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ASSOCIATION OF ADMISSION HBA1C WITH EARLY IN-HOSPITAL COMPLICATIONS OF ANTERIOR WALL ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION IN ADULTS WITH TYPE 2 DIABETES: A CROSS-SECTIONAL STUDY

Imran Basha Shaik[1], Haider Shaik[2], Hurunnisa Shaik[3], Hema Sundar K[4]

[1] senior resident, department of cardiology, katuri medical college.
[2] Assistant professor, department of cardiology, katuri medical college.
[3] senior resident, department of cardiology, katuri medical college.
[4] professor, department of cardiology, katuri medical college.

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Corresponding Author:

Imran Basha Shaik
senior resident, department of cardiology, katuri medical college.

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ABSTRACT

Background: Glycated hemoglobin (HbA1c) reflects glycemic exposure preceding acute myocardial infarction. Its relationship with early nonfatal complications in patients with established type 2 diabetes and anterior wall ST-segment elevation myocardial infarction (STEMI) remains incompletely characterized. This study assessed the association between admission HbA1c and early in-hospital complications and examined its relationship with echocardiographic findings and clinical outcomes.

Methods: This hospital-based cross-sectional study was conducted over 24 months at Katuri Medical College and Hospital, Guntur, India. A convenience sample of 100 adults with established type 2 diabetes and acute anterior wall STEMI was enrolled. Participants underwent clinical, electrocardiographic, and two-dimensional echocardiographic assessment. Admission HbA1c was classified into four categories from 6.5–7.4% to ≥9.5%. Early complications, regional wall motion abnormalities, left ventricular systolic dysfunction, and in-hospital clinical outcomes were compared across HbA1c categories.

Results: The mean age was 58.2 ± 9.6 years, and 68% of participants were men. Mean admission HbA1c was 8.12 ± 1.24%. In the HbA1c-stratified analysis, early complications occurred in 41.7%, 52.9%, 76.9%, and 75.0% of participants across the four ascending HbA1c categories, respectively. Left ventricular failure and arrhythmias were the most frequently recorded early complications. Regional wall motion abnormalities were observed in 72% of participants and left ventricular systolic dysfunction in 80%. Both findings were more frequent in the higher HbA1c categories. Recovery and discharge was the most common in-hospital outcome, with its proportion declining from 91.7% in the lowest HbA1c category to 50.0% in the highest.

Conclusion: Higher admission HbA1c categories were associated with more frequent early complications and echocardiographic abnormalities among adults with established type 2 diabetes and anterior wall STEMI. Prospective studies with adjustment for infarct severity and reperfusion characteristics are needed to determine whether HbA1c adds predictive value to established clinical assessments.

Keywords: *Glycated hemoglobin A, ST elevation myocardial infarction, type 2 diabetes mellitus, left ventricular dysfunction, in-hospital complications.*

INTRODUCTION

Acute ST-segment elevation myocardial infarction (STEMI) requires prompt reperfusion and close monitoring for complications during hospitalization. In anterior wall STEMI, impaired contraction of the affected myocardium can compromise left ventricular function, while acute heart failure, arrhythmias, cardiogenic shock, and mechanical

complications can further complicate the clinical course [1]. In India, the CREATE registry documented delays in presentation and differences in access to treatment among patients with acute coronary syndromes (ACS), highlighting the importance of examining early outcomes in local hospital settings [2]. A subsequent analysis of the Indian Acute Coronary Syndrome Quality Improvement in Kerala (ACS QUIK) trial found that patients with diabetes had a higher risk of major adverse cardiovascular events after acute myocardial infarction than patients without diabetes [3].

Among patients with established type 2 diabetes, glycemic status at presentation can be assessed on two different time scales. Admission glucose reflects circulating glucose at the time of sampling and may rise during the acute stress response to myocardial infarction. Glycated hemoglobin (HbA1c) reflects average glycemic exposure over the preceding two to three months, with recent weeks contributing more heavily to the measurement [4]. This distinction is clinically relevant because two patients with similar admission glucose concentrations may have had substantially different glycemic exposure before the infarction. Conversely, patients with similar HbA1c values may have different acute glucose responses. Studies that have examined both measures suggest that their associations with outcomes can differ according to the endpoint and observation period [5,6].

Evidence linking HbA1c to early outcomes in patients with established diabetes remains mixed. In patients without known diabetes who underwent percutaneous coronary intervention for STEMI, Timmer et al. found that admission HbA1c was associated with long-term mortality [6]. In contrast, Britton et al. found no clear association between HbA1c and in-hospital mortality among patients with diabetes admitted with acute myocardial infarction [7]. A systematic review and meta-analysis by Pan et al. similarly found that the association between HbA1c and short-term mortality varied by diabetes status, with no statistically significant association in the subgroup with established diabetes [8]. These studies differ in population and follow-up, and their mortality findings leave open whether HbA1c is associated with nonfatal complications during hospitalization.

Ventricular function provides a complementary way to examine the relationship between antecedent glycemia and the early clinical course. Echocardiography can identify regional wall motion abnormalities and quantify global left ventricular systolic function through the left ventricular ejection fraction. It can also help identify structural complications such as acute mitral regurgitation and ventricular septal rupture [1]. Using cardiac magnetic resonance after acute myocardial infarction, Gao et al. found that higher HbA1c was associated with impaired myocardial strain among patients with diabetes [9]. Myocardial strain and ejection fraction measure different aspects of ventricular performance, and neither directly measures the occurrence of clinical complications. Examining echocardiographic findings alongside clinical events can therefore show whether differences across HbA1c categories are apparent in ventricular function, in the in-hospital clinical course, or in both.

The available evidence includes mixed ACS populations, patients with and without known diabetes, and outcomes measured at different intervals [6–9]. A focused assessment of adults with established type 2 diabetes and anterior wall STEMI can help characterize the relationship between admission HbA1c and early complications within a defined clinical population. This study was therefore conducted at Katuri Medical College and Hospital, Guntur, to describe the distribution of admission HbA1c and evaluate its association with early in-hospital complications of anterior wall STEMI. Secondary objectives were to examine the relationships between HbA1c categories and regional wall motion abnormalities, the presence and severity of left ventricular systolic dysfunction, and in-hospital clinical outcomes.

MATERIALS AND METHODS

Study design and setting: This hospital-based cross-sectional study was conducted over 24 months in the Department of General Medicine at Katuri Medical College and Hospital, Guntur, India. The study included 100 adults with established type 2 diabetes mellitus who presented with acute anterior wall ST-segment elevation myocardial infarction (STEMI). Participants were enrolled by convenience sampling from patients evaluated in the outpatient department, general medicine wards, and intensive care unit.

Study population and eligibility criteria: Men and women older than 18 years with previously diagnosed type 2 diabetes mellitus and acute anterior wall STEMI were eligible. The diagnosis of anterior wall STEMI was based on electrocardiographic findings and two-dimensional echocardiographic assessment. Patients with anemia, sepsis, hemoglobinopathies, or hypothyroidism were excluded. Patients who declined participation were also excluded.

Sample size: The sample size was estimated using the single-proportion formula, ($n = Z^2p(1-p)/d^2$), with an anticipated proportion of 50% for elevated HbA1c among patients with diabetes and acute myocardial infarction, a 95% confidence level, and an absolute precision of 10 percentage points. The estimated sample size was approximately 96 participants. A total of 100 patients were enrolled.

Clinical and laboratory assessment: Demographic characteristics, socioeconomic status, occupation, duration of diabetes, comorbidities, smoking history, alcohol use, presenting symptoms, and clinical examination findings were recorded using a structured proforma. Laboratory investigations included a complete blood count, fasting blood glucose,

postprandial blood glucose, glycated hemoglobin (HbA1c), and cardiac troponin I. Admission HbA1c was expressed as a percentage and analyzed in four categories of 6.5–7.4%, 7.5–8.4%, 8.5–9.4%, and ≥9.5%.

Cardiac assessment included a 12-lead electrocardiogram (ECG) and two-dimensional echocardiography. The ECG was used to characterize the distribution of ST-segment elevation and identify rhythm disturbances. Echocardiography was used to assess regional wall motion abnormalities, left ventricular ejection fraction (LVEF), and structural complications. Left ventricular systolic dysfunction was defined as LVEF <50%. Systolic function was categorized as preserved (≥50%), mildly impaired (40–49%), moderately impaired (30–39%), or severely impaired (<30%).

Early complications and in-hospital outcomes: Early complications assessed during hospitalization included left ventricular failure, arrhythmias, cardiogenic shock, mitral regurgitation, and ventricular septal rupture. Left ventricular failure was identified from clinical features of heart failure, such as dyspnea, orthopnea, and basal crackles, together with radiographic evidence of pulmonary congestion and/or echocardiographic evidence of reduced left ventricular systolic function. Arrhythmias were identified on ECG during hospitalization and included tachyarrhythmias and atrioventricular conduction blocks. Cardiogenic shock was defined as systolic blood pressure <90 mmHg persisting for more than 30 minutes, with evidence of end-organ hypoperfusion in the presence of cardiac dysfunction after infarction. Mitral regurgitation was detected by Doppler echocardiography, and ventricular septal rupture was identified by echocardiographic demonstration of an interventricular septal defect with left-to-right shunting.

The main analysis examined the association between admission HbA1c category and the occurrence of an early in-hospital complication. Additional analyses examined HbA1c in relation to regional wall motion abnormalities, the presence and severity of left ventricular systolic dysfunction, and in-hospital clinical outcomes. Clinical outcomes were recorded as recovery and discharge, persistent heart failure, cardiogenic shock, or in-hospital death.

Statistical analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics, version 25. Continuous variables were summarized as means and standard deviations or medians and interquartile ranges, as applicable. Categorical variables were summarized as frequencies and percentages. Associations between HbA1c categories and categorical echocardiographic findings, early complications, and in-hospital outcomes were assessed using the chi-square test. Pearson's correlation coefficient was used to examine relationships involving HbA1c and measures of infarction severity or complications.

Ethical considerations: Informed consent was obtained from each participant before enrollment. Participation was voluntary.

RESULTS

The study included 100 adults with established type 2 diabetes mellitus and acute anterior wall ST-segment elevation myocardial infarction (STEMI). Most participants were aged 50–69 years, men outnumbered women by approximately two to one, and hypertension was the most common comorbidity.

Table 1. Demographic characteristics, comorbidities, and substance use history (N = 100)

Characteristic	Category or summary measure	Value
Age, years	Mean ± SD	58.2 ± 9.6
	Median (IQR)	57 (50–65)
	Range	40–89
	40–49	18 (18%)
	50–59	40 (40%)
	60–69	30 (30%)
	70–79	8 (8%)
	80–89	4 (4%)
Sex	Men	68 (68%)
	Women	32 (32%)
Socioeconomic status	Upper	6 (6%)
	Upper middle	20 (20%)
	Lower middle	36 (36%)
	Upper lower	28 (28%)

	Lower	10 (10%)
	Socioeconomic score, mean ± SD	12.4 ± 3.1
	Socioeconomic score, median (IQR)	12 (10–15)
Occupational status	Unemployed	8 (8%)
	Unskilled	26 (26%)
	Semi-skilled	34 (34%)
	Skilled	22 (22%)
	Professional	10 (10%)
	Occupational score, mean ± SD	5.9 ± 1.8
	Occupational score, median (IQR)	6 (5–7)
Comorbidities	Hypertension	58 (58%)
	Dyslipidemia	42 (42%)
	Obesity	26 (26%)
	Chronic kidney disease	12 (12%)
	Chronic obstructive pulmonary disease	10 (10%)
	Number of comorbidities, mean ± SD	1.48 ± 0.62
	Number of comorbidities, median (IQR)	1 (1–2)
Smoking history	Non-smoker	62 (62%)
	Current smoker	28 (28%)
	Former smoker	10 (10%)
	Smoking exposure, mean ± SD, pack-years	12.6 ± 5.4
	Smoking exposure, median (IQR), pack-years	11 (8–16)
Alcohol use history	No alcohol use	64 (64%)
	Current alcohol use	24 (24%)
	Former alcohol use	12 (12%)
	Duration among current users, mean ± SD, years	9.8 ± 4.3
	Duration among current users, median (IQR), years	9 (6–13)

Values are n (%) unless a summary measure is specified. Socioeconomic status was classified using the Modified Kuppuswamy Scale. Participants could have more than one comorbidity. Smoking exposure was summarized among smokers and duration of alcohol use among current users. SD, standard deviation. IQR, interquartile range.

Diabetes duration and glycemic profile

Three quarters of participants had an admission HbA1c of at least 7.5%, with the largest group in the 7.5–8.4% category. The largest diabetes-duration group comprised participants diagnosed less than five years earlier.

Table 2. Diabetes duration, admission HbA1c, and blood glucose measurements (N = 100)

Variable	Category or summary measure	Value
Duration of diabetes, years	<5	38 (38%)
	5–10	34 (34%)
	11–15	18 (18%)
	>15	10 (10%)
	Mean ± SD	7.6 ± 4.2
Admission HbA1c, %	6.5–7.4	24 (24%)
	7.5–8.4	34 (34%)

	8.5–9.4	26 (26%)
	≥9.5	16 (16%)
	Mean ± SD	8.12 ± 1.24
	Median (IQR)	7.9 (7.3–8.9)
Fasting blood glucose, mg/dL	<100	22 (22%)
	100–125	36 (36%)
	≥126	42 (42%)
	Mean ± SD	134.6 ± 38.2
	Median (IQR)	128 (108–156)
Postprandial blood glucose, mg/dL	<140	18 (18%)
	140–199	32 (32%)
	≥200	50 (50%)
	Mean ± SD	214.8 ± 62.5
	Median (IQR)	206 (168–248)

Values are n (%) unless a summary measure is specified. HbA1c, glycated hemoglobin. SD, standard deviation. IQR, interquartile range.

Clinical presentation and electrocardiographic findings

Chest pain was universal, and sweating was the most frequent accompanying symptom. Anteroseptal infarction was the most common clinical subtype, and ST-segment elevation in leads V1–V4 was the most frequent recorded ECG pattern.

Table 3. Presenting symptoms, anterior wall STEMI subtypes, and ECG patterns (N = 100)

Domain	Finding	n (%)
Presenting symptoms	Chest pain	100 (100%)
	Sweating	72 (72%)
	Breathlessness	38 (38%)
	Nausea or vomiting	26 (26%)
	Palpitations	18 (18%)
	Syncope	6 (6%)
Anterior wall STEMI subtype	Anteroseptal infarction	38 (38%)
	Anterolateral infarction	26 (26%)
	Extensive anterior infarction	22 (22%)
	True anterior infarction	14 (14%)
ECG pattern	ST-segment elevation in V1–V4	46 (46%)
	ST-segment elevation in V1–V6	32 (32%)
	ST-segment elevation in V3–V6, I, and aVL	14 (14%)
	ST-segment elevation in V3–V4	8 (8%)

Participants could report more than one symptom. STEMI subtypes and ECG lead patterns are presented as separate distributions. STEMI, ST-segment elevation myocardial infarction. ECG, electrocardiogram.

Echocardiographic findings by admission HbA1c

Regional wall motion abnormalities and left ventricular systolic dysfunction were more frequent in the higher HbA1c categories. Mild systolic dysfunction was the most common ejection-fraction category overall.

Table 4. Echocardiographic findings by admission HbA1c category (N = 100)

Echocardiographic finding	Overall (N = 100)	HbA1c 6.5–7.4% (n = 24)	HbA1c 7.5–8.4% (n = 34)	HbA1c 8.5–9.4% (n = 26)	HbA1c ≥9.5% (n = 16)	*p* value

Regional wall motion abnormalities						**<0.05**
Present	72 (72%)	12 (50.0%)	24 (70.6%)	22 (84.6%)	14 (87.5%)	
Absent	28 (28%)	12 (50.0%)	10 (29.4%)	4 (15.4%)	2 (12.5%)	
Left ventricular systolic dysfunction						**<0.05**
Present	80 (80%)	14 (58.3%)	28 (82.4%)	22 (84.6%)	16 (100%)	
Absent	20 (20%)	10 (41.7%)	6 (17.6%)	4 (15.4%)	0 (0%)	
LVEF category						**<0.05**
Preserved (≥50%)	20 (20%)	10 (41.7%)	6 (17.6%)	3 (11.5%)	1 (6.3%)	
Mild dysfunction (40–49%)	42 (42%)	8 (33.3%)	16 (47.1%)	12 (46.2%)	6 (37.5%)	
Moderate dysfunction (30–39%)	24 (24%)	4 (16.7%)	8 (23.5%)	7 (26.9%)	5 (31.3%)	
Severe dysfunction (<30%)	14 (14%)	2 (8.3%)	4 (11.8%)	4 (15.4%)	4 (25.0%)	

Values are n (%) calculated using the column denominator. Percentages may differ slightly from 100% because of rounding. Binary systolic dysfunction and LVEF severity are presented as separate tabulations. Each p value applies to the corresponding overall comparison across HbA1c categories. LVEF, left ventricular ejection fraction.

Mean LVEF was **43.6 ±8.9%** in the full cohort, with a median of **42%** (IQR 38–49%). In participants classified as having systolic dysfunction, mean LVEF was **41.2 ±6.8%**, with a median of **42%** (IQR 37–46%). In the binary systolic function analysis, mean HbA1c was **8.4 ±1.1%** among participants with dysfunction and **7.3 ±0.8%** among those without it. In the severity analysis, mean HbA1c was **9.1 ±0.8%** in the severe dysfunction category and **7.4 ±0.9%** in the preserved category.

Early in-hospital complications by admission HbA1c

Left ventricular failure and arrhythmias were the most frequently recorded early complications. In the HbA1c cross-tabulation, early complications were more frequent in the two highest categories than in the two lower categories. Mean HbA1c was **8.6 ±1.2%** among participants with complications and **7.4 ±0.9%** among those without complications.

Table 5. Frequency of early in-hospital complications and association with admission HbA1c (N = 100)

Complication profile or HbA1c category	Denominator	Frequency or complication present, n (%)	No complication, n (%)
A. Overall complication profile			
Left ventricular failure	100	30 (30%)	-
Arrhythmias	100	26 (26%)	-
Cardiogenic shock	100	12 (12%)	-
Mitral regurgitation	100	8 (8%)	-
Ventricular septal rupture	100	4 (4%)	-
No early complication	100	-	20 (20%)
B. Any early complication by admission HbA1c			
6.5–7.4%	24	10 (41.7%)	14 (58.3%)
7.5–8.4%	34	18 (52.9%)	16 (47.1%)
8.5–9.4%	26	20 (76.9%)	6 (23.1%)
≥9.5%	16	12 (75.0%)	4 (25.0%)
Overall in the HbA1c cross-tabulation	**100**	**60 (60%)**	**40 (40%)**

Panels A and B reproduce separate tabulations. Percentages use the denominator shown for each row. An em dash indicates that the cell is inapplicable. The test statistic for the association in Panel B was $\chi^2 = 10.84$, $p = 0.012$.

In-hospital clinical outcomes by admission HbA1c

Recovery and discharge was the most common outcome. The proportion recovering was lower in the higher HbA1c categories, and both in-hospital deaths occurred among participants with HbA1c ≥8.5%.

Table 6. In-hospital clinical outcomes by admission HbA1c category (N = 100)

Admission HbA1c, %	Total, n	Recovered or discharged, n (%)	Persistent heart failure, n (%)	Cardiogenic shock, n (%)	In-hospital death, n (%)
6.5–7.4	24	22 (91.7%)	2 (8.3%)	0 (0%)	0 (0%)
7.5–8.4	34	30 (88.2%)	3 (8.8%)	1 (2.9%)	0 (0%)
8.5–9.4	26	18 (69.2%)	5 (19.2%)	2 (7.7%)	1 (3.8%)
≥9.5	16	8 (50.0%)	4 (25.0%)	3 (18.8%)	1 (6.3%)
Overall	**100**	**78 (78%)**	**14 (14%)**	**6 (6%)**	**2 (2%)**

Percentages use the row denominator and may differ slightly from 100% because of rounding. Cardiogenic shock in this table refers to the recorded clinical outcome. The test statistic for the association between HbA1c category and clinical outcome was $\chi^2 = 11.26$, $p = 0.024$.

DISCUSSION

Among adults with established type 2 diabetes and acute anterior wall ST-segment elevation myocardial infarction (STEMI), early in-hospital complications were more frequent in the two highest admission HbA1c categories than in the two lower categories. The proportions were similar in the 8.5–9.4% and ≥9.5% groups, suggesting a difference between the lower and higher categories without a steady increase across the full HbA1c range. Left ventricular failure and arrhythmias were the most frequently recorded early complications. Regional wall motion abnormalities and left ventricular systolic dysfunction were also more frequent at higher HbA1c levels. Together, these findings describe differences in early morbidity and ventricular function within a population that already had diabetes.

The pattern of early complications is broadly consistent with the findings of Vora et al., who reported complicated myocardial infarction in 31.8% of patients with elevated HbA1c and 14.3% of those in the lower HbA1c group [10]. Their study enrolled patients with several forms of acute coronary syndrome and no prior diagnosis of diabetes, so the direction of the association is more comparable than the absolute complication rates. The Indian ACS QUIK analysis likewise found that diabetes was associated with more adverse events following myocardial infarction [3]. That analysis compared patients with and without diabetes, whereas the present study examined differences in antecedent glycemia among patients with established type 2 diabetes and a defined infarct location.

The echocardiographic findings complement the clinical observations. Gao et al. reported an association between higher HbA1c and impaired myocardial strain on cardiac magnetic resonance imaging among patients with diabetes after acute myocardial infarction [9]. The present study assessed regional wall motion and ejection fraction by echocardiography, which characterize ventricular performance differently from myocardial strain. The similar direction of the findings supports further examination of the relationship between antecedent glycemia and ventricular function after infarction. Infarct extent, pre-existing ventricular dysfunction, and the timing and success of reperfusion could also account for differences in echocardiographic findings across HbA1c categories [1,9].

Recovery and discharge remained the most common outcome, although the proportion recovering was lower in the higher HbA1c categories. With only two in-hospital deaths, the study offers limited information about mortality. This distinction matters because Britton et al. found no clear association between HbA1c and in-hospital mortality among patients with diabetes and acute myocardial infarction, and Pan et al. found no statistically significant association with short-term mortality in the subgroup with established diabetes [7,8]. Acute glucose elevations may also carry information distinct from HbA1c. In a post hoc analysis of the HI-5 trial, Lee et al. found that hyperglycemia relative to estimated usual glycemia was associated with complications after acute myocardial infarction [11]. Studying both measures together may help clarify their respective contributions to early outcomes.

The focused population and the use of structured clinical, electrocardiographic, and echocardiographic assessments allowed the study to examine several aspects of the early hospital course within the same cohort. Admission HbA1c provided context on glycemic exposure preceding infarction [4]. Its additional value for predicting early complications alongside established clinical and echocardiographic measures remains a question for prospective studies.

The study was limited by its single-center cross-sectional design, convenience sampling, and sample size. Sparse counts for individual complications and deaths limited assessment of those outcomes, and observation ended during hospitalization. The associations were unadjusted, leaving potential confounding by infarct extent, time to reperfusion, pre-existing ventricular function, diabetes duration, and comorbidities. Variation in echocardiographic assessment may also have influenced the classification of ventricular dysfunction. These limitations constrain the precision and generalizability of the findings and preclude causal interpretation.

CONCLUSION

Among adults with established type 2 diabetes and acute anterior wall ST-segment elevation myocardial infarction, early in-hospital complications were more frequent in the higher admission HbA1c categories. Left ventricular failure and arrhythmias were the most frequently recorded complications. Regional wall motion abnormalities and left ventricular systolic dysfunction were also more frequent at higher HbA1c levels, while recovery and discharge were less frequent. The complication frequency was similar in the two highest HbA1c categories, so the observed pattern does not establish a threshold for clinical use. These findings indicate that admission HbA1c can provide context on antecedent glycemia when interpreting the early hospital course alongside clinical and echocardiographic findings. Given the single-center design and unadjusted comparisons, larger prospective studies should determine whether HbA1c adds predictive information beyond established measures of infarct severity, ventricular function, and reperfusion status.

DECLARATIONS

Ethics approval and consent to participate. Institutional ethics approval and all required permissions were obtained before the study began. All participants provided informed consent before enrollment.

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Conflicts of interest. The authors declare no conflicts of interest.

Data availability. The data are available from the corresponding author upon reasonable request.

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