

Increase in the proportion of patients hospitalized with acute myocardial infarction with do-not-resuscitate orders already in place between 2001 and 2007: a nonconcurrent prospective study

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Background and objective: Shared decision making and advance planning in end-of-life decisions have become increasingly important aspects of the management of seriously ill patients. Here, we describe the use and timing of do-not-resuscitate (DNR) orders in patients hospitalized with acute myocardial infarction (AMI).

Study design and setting: The nonconcurrent prospective study population consisted of 4182 patients hospitalized with AMI in central Massachusetts in four annual periods between 2001 and 2007.

Results: One-quarter (25%) of patients had a DNR order written either prior to or during hospitalization. The frequency of DNR orders remained constant (24% in 2001; 26% in 2007). Among patients with DNR orders, there was a significant increase in orders written prior to hospitalization (2001: 9%; 2007: 55%). Older patients and those with a medical history of heart failure or myocardial infarction were more likely to have prior DNR orders than respective comparison groups. Patients with prior DNR orders were less likely to die 1 month after hospitalization than patients whose DNRs were written during hospitalization.

Conclusion: Although the use of DNR orders in patients hospitalized with AMI was stable during the period under study, in more recent years, patients are increasingly being hospitalized with DNR orders already in place.

Keywords: epidemiology, myocardial infarction, survival, end of life, longitudinal, cardiology

Introduction

The use of do-not-resuscitate (DNR) orders has increased over the past decade. This is partially due to the aging of the US population and to the increased awareness of the patient's and family's role in end-of-life decisions brought on, in part, by the implementation of the Patient Self-determination Act in 1991.¹ While the characteristics of patients with DNR orders have been examined over the past two decades,²⁻⁶ trends in the writing and timing of DNR orders have not been studied. These issues are particularly relevant among patients hospitalized with acute myocardial infarction (AMI), one of the leading causes of death in the USA. One multicenter study found that there was little change in the overall use of DNR orders in patients hospitalized with AMI at 29 medical centers between 1991 and 1997.⁷ Although there was an increase in the frequency of early DNR orders (within the first 2 days of hospital admission), there was a concurrent decrease in the use of late DNR orders (written 3 days or more after admission). Other studies, including a previous study from the Worcester Heart

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Attack Study, have reported increasing use of DNR orders over time in patients hospitalized with AMI.^{5,6,8–10} However, these studies have not examined trends after 2000 in the use of, and patient factors associated with, DNR orders and trends in the timing (whether they were in place prior to hospitalization or written during the index hospitalization) of DNR orders in hospitalized patients.

The present study examined trends (2001–2007) in the writing and timing of DNR orders and associated patient characteristics in residents of a large central New England community hospitalized with AMI at all area medical centers.¹¹

Methods

Data for this study were derived from the Worcester Heart Attack Study. This is an ongoing population-based investigation examining long-term trends in the incidence, hospital, and post-discharge case-fatality rates of AMI among residents of the Worcester metropolitan area hospitalized at all central Massachusetts medical centers. The details of this study have been described previously.^{10–12} In brief, the medical records of patients hospitalized for possible AMI at all greater Worcester medical centers were individually reviewed and a diagnosis of AMI was validated according to predefined criteria.^{11,12} Patients who developed AMI secondary to an interventional procedure or surgery and those with terminal illness (end-stage liver disease) were excluded from the study sample. A total of 4182 patients hospitalized with validated AMI during four annual periods between 2001 and 2007 constituted the population of this study.

Data collection

Trained study physicians and nurses abstracted demographic, medical history, and clinical data from the hospital medical records of eligible patients with confirmed AMI. Information was collected about patients' age, sex, comorbidities (angina, diabetes, heart failure, and stroke), AMI order (initial vs prior) and type (ST segment elevation myocardial infarction [STEMI] vs non-STEMI), hospital treatment practices, and hospital discharge status. Information was collected about the occurrence of in-hospital complications including stroke,¹³ atrial fibrillation,¹⁴ heart failure,¹⁵ and cardiogenic shock.¹⁶ Information about the use of DNR orders was collected through the review of hospital records and physicians' progress notes. Information on whether DNR orders were in place prior to hospitalization was also collected from the review of the medical chart. Quality control checks conducted by the study's principal investigator and a physician study

coordinator included the double review of a random sample of 5% of hospital charts on an ongoing basis. Intra-rater quality control was confirmed by having reviewers repeat data abstraction a few months after initial abstraction for approximately 5% of charts to ensure high-quality data abstraction. Survival status after hospital discharge was ascertained through a review of the medical records for additional hospitalizations and a national search of death records for Worcester residents.

Data analysis

Changes over time in the frequency of DNR orders were calculated using linear trends analysis. We compared differences in demographic and clinical characteristics, treatment practices, and hospital outcomes in patients with and without DNR orders and also according to the timing of DNR orders using chi-square tests. Logistic regression analysis was performed to identify variables independently associated with the presence of DNR orders as well as the timing of these orders. The model included demographic characteristics, previous comorbidities, and acute myocardial infarct (AMI)-associated characteristics (initial vs recurrent, location of AMI and ST-elevation myocardial infarct (STEMI) vs Non-STEMI), the occurrence of in-hospital complications (atrial fibrillation, heart failure, cardiogenic shock, and stroke), survival status, and information about the receipt of treatments (medications) and interventional strategies (cardiac catheterization, percutaneous coronary intervention [PCI], and coronary artery bypass graft [CABG]). Multivariate logistic regression analysis was also used to examine the association between the presence and timing of DNR orders (in place prior to hospitalization vs recorded during the acute hospitalization) and in-hospital and 30-day post-admission death rates, adjusting for all variables described above.

Results

Prevalence and trends in the use of DNR orders

Approximately one in four (25%) residents of the Worcester metropolitan area hospitalized for AMI between 2001 and 2007 had a DNR order noted in their medical record either at the time of admission or during the in-hospital stay. The frequency of DNR orders did not significantly increase over the 6-year study period (23.9% in 2001; 26.4% in 2007 [$P = 0.36$]). In multivariable adjusted models, the odds of patients hospitalized with AMI having a DNR order increased slightly (17%) over time but were not significantly different from the reference year of 2001 (Table 1).

Table 1 Changing trends in the use of do-not-resuscitate orders in patients hospitalized with acute myocardial infarction (AMI) (Worcester Heart Attack Study)¹⁰

Study years	Model 1 [†]	Model 2 [‡]
	Odds ratio (95% CI)	Odds ratio (95% CI)
2001*	1.0	1.0
2003	1.00 (0.80, 1.25)	1.10 (0.87, 1.39)
2005	1.05 (0.83, 1.32)	1.17 (0.92, 1.50)
2007	0.99 (0.77, 1.28)	1.17 (0.89, 1.54)

Notes: *Referent year; [†]adjusted for age, sex, comorbid conditions (history of angina, diabetes, hypertension, heart failure), and AMI-associated characteristics (AMI order, location, and type); [‡]additional adjustments for development of hospital complications (atrial fibrillation, heart failure, cardiogenic shock, stroke), and in-hospital medications (angiotensin-converting-enzyme inhibitors, anticoagulants, aspirin, beta-blockers, calcium antagonists, thrombolytic therapy).

Abbreviation: CI, confidence interval.

Information about the timing of DNR orders (in place prior to hospitalization vs written during hospitalization) was available for all patients. Approximately two-thirds (65%) had their DNR order written during hospitalization. While the majority of the DNR orders were written during hospitalization, the proportion of patients with DNR orders in place prior to hospitalization increased significantly over the period under study (Figure 1).

Characteristics of patients with DNR orders

Compared with patients without DNR orders, those who had written DNR orders were older, more likely to be female, and to have a history of several comorbidities (eg, diabetes, hypertension; Table 2). Patients with a DNR order were more likely to have had a prior AMI, to have developed a non-STEMI, and to have experienced several in-hospital complications (eg, atrial fibrillation). Patients with DNR orders were less likely to be treated with several evidence-based cardiac medications during hospitalization for AMI,

including angiotensin-converting-enzyme inhibitors, anticoagulants, aspirin, beta-blockers, and thrombolytics, and were significantly less likely than patients without a DNR order to have undergone cardiac catheterization, a PCI, or coronary artery bypass surgery. As expected, patients with a DNR order were significantly more likely to have died during the index hospitalization than patients without DNR orders.

Several characteristics of patients also differed according to whether the DNR order was in place prior to hospitalization or was written during the index hospitalization. Compared with patients whose DNR orders were written during hospitalization, those who had prior DNR orders were more often older; female; and were more likely to have a history of heart failure, stroke, and renal disease (Table 2). Conversely, these patients were less likely to have had their hospital stay complicated by atrial fibrillation, stroke, or cardiogenic shock (Table 2). Patients with a prior DNR order were less likely to have developed a STEMI than those who had a DNR order written during hospitalization. Patients with a prior DNR order were more likely to have been treated with beta-blockers but were less likely to have been treated with thrombolytic therapy than patients whose DNR orders were written during their hospital stay. Hospital case-fatality rates were significantly lower among patients with prior DNR orders (20%) compared with those who had their DNR orders written during their acute hospitalization (34%).

Factors associated with the use of DNR orders

After adjusting for the previously described covariates, older age, female sex, history of a previous myocardial infarction (MI), and development of several clinical complications, including heart failure and stroke, were significantly associated with the receipt of DNR orders (Table 3). Patients with a history of heart failure or stroke were significantly more likely to have DNR orders in their charts while patients who underwent cardiac catheterization, PCI, or coronary artery bypass surgery were significantly less likely to have received DNR orders. Expectedly, patients who died during the index hospitalization were significantly more likely to have received a DNR order.

We also examined factors associated with the timing of DNR orders (Table 3). Among patients for whom a DNR order was written, approximately one-third (35%) had a DNR order in place prior to hospitalization for AMI. In adjusted models, older age (≥ 75 years) and history of heart failure or a prior MI were significantly associated with having a prior

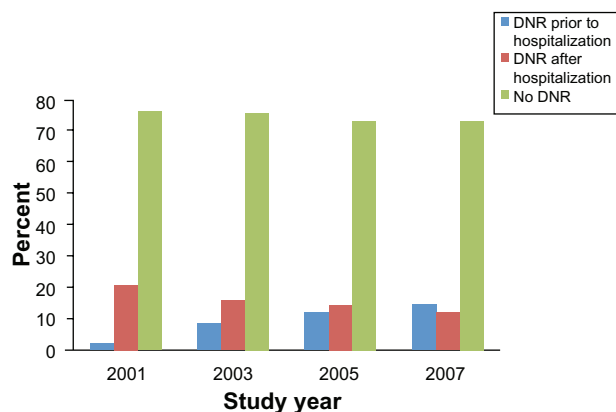


Figure 1 Trends in the use and timing of do-not-resuscitate (DNR) orders in patients hospitalized for acute myocardial infarction (Worcester Heart Attack Study).¹⁰

Table 2 Characteristics of patients hospitalized with acute myocardial infarction (AMI) according to do-not-resuscitate (DNR) orders and timing (Worcester Heart Attack Study)¹⁰

Characteristic	All DNR orders (n = 1051)	No DNR order written (n = 3131)	P value*	DNR order written prior to hospitalization (n = 364)	DNR order written during hospitalization (n = 678)	P value†
Age (years)						
<65	5.7	40.4		2.8	7.3	
65–74	11.6	23.2		8.0	13.0	
75–84	37.7	27.0		41.9	35.5	
≥85	45.0	9.3	<0.001	47.4	44.3	<0.001
Female, %	63.4	37.8	<0.001	67.3	61.4	<0.001
Medical History, %						
Angina pectoris	17.5	18.2	0.61	14.8	19.3	0.21
Diabetes mellitus	36.6	33.0	0.03	36.0	37.0	0.18
Hypertension	78.3	71.3	<0.001	75.8	79.7	0.09
Heart failure	43.2	18.5	<0.001	48.9	40.4	<0.001
Stroke	20.5	9.0	<0.001	23.1	19.3	<0.001
Cancer	19.9	14.0	<0.001	21.4	19.0	0.33
Liver disease	0.9	1.21	0.49	0.82	1.03	0.76
Renal disease	28.4	15.5	<0.001	32.7	26.4	<0.001
AMI characteristics						
Initial	54.5	68.3	<0.001	55.0	54.1	0.88
ST elevation	24.1	35.8	<0.001	21.2	25.4	0.02
Clinical complications						
Atrial fibrillation	32.0	18.2	<0.001	26.7	35.1	<0.001
Heart failure	60.5	32.4	<0.001	62.4	59.9	0.46
Cardiogenic shock	8.7	4.4	<0.001	5.5	10.5	<0.001
Stroke	3.6	0.9	<0.001	1.4	4.7	<0.001
In-hospital medications						
ACE inhibitors	55.0	67.7	<0.001	53.7	54.7	0.89
Heparin/anticoagulants	74.2	83.1	<0.001	74.5	73.9	0.72
Aspirin	86.4	94.3	<0.001	86.8	86.3	0.96
Beta-blockers	83.7	93.0	<0.001	86.3	82.5	0.02
Calcium antagonists	26.7	23.2	0.02	26.1	27.4	0.39
Thrombolytic therapy	1.9	5.2	<0.001	0.8	2.5	<0.001
Intervention procedures						
Cardiac catheterization	23.9	71.1	<0.001	20.6	25.5	<0.001
Percutaneous coronary intervention	14.9	50.4	<0.001	12.4	16.4	<0.001
Coronary artery bypass surgery	1.3	8.1	<0.001	0.6	1.5	<0.001
Hospital case-fatality rate	29.3	3.5	<0.001	20.2	34.2	<0.001

Notes: *P values compare patients with DNR orders written with those whose without DNR orders; †P values compare patients with DNR orders written prior to hospitalization with those whose DNR orders were written during hospitalization.

Abbreviation: ACE, angiotensin-converting enzyme.

DNR order. Patients with a prior DNR order were also less likely to have a history of angina, to have developed a stroke as a complication of AMI, and to have died during the index hospitalization than patients whose DNR orders were written during hospitalization.

Timing of DNR orders and hospital survival

Although we did not have specific information available about the situation in which in-hospital DNR orders were

written, the timing of these orders with respect to hospital mortality may provide insights into the circumstances of their writing. Of the DNR orders that were written during hospitalization, 74% were written within 2 days of admission. Patients whose DNR orders were written later in their hospital stay were significantly more likely to have died within 3 days of the DNR order being written than patients with early DNR orders (49% vs 31%; $P < 0.001$), suggesting that these later DNR orders may have been written in response to clinical deterioration.

Table 3 Factors associated with having a do-not-resuscitate (DNR) order, and timing of the writing of the order, in patients hospitalized with acute myocardial infarction (AMI) (Worcester Heart Attack Study)¹⁰

Characteristic	DNR order written [†]		DNR order written after hospital admission [‡]	
	Odds ratio (95% confidence interval)		Odds ratio (95% confidence interval)	
	Model 1	Model 2	Model 1	Model 2
Age, years				
<65	1.0	1.0	1.0	1.0
65–74	2.88 (2.04, 4.07)	2.06 (1.41, 3.01)	1.59 (0.68, 3.73)	1.79 (0.74, 4.30)
75–84	7.24 (5.32, 9.86)	4.88 (3.48, 6.83)	2.89 (1.35, 6.16)	2.84 (1.30, 6.21)
≥85	25.26 (18.27, 34.93)	14.30 (10.00, 20.45)	2.65 (1.24, 5.68)	2.31 (1.05, 5.09)
Male	0.51 (0.43, 0.61)	0.52 (0.43, 0.63)	0.76 (0.56, 1.01)	0.76 (0.56, 1.04)
Medical history				
Angina pectoris	0.70 (0.56, 0.87)	0.81 (0.63, 1.03)	0.71 (0.50, 1.04)	0.67 (0.46, 0.99)
Diabetes mellitus	1.11 (0.92, 1.33)	1.09 (0.86, 1.34)	1.01 (0.75, 1.37)	1.04 (0.76, 1.41)
Hypertension	0.78 (0.63, 0.96)	0.86 (0.68, 1.09)	0.74 (0.54, 1.04)	0.75 (0.53, 1.06)
Heart failure	2.22 (1.83, 2.69)	1.67 (1.34, 2.08)	1.59 (1.19, 2.13)	1.58 (1.16, 2.15)
Stroke	2.09 (1.66, 2.63)	1.71 (1.33, 2.20)	1.28 (0.91, 1.79)	1.32 (0.93, 1.88)
AMI characteristics				
Initial	0.74 (0.62, 0.89)	0.74 (0.60, 0.90)	1.12 (0.84, 1.50)	1.18 (0.88, 1.58)
Anterior	0.97 (0.74, 1.28)	0.93 (0.68, 1.27)	1.26 (0.80, 2.00)	1.29 (0.81, 2.07)
ST segment elevation	0.96 (0.76, 1.20)	0.83 (0.64, 1.09)	1.40 (0.96, 2.05)	1.20 (0.80, 1.80)
Clinical complications				
Atrial fibrillation		1.17 (0.95, 1.46)		0.78 (0.57, 1.08)
Heart failure		1.34 (1.09, 1.65)		1.03 (0.76, 1.41)
Cardiogenic shock		1.32 (0.86, 2.03)		0.63 (0.34, 1.18)
Stroke		2.20 (1.19, 4.07)		0.29 (0.10, 0.86)
In-hospital medications				
ACE inhibitors		0.91 (0.73, 1.11)		0.74 (0.54, 1.01)
Heparin/anticoagulants		0.99 (0.79, 1.25)		1.05 (0.76, 1.48)
Aspirin		1.34 (0.96, 1.87)		0.98 (0.62, 1.55)
Beta-blockers		1.03 (0.75, 1.41)		1.34 (0.87, 2.09)
Calcium antagonists		0.86 (0.71, 1.09)		0.92 (0.66, 1.29)
Thrombolytic therapy		0.56 (0.31, 1.04)		0.44 (0.12, 1.61)
Diagnostic and interventional procedures				
Cardiac catheterization		0.46 (0.34, 0.62)		0.95 (0.55, 1.62)
Percutaneous coronary intervention		0.66 (0.47, 0.92)		1.06 (0.56, 1.98)
Coronary artery bypass surgery		0.41 (0.22, 0.79)		0.56 (0.11, 2.89)
Hospital death		9.23 (6.74, 12.63)		0.57 (0.39, 0.83)

Notes: The respective referent categories are: age < 65 years, female sex, absence of selected medical history variables, previous AMI, non-Q wave AMI, inferior or posterior AMI, absence of selected clinical complications, absence of selected prescribed medications, absence of selected in-hospital procedures, and hospital survival status.

[†]N = 4182; [‡]analysis includes only patients with DNR orders, N = 1051.

Abbreviation: ACE, angiotensin-converting enzyme.

Receipt of DNR orders and 30-day death rates

We also examined the relation between use of DNR orders and the risk of dying at 30-days post-hospital admission, adjusting for demographic characteristics, previous comorbidities, and AMI-associated characteristics (initial vs recurrent, location of AMI and STEMI vs non-STEMI), the occurrence of in-hospital complications (atrial fibrillation, heart failure, cardiogenic shock, and stroke), survival status, and information about the receipt of treatments (medications) and interventional strategies (cardiac catheterization, PCI,

and CABG). Compared with patients without a DNR order, those with a DNR order experienced significantly higher 30-day crude mortality rates (38.1% vs 5.6%; $P < 0.001$). In adjusted models, patients with a DNR order had significantly higher odds of dying at 30-days post-admission (odds ratio [OR] = 6.27; 95% confidence interval [CI] 4.84, 8.13) compared with patients without a DNR order.

Among patients with DNR orders, short-term survival varied according to the timing of DNR orders. Compared with patients whose DNR orders were written during hospitalization, those with a prior DNR order had significantly lower 30-day

post-admission mortality rates (31.3% vs 41.6% ; $P = 0.001$) and significantly lower adjusted odds of dying during this high-risk period (OR = 0.68; 95% CI 0.48, 0.95).

As a sensitivity analysis, we excluded patients with renal disease (N = 783) from our analysis; the results did not change appreciably.

Discussion

The results of this community-wide study of greater Worcester residents hospitalized with AMI between 2001 and 2007 suggest that the overall use of DNR orders has remained stable over this relatively contemporary period. However, we also found that the timing of DNR orders has changed during the period under study. Although the majority of DNR orders were written during hospitalization (65%), there was a significant increase in the proportion of DNR orders written prior to hospitalization for AMI, highlighting the changing behaviors in the writing of DNRs as well as changes in the demographic and clinical profiles of patients hospitalized for AMI. We identified several demographic and clinical factors associated with the use and timing of DNR orders.

Prevalence and trends in use and timing of DNR orders

Published estimates of the use of DNR orders in all hospitalized patients vary widely, ranging from 5% to 35%. These estimates depend on the years under study, characteristics of the patient population, and the disease under study.⁴⁻⁸ Among patients hospitalized for AMI, DNR rates have been generally reported to be between 15% and 25%.^{5,7,17,18} Our rate of 25% is on the high end of previously published rates, which probably reflects the more contemporary nature of this cohort.

There are relatively few studies on changing trends in the use of DNR orders in patients hospitalized with AMI. One multicenter study of 91,539 patients hospitalized with a variety of acute and chronic conditions at 29 medical centers throughout the USA reported little change in DNR orders between 1991 and 1997.⁷ Among the 10,426 patients in this study who were hospitalized for AMI, there was a significant increase in the writing of DNR orders in early but not late study years. Early increases in DNR use have been attributed to the development of legislation, such as the Patient Self-determination Act, which increased awareness of the patient's and family's role in end-of-life decisions.¹ We found that DNR rates did not increase during our contemporary study period, 2001–2007.

The increasing proportion of patients hospitalized for AMI admitted to the hospital with DNR orders already in

place may be attributable to the older age of these patients and the growing proportion of patients hospitalized with a previous MI and other comorbidities during the past several decades.¹⁹

Factors associated with the use of DNR orders

Consistent with findings from previous studies,^{2,4,7,17,20} we identified several patient characteristics independently associated with the writing of DNR orders, including older age, female sex, history of a prior MI, existing comorbidities, and the development of several clinically significant hospital complications. In our study and others, female sex and older age appear to be the factors most strongly associated with the receipt of DNR orders.^{2,6,8,21} While there is some evidence to suggest that older patients and women are less likely to want aggressive treatment,^{22,23} it is difficult to rule out elements of physician bias in the application of DNR orders. In addition, older patients may have more comorbidities present, which may contribute to the higher rate of DNR orders observed in this group.⁶ However, previous studies have found that even after controlling for severity of disease, age is independently associated with the writing of DNR orders.^{2,6}

Patients with DNR orders were significantly less likely to receive most evidence-based therapies during hospitalization, including medications and procedures. In some cases, the lack of use of evidence-based therapies may be appropriate in patients with DNR orders. In light of the invasive nature of cardiac catheterization and CABG surgery, the lower utilization of coronary revascularization procedures among patients with DNR orders probably reflects both patient and provider preference. However, the underutilization of evidence-based cardiac medications such as aspirin in patients with DNR orders cannot be explained on this basis.

Older patients and those with a history of heart failure or MI were more likely to have a DNR order in place prior to hospitalization. Since many providers require reversal of a DNR order prior to performing an interventional procedure (eg, cardiac catheterization), the presence of a DNR order prior to admission may strongly influence the treatment strategy employed for patients hospitalized with an AMI.

DNR orders and mortality

As expected, we found higher in-hospital death rates in patients with DNR orders, a finding which has been reported in a number of prior studies.^{3,5,17,20} This finding could represent bias toward less aggressive patient treatment or, alternatively, an association between DNR orders and clinical parameters

that affect prognosis, neither of which were captured in our data. In addition, the timing of DNR orders was associated with hospital prognosis, as patients who had prior DNR orders experienced significantly lower hospital death rates compared with those who had DNR orders written during hospitalization.

In-hospital DNR orders, particularly late in the hospital course, are likely to reflect a reaction to a rapid and unexpected clinical deterioration. We found that patients whose DNR orders were written later in their hospital stay were significantly more likely to die within 3 days of the order being written than those whose orders were written early in their hospital stay, suggesting that later DNR orders may have been written in response to clinical deterioration rather than as part of an advanced care plan. Unfortunately, we were unable to determine the proportion of hospital deaths that were attributed to withdrawal or withholding of life support or other treatment-related factors due to our methods of data collection. Thus, appropriate caution needs to be exercised in examining the association between timing of DNR orders and short-term mortality.

Survival 1 month following hospital discharge for AMI has also been found to be lower in patients with DNR orders.^{7,18} In our study, patients with a DNR order were more than six times more likely to die within 30 days of admission than patients without DNR orders. Among patients with a DNR order, those with prior DNR orders experienced significantly lower odds of dying during the 30 days after hospital admission. Given the shift from late to early writing of DNR orders observed in this and other studies,⁷ the relationship between timing of DNR orders and patient outcome warrants further examination.

Study strengths and limitations

The strengths of the present investigation include our population-based design that included all patients hospitalized for AMI from a well-characterized urban New England community. All cases of possible AMI were independently validated according to standardized criteria and we were able to examine the role of a number of factors that may have contributed to the receipt of DNR orders.

The limitations of this study were that we did not have information on characteristics of physicians who wrote the orders or about the influence of patient cultural, psychosocial, or quality of life factors or circumstances that may have affected the use and timing of DNR orders, such as acute changes in patients' clinical status that may have precipitated the writing of DNR orders and use of advance directives or

health proxy status. These limitations affect our ability to fully characterize the circumstances around the writing of the DNR orders. Further, we did not have information available on nursing home or dementia status or on the timing of procedures, some of which may have resulted in the reversal (or rescinding) of DNR orders, such as cardiac catheterization or in-hospital complications. With respect to the timing of DNR orders being written, we are unable to comment on whether DNRs written during hospitalization were in response to acute clinical deterioration. We also do not have information on how long DNR orders that were written prior to hospitalization had been in place. In addition, this cohort consists largely of white patients and thus may lack generalizability to other racial/ethnic groups.

Conclusion

The results of this study in residents of a large central New England community suggest that the writing of DNR orders in patients hospitalized with AMI has remained stable since 2001. Patients with AMI are increasingly more likely to be hospitalized with DNR orders already in place, highlighting the growing attention to end-of-life issues in both chronic and acute care.

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Disclosure

The authors declare no conflicts of interest in this work.

References

1. US Omnibus Budget Reconciliation Act of 1990. Pubic Law 101-508, 104 Stat 1388, enacted November 5, 1990.
2. Boyd K, Teres D, Rapoport J, Lemeshow S. The relationship between age and the use of DNR orders in critical care patients. Evidence for age discrimination. *Arch Intern Med.* 1996;156(16):1821–1826.
3. Chen JL, Sosnov J, Lessard D, Goldberg RJ. Impact of do-not-resuscitation orders on quality of care performance measures in patients hospitalized with acute heart failure. *Am Heart J.* 2008;156(1):78–84.
4. Hakim RB, Teno JM, Harrell FE Jr, et al. Factors associated with do-not-resuscitate orders: patients' preferences, prognoses, and physicians' judgments. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. *Ann Intern Med.* 1996;125(4):284–293.

5. Jackson EA, Yarzebski JL, Goldberg RJ, et al. Do-not-resuscitate orders in patients hospitalized with acute myocardial infarction: the Worcester Heart Attack Study. *Arch Intern Med.* 2004;164(7):776–783.
6. Wenger NS, Pearson ML, Desmond KA, et al. Epidemiology of do-not-resuscitate orders: disparity by age, diagnosis, gender, race, and functional impairment. *Arch Intern Med.* 1995;155(19):2056–2062.
7. Baker DW, Einstadter D, Husak S, Cebul RD. Changes in the use of do-not-resuscitate orders after implementation of the Patient Self-determination Act. *J Gen Intern Med.* 2003;18(5):343–349.
8. Jayes RL, Zimmerman JE, Wagner DP, Draper EA, Knaus WA. Do-not-resuscitate orders in intensive care units. Current practices and recent changes. *JAMA.* 1993;270(18):2213–2217.
9. Teno JM, Branco KJ, Mor V, et al. Changes in advance care planning in nursing homes before and after the patient Self-Determination Act: report of a 10-state survey. *J Am Geriatr Soc.* 1997;45(8):939–944.
10. Floyd KC, Yarzebski J, Spencer FA, et al. A 30-year perspective (1975–2005) into the changing landscape of patients hospitalized with initial acute myocardial infarction: Worcester Heart Attack Study. *Circ Cardiovasc Qual Outcomes.* 2009;2(2):88–95.
11. Goldberg RJ, Yarzebski J, Lessard D, Gore JM. A two-decades (1975 to 1995) long experience in the incidence, in-hospital and long-term case-fatality rates of acute myocardial infarction: a community-wide perspective. *J Am Coll Cardiol.* 1999;33(6):1533–1539.
12. Goldberg RJ, Gore JM, Alpert JS, Dalen JE. Incidence and case fatality rates of acute myocardial infarction (1975–1984): The Worcester Heart Attack Study. *Am Heart J.* 1988;115(4):761–767.
13. Saczynski JS, Spencer FA, Gore JM, et al. Twenty-year trends in the incidence of stroke complicating acute myocardial infarction: Worcester Heart Attack Study. *Arch Intern Med.* 2008;168(19):2104–2110.
14. Saczynski JS, McManus D, Zhou Z, et al. Trends in atrial fibrillation complicating acute myocardial infarction. *Am J Cardiol.* 2009;104(2):169–174.
15. Spencer FA, Meyer TE, Goldberg RJ, et al. Twenty year trends (1975–1995) in the incidence, in-hospital and long-term death rates associated with heart failure complicating acute myocardial infarction: a community-wide perspective. *J Am Coll Cardiol.* 1999;34(5):1378–1387.
16. Goldberg RJ, Spencer FA, Gore JM, Lessard D, Yarzebski J. Thirty-year trends (1975 to 2005) in the magnitude of, management of, and hospital death rates associated with cardiogenic shock in patients with acute myocardial infarction: a population-based perspective. *Circulation.* 2009;119(9):1211–1219.
17. Gan SC, Beaver SK, Houck PM, MacLehose RF, Lawson HW, Chan L. Treatment of acute myocardial infarction and 30-day mortality among women and men. *N Engl J Med.* 2000;343(1):8–15.
18. Baker DW, Einstadter D, Husak SS, Cebul RD. Trends in postdischarge mortality and readmissions: has length of stay declined too far? *Arch Intern Med.* 2004;164(5):538–544.
19. Goldberg RJ, Spencer FA, Yarzebski J, et al. A 25-year perspective into the changing landscape of patients hospitalized with acute myocardial infarction (the Worcester Heart Attack Study). *Am J Cardiol.* 2004;94(11):1373–1378.
20. García JA, Romano PS, Chan BK, Kass PH, Robbins JA. Sociodemographic factors and the assignment of do-not-resuscitate orders in patients with acute myocardial infarctions. *Med Care.* 2000;38(6):670–678.
21. Wenger NS, Pearson ML, Desmond KA, Kahn KL. Changes over time in the use of do not resuscitate orders and the outcomes of patients receiving them. *Med Care.* 1997;35(4):311–319.
22. Frankl D, Oye RK, Bellamy PE. Attitudes of hospitalized patients toward life support: a survey of 200 medical inpatients. *Am J Med.* 1989;86(6):645–648.
23. Hamel MB, Teno JM, Goldman L, et al. Patient age and decisions to withhold life-sustaining treatments from seriously ill, hospitalized adults. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment. *Ann Intern Med.* 1999;130(2):116–125.

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