cardiovascular disease (CVD)-related readmissions according to the presence and timing of ventricular tachycardia (VT): Worcester Heart Attack Study. Early = within 48 hours of index admission; AMI, acute myocardial infarction; NSTEMI, non-STEMI; STEMI, ST-segment-elevation myocardial infarction.

and use of this approach limited the amount of missing follow-up data while reducing study-associated costs. We collected data on all-cause and CVD-related rehospitalizations, with the latter defined as a readmission for either heart failure, recurrent myocardial infarction, angina pectoris, or a cardiac arrhythmia.[14] This study is compliant with the STROBE Statement—checklist of items that should be included in reports of observational studies (Supplemental Table S1). Full adjusted models were showed in Supplemental Tables S2 and S3.

Data analysis

Differences in the distribution of selected characteristics, in-hospital complications, and use of cardiac diagnostic/revascularization procedures and cardiac medications among patients who developed early VT, those who developed late VT, and those who did not develop VT during the index hospitalization were compared using χ^2 tests for discrete variables, and analysis of variance for continuous variables.

Multivariable-adjusted logistic regression analyses were carried out to examine the relationship between the occurrence of early and late VT with the frequency of 30-day rehospitalization while controlling for several potentially confounding variables of prognostic importance. We a priori included age and sex in the regression models. Other variables, including the patient's medical history (eg, angina, diabetes mellitus, hypertension, stroke, or heart failure), in-hospital complications (eg, any heart failure, cardiogenic shock, atrial fibrillation, severe hemorrhage), length of hospital stay, coronary revascularization (coronary artery bypass graft surgery [CABG] or percutaneous coronary intervention, and pharmacotherapy were included in our multivariable adjusted models, if they were significantly associated with patients being hospitalized. In addition, we stratified our analyses according to the timing of VT (early vs late), type of AMI (STEMI vs NSTEMI), and cause of rehospitalization (all-cause vs CVD-related). All statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC).

Table 1. Characteristics of patients hospitalized with an acute myocardial infarction according to the occurrence and timing of ventricular tachycardia (VT) during hospitalization: Worcester Heart Attack Study

Characteristics	No VT (n = 3082)	Early VT (n = 367)	Late VT (n = 85)	*P*
Age, y	68 [57–79]	65 [55–78]	73 [63–83]	< 0.01
Female	42.6	27.5	29.41	< 0.01
SBP, mm Hg	142 [123–160]	140 [118–159]	140 [118–159]	0.39
DBP, mm Hg	78 [65–91]	80 [67–90]	72 [64–87]	< 0.01
Hemoglobin, g/dL	13.5 [12–14]	13.7 [12.1–15.1]	13.2 [11.6–14.6]	0.02
Creatinine, mg/dL	1.1 [1.0–1.4]	1.1 [1.0–1.4]	1.2 [0.9–1.7]	0.01
STEMI	30.1	51.8	22.4	< 0.01
Medical history				
Angina	8.5	6.8	11.8	0.29
Diabetes	36.3	33.0	43.5	0.16
Dyslipidemia	69.1	64.9	72.9	0.18
Hypertension	76.2	73.0	81.2	0.21
Stroke	9.8	9.0	5.9	0.45
Heart failure	20.6	25.9	31.8	< 0.01
Hospital complication				
Heart failure	30.2	34.9	57.7	< 0.01
Cardiogenic shock	3.5	5.7	10.6	< 0.01
Atrial fibrillation	14.8	22.1	41.2	< 0.01
Severe hemorrhage	18.8	26.4	42.4	< 0.01
Cardiac catheterization	75.6	83.4	76.5	< 0.01
Revascularization				
PCI	54.6	64.3	44.7	< 0.01
CABG	6.8	5.5	18.8	< 0.01
Pharmacotherapy				
Beta blockers	96.1	94.6	97.7	0.26
Antiarrhythmic agents	8.3	24.8	24.7	< 0.01
Aspirin	97.1	97.6	97.7	0.86
Statins	88.6	90.2	90.6	0.59
ACEIs/ARBs	72.1	77.7	70.6	0.07
Length of hospital stay, d	3 [2–6]	4 [3–6]	7 [6–11]	< 0.01
Discharge location				0.01
Home	77.3	79.3	58.8	
Nursing home/SNF	15.1	13.8	28.2	
Rehabilitation	5.8	5.8	11.8	
Other	1.8	1.1	1.2	

Data are presented as either percentage or median [interquartile range].

ACEIs, angiotensin-converting enzyme inhibitors; ARBs, angiotensin receptor blockers; CABG, coronary artery bypass surgery; DBP, diastolic blood pressure; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI: ST-segment-elevation myocardial infarction; SNF, skilled nursing facility.

Results

Patient characteristics

We included 3534 patients who were admitted to participating central Massachusetts hospitals for a first AMI during 2005, 2007, 2009, 2011, and 2015. The average age of this study population was 67.2 years; 40.7% were female; and 32.2% had a STEMI. VT occurred in 452 patients (13.7%), with 367 of these episodes (81.2%) occurring during the first 48 hours of hospitalization, and a smaller number of VT episodes (85 episodes, 18.8%) occurring thereafter (Fig. 2). The frequency of VT was 18.3% in patients with a STEMI, and 10.1% in patients who were diagnosed with an NSTEMI.

Patients who developed late VT were older, had lower blood pressure findings and kidney function at the time of hospital presentation, and were more likely to have developed several in-hospital complications, compared to patients who developed early VT or who did not develop VT during their index hospitalization (Table 1). More than one-half of patients who developed early VT were diagnosed with a STEMI, compared to less than one-quarter and one-third of patients who developed late VT or who did not develop VT, respectively. Approximately two-thirds to three-quarters of patients underwent coronary revascularization (percutaneous coronary intervention or CABG surgery), with patients who developed late VT being more likely to undergo CABG surgery (18.8%), compared with those who developed early VT (5.5%) or who did not develop VT (6.8%). All 3 groups of patients received similar pharmacotherapy regimens, with the exception of antiarrhythmic agents, which were used more frequently in patients who developed early or late VT.

Occurrence of VT and all-cause rehospitalization

Among the 3534 patients studied, 611 patients (17.3%) were rehospitalized for any reason during the first 30 days after being discharged from the hospital after their AMI. The 30-day all-cause rehospitalization rates were 28.2% in patients who developed late VT, compared with 18.8% and 16.8% in patients who developed early VT or who did not develop VT, respectively (Fig. 2).

The unadjusted odds of all-cause rehospitalization were approximately 2 times higher in patients with late VT than they were in patients who did not develop VT (Table 2).

Table 2. Odds ratio (OR) and 95% confidence intervals (CIs) for 30-day all-cause hospital readmissions among patients discharged from the hospital after an acute myocardial infarction (AMI) according to the occurrence and timing of ventricular tachycardia (VT) during hospitalization: Worcester Heart Attack Study

Subgroups	All-cause readmission, n (%)	Unadjusted, OR (95% CI)	Multivariable adjusted,* OR (95% CI)
All AMI			
No VT	518 (16.8)	Reference	Reference
Early VT	69 (18.8)	1.15 (0.87−1.51)	1.12 (0.83−1.51)
Late VT	24 (28.2)	**1.95 (1.20−3.15)**	1.63 (0.99−2.69)
STEMI			
No VT	133 (14.3)	Reference	Reference
Early VT	28 (14.7)	1.03 (0.67−1.61)	1.18 (0.75−1.88)
Late VT	6 (31.6)	**2.76 (1.03−7.39)**	2.22 (0.79−6.26)
NSTEMI			
No VT	385 (17.9)	Reference	Reference
Early VT	41 (23.2)	1.38 (0.96−2.00)	1.17 (0.79−1.74)
Late VT	18 (27.3)	1.72 (0.99−2.99)	1.45 (0.81−2.57)

Bold indicates statistical significance.

NSTEMI, non-ST-segment-elevation myocardial infarction; STEMI, ST-segment-elevation myocardial infarction.

*Adjusted for age, sex, in-hospital complications, and the receipt of coronary artery bypass graft surgery or percutaneous coronary intervention.

However, after adjusting for several potentially confounding factors, the elevation in odds of rehospitalization among patients who developed late VT was no longer statistically significant (odds ratio = 1.63, 95% confidence interval = 0.99-2.69). The odds of rehospitalization were similar in patients who developed early VT, compared with the odds in those who did not develop VT. When we stratified our analysis according to the subtype of AMI, among patients who developed a STEMI, patients who experienced late but not early VT had markedly higher odds of being rehospitalized, compared with patients who did not develop VT (Table 2). In patients who developed an NSTEMI, neither early nor late VT was associated with having greater odds of being rehospitalized.

Occurrence of VT and CVD-related rehospitalization

Among the 611 patients who were rehospitalized within 30 days postdischarge, 433 patients (70.9%) were rehospitalized for CVD-related causes. The CVD-related rehospitalization rates were 15.3%, 11.2%, and 12.3% in patients who developed late VT, who developed early VT, and who did not develop VT in the hospital, respectively (Fig. 2). In examining the rates of rehospitalization according to AMI subtype, the frequency of CVD-related rehospitalization in patients who developed late VT, who developed early VT, and who did not develop VT were 15,6%, 10.0%, and 10.8%, respectively, in patients with a STEMI, and 15.2%, 12.4%, and 13.0%, respectively, in patients diagnosed with an NSTEMI. After multivariable adjustment for several potentially confounding demographic and clinical variables of prognostic importance, we did not find any association between survivors of in hospital VT and CVD-related rehospitalization, either in all patients or in separate examination in patients with either a STEMI or an NSTEMI (Table 3).

Discussion

To the best of our knowledge, our study is the first to examine the association between the occurrence of VT during hospitalization for an AMI and subsequent risk of rehospitalization. We observed nonsignificantly higher odds of 30-day all-cause rehospitalization among patients who developed late but not early VT, compared with those who did not develop VT during their hospital stay for an initial AMI. In addition, this association was observed to be more prominent in patients who developed a STEMI vs an NSTEMI.

Table 3. Odd ratios (ORs) and 95% confidence intervals (CIs) for 30-day cardiovascular disease (CVD)-related readmission among patients discharged from the hospital after an acute myocardial infarction (AMI) according to the occurrence and timing of ventricular tachycardia (VT) during hospitalization: Worcester Heart Attack Study

Subgroups	CVD-related readmission, n (%)	Unadjusted, OR (95% CI)	Multivariable adjusted,* OR (95% CI)
All AMI			
No VT	379 (12.3)	Reference	Reference
Early VT	41 (11.2)	0.90 (0.64−1.26)	0.83 (0.57−1.20)
Late VT	13 (15.3)	1.29 (0.71−2.35)	1.15 (0.61−2.15)
STEMI			
No VT	100 (10.8)	Reference	Reference
Early VT	19 (10.0)	0.92 (0.55−1.55)	1.08 (0.63−1.83)
Late VT	3 (15.8)	1.55 (0.45−5.43)	1.47 (0.41−5.29)
NSTEMI			
No VT	279 (13.0)	Reference	Reference
Early VT	22 (12.4)	0.95 (0.60−1.52)	0.71 (0.42−1.22)
Late VT	10 (15.2)	1.20 (0.61−2.38)	1.06 (0.52−2.19)

CVD-related readmission = any readmission for heart failure, recurrent myocardial infarction, angina pectoris, or cardiac arrhythmias.

NSTEMI, non-ST-segment elevation myocardial infarction;.STEMI, ST-segment-elevation myocardial infarction.

*Adjusted for age, sex, in-hospital complications, and the receipt of coronary bypass graft surgery or percutaneous coronary intervention.

Although patient survival remains a key clinical outcome, 30-day rehospitalization is another important measure relating to the quality of care for patients discharged from the hospital after an AMI. Despite the use of many different interventions that have been developed for purposes of reducing the 30-day rate of rehospitalization, the frequency of readmission following hospital discharge for an AMI remains high, with more than 1 in 10 patients being readmitted soon after discharge.[14,20-22] Patients who have relatively common comorbidities, such as kidney disease, heart failure, and diabetes mellitus, have been shown to be at higher risk for 30-day rehospitalization.[15] Other factors, including advanced age, low income, and the in-hospital complications of atrial fibrillation, heart failure, and recurrent chest pain, have also been associated with a higher readmission rate.[23]

Despite having a lack of statistical significance, the findings from our study suggest that patients who developed VT at a later time during their hospitalization for an AMI had a greater risk of being readmitted to the hospital in comparison with patients who developed VT earlier during their hospitalization or who did not develop VT. Prior studies have demonstrated differences in patients' prognosis based on the timing of VT, with patients who developed this ventricular arrhythmia at a later time during their hospitalization for an AMI having an increased risk for worse outcomes than patients who developed this arrhythmia earlier.[24] A study of 1718 patients who developed a STEMI and were admitted to a single Swedish tertiary-care hospital between 2007 and 2009 found that patients who developed early ventricular fibrillation (within 48 hours of hospitalization) were at greater risk for dying in the hospital, but not with a worse long-term outcome, in comparison with patients who did not develop ventricular fibrillation.[25] Similar associations have been observed between early and late ventricular fibrillation and various clinical outcomes.[8] For example, in a study of 5839 patients who were hospitalized for an AMI in Israel between 1981 and 1983, patients who developed late (after 24 hours) ventricular fibrillation had an associated 4-fold higher risk of dying in the hospital.[26] More recent studies in patients who were treated invasively for their AMI also showed worse long-term outcomes in patients who developed late VT. In an analysis of data from 4363 patients who were hospitalized with a STEMI in Zabrze, Poland between 2004 and 2014, long-term mortality incidence was increased in patients who developed late, but not early, ventricular arrhythmias, compared to that in arrhythmia-free patients.[8]

The mechanisms underlying differences in prognosis observed in previous investigations, and in hospital readmission rates found in the present study for patients who develop early vs late VT, are not fully understood. However, patients who develop late VT have been postulated to experience worse outcomes because they are more likely to have concomitant left ventricular dysfunction and severe heart failure.[24] In the present study, patients who developed late VT were more likely to have other important comorbidities, were older, and were more likely to have developed both cardiovascular and noncardiovascular (eg, hemorrhage) complications during hospitalization. Thus, the presence of late VT may indicate a globally sicker population that tended to be readmitted to the hospital more frequently. On the other hand, early VT is thought to be related to the early inflammatory response following the development of an AMI, which tends to be transient and has fewer adverse prognostic effects.[12]

When we examined the cause of rehospitalization, 30-day CVD-related rehospitalization was not associated with the in-hospital occurrence of VT or its timing (Table 3). This finding suggests that non−CVD related rehospitalization played an important role in the higher readmission rates of patients who developed late VT, as they suffered more frequently from other important comorbidities (Table 1). Although CVD-related causes were common, non-CVD causes still accounted for approximately 30% of total rehospitalizations in our study. Given this finding, efforts to optimize the management of other comorbidities, especially among patients who develop late VT, might reduce the frequency of rehospitalization in patients who develop VT during hospitalization for an AMI.

When the possible differential impact of the timing of VT in patients who developed the 2 major subtypes of AMI was examined, the odds of being rehospitalized for any cause were more pronounced among patients who developed late VT in the setting of a STEMI, though they were still suggestive of an increased risk of being rehospitalized among those who experienced an NSTEMI. These findings suggest that late VT can serve as a marker to identify patients who are at greater risk for being rehospitalized over the subsequent 30 days and should receive intensive transitional care and targeted surveillance to prevent these untoward events.

Study strengths and limitations

Our study has several strengths. To the best of our knowledge, it is the first to examine the association between the timing of occurrence of VT with subsequent hospital readmission among those discharged from the hospital after a first AMI. The study included patients with an independently validated AMI in the community setting who were admitted to the major central Massachusetts hospitals. Patients were managed in the cardiac care unit with continuous telemetry monitoring, which ensures a high capture rate of cardiac arrhythmia and high accuracy of diagnosis. We were able to examine cause-specific rehospitalization, which provided more granularity in understanding the risk of rehospitalization among patients with VT. On the other hand, we did not collect data on the duration or morphology of VT, their development in relation to the administration of coronary reperfusion therapy or implantable cardioverter defibrillators, or on the extent of coronary artery disease or left ventricular dysfunction, which might have affected the development of VT or the risk for being hospitalized. The number of patients who developed VT, especially late VT, was small (85 patients), which reduced the study's statistical power. Therefore, some of the estimates in the present study may have failed to have reached statistical significance despite their clinical relevance. Finally, due to the nature of any observational study, our findings might be influenced by unmeasured confounding variables. Larger, ideally multicentre, observational studies utilizing a quasi-experimental design should be carried out to overcome these limitations in examining the association

between VT and its timing to clinically meaningful long-term patient outcomes.

Conclusions

The presence of late VT after a patient is discharged from the hospital after an AMI may be associated with a higher likelihood of hospital readmission within 30 days, especially in patients who developed a STEMI. However, larger studies in different geographic areas and population settings remain needed to more systematically examine the association between VT and its timing with the risk of being hospitalized during the subsequent 30 days among patients discharged from the hospital after an AMI.

Data Availability

The data that support the findings of this study are available from the authors upon reasonable request.

Ethics Statement

This study adhered to the relevant ethical guidelines. This study did not involve patients' identifiable information or animal subjects.

Patient Consent

The authors confirm that patient consent is not applicable, as this was a retrospective observational study using de-identified data routinely collected in hospital medical records.

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Disclosures

The authors have no conflicts of interest to disclose.

References

1. Virani SS, Alonso A, Aparicio HJ, et al. Heart disease and stroke statistics-2021 update: a report from the American Heart Association. Circulation 2021;143:e254-743.

2. Henkel DM, Witt BJ, Gersh BJ, et al. Ventricular arrhythmias after acute myocardial infarction: a 20-year community study. Am Heart J 2006;151:806-12.

3. Tran HV, Ash AS, Gore JM, et al. Twenty-five year trends (1986-2011) in hospital incidence and case-fatality rates of ventricular tachycardia and ventricular fibrillation complicating acute myocardial infarction. Am Heart J 2019;208:1-10.

4. Newby KH, Thompson T, Stebbins A, et al. Sustained ventricular arrhythmias in patients receiving thrombolytic therapy: incidence and outcomes. The GUSTO Investigators. Circulation 1998;98:2567-73.

5. Al-Khatib SM, Granger CB, Huang Y, et al. Sustained ventricular arrhythmias among patients with acute coronary syndromes with no ST-segment elevation: incidence, predictors, and outcomes. Circulation 2002;106:309-12.

6. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. J Am Coll Cardiol 2018;72:e91-220.

7. Demidova MM, Rylance R, Koul S, et al. Prognostic value of early sustained ventricular arrhythmias in ST-segment elevation myocardial infarction treated by primary percutaneous coronary intervention: a substudy of VALIDATE-SWEDEHEART trial. Heart Rhythm O2 2023;4:200-6.

8. Podolecki T, Lenarczyk R, Kowalczyk J, et al. Prognostic significance of complex ventricular arrhythmias complicating ST-segment elevation myocardial infarction. Am J Cardiol 2018;121:805-9.

9. Mehta RH, Starr AZ, Lopes RD, et al. Incidence of and outcomes associated with ventricular tachycardia or fibrillation in patients undergoing primary percutaneous coronary intervention. JAMA 2009;301:1779-89.

10. Volpi A, Cavalli A, Franzosi MG, et al. One-year prognosis of primary ventricular fibrillation complicating acute myocardial infarction. The GISSI (Gruppo Italiano per lo Studio della Streptochinasi nell'Infarto miocardico) investigators. Am J Cardiol 1989;63:1174-8.

11. Al-Khatib SM, Stebbins AL, Califf RM, et al. Sustained ventricular arrhythmias and mortality among patients with acute myocardial infarction: results from the GUSTO-III trial. Am Heart J 2003;145:515-21.

12. Tran VH, Mehawej J, Abboud DM, et al. Age and sex differences and temporal trends in the use of invasive and noninvasive procedures in patients hospitalized with acute myocardial infarction. J Am Heart Assoc 2022;11:e025605.

13. Goldberg RJ, Tisminetzky M, Tran HV, et al. Decade long trends (2001−2011) in the incidence rates of initial acute myocardial infarction. Am J Cardiol 2019;123:206-11.

14. Chen HY, Tisminetzky M, Lapane KL, et al. Decade-long trends in 30-day rehospitalization rates after acute myocardial infarction. J Am Heart Assoc 2015;4:e002291.

15. McManus DD, Gore J, Yarzebski J, et al. Recent trends in the incidence, treatment, and outcomes of patients with STEMI and NSTEMI. Am J Med 2011;124:40-7.

16. Katritsis Demosthenes G, Zareba W, Camm AJ. Nonsustained ventricular tachycardia. J Am Coll Cardiol 2012;60:1993-2004.

17. Tran HV, Gore JM, Darling CE, et al. Clinically significant ventricular arrhythmias and progression of depression and anxiety following an acute coronary syndrome. J Psychosom Res 2019;117:54-62.

18. Tran HV, Gore JM, Darling CE, et al. Hyperglycemia and risk of ventricular tachycardia among patients hospitalized with acute myocardial infarction. Cardiovasc Diabetol 2018;17:136.

19. Tran HV, Lessard D, Tisminetzky MS, et al. Trends in length of hospital stay and the impact on prognosis of early discharge after a first uncomplicated acute myocardial infarction. Am J Cardiol 2018;121:397-402.

20. Wang H, Zhao T, Wei X, Lu H, Lin X. The prevalence of 30-day readmission after acute myocardial infarction: a systematic review and meta-analysis. Clin Cardiol 2019;42:889-98.

21. Rymer JA, Chen AY, Thomas L, et al. Readmissions after acute myocardial infarction: How often do patients return to the discharging hospital? J Am Heart Assoc 2019;8:e012059.

22. Ranasinghe I, Wang Y, Dharmarajan K, et al. Readmissions after hospitalization for heart failure, acute myocardial infarction, or pneumonia

among young and middle-aged adults: a retrospective observational cohort study. PLoS Med 2014;11:e1001737.

23. Rashidi A, Whitehead L, Glass C. Factors affecting hospital readmission rates following an acute coronary syndrome: a systematic review. J Clin Nurs 2022;31:2377-97.

24. Takada T, Shishido K, Hayashi T, et al. Impact of late ventricular arrhythmias on cardiac mortality in patients with acute myocardial infarction. J Interv Cardiol 2019;2019:5345178.

25. Demidova MM, Smith JG, Hoijer CJ, et al. Prognostic impact of early ventricular fibrillation in patients with ST-elevation myocardial infarction treated with primary PCI. Eur Heart J. Acute Cardiovasc Care 2012;1:302-11.

26. Behar S, Kishon Y, Reicher-Reiss H, et al. Prognosis of early versus late ventricular fibrillation complicating acute myocardial infarction. Int J Cardiol 1994;45:191-8.

Supplementary Material

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