Published in final edited form as:
Acad Emerg Med. 2021 September ; 28(9): 1051–1060. doi:10.1111/acem.14235.

Established Evidence-based Treatment Guidelines Help Mitigate Disparities in Quality of Emergency Care

Stacy A. Trent, MD MPH[1,2], **Nigel George, MD**[3], **Edward P. Havranek, MD**[4,5], **Adit A. Ginde, MD MPH**[2], **Jason S. Haukoos, MD, MSc**[1,2,6]

[1]Department of Emergency Medicine, Denver Health Medical Center, Denver, Colorado

[2]Department of Emergency Medicine, University of Colorado School of Medicine, Aurora, Colorado

[3]Department of Emergency Medicine, Piedmont Athens Regional Medical Center, Athens, Georgia

[4]Department of Medicine, Denver Health Medical Center, Denver, Colorado

[5]Division of Cardiology, University of Colorado School of Medicine, Aurora, Colorado

[6]Department of Epidemiology, Colorado School of Public Health, Aurora, Colorado

Abstract

Background: Evidence-based guidelines are often cited as a means of ensuring high quality care for all patients. Our objective was to assess whether emergency department (ED) adherence to core evidence-based guidelines differed by patient sex and race/ethnicity and to assess the effect of ED guideline adherence on patient outcomes by sex and race/ethnicity.

Methods: We conducted a pre-planned secondary analysis of data from a multi-center retrospective observational study evaluating variation in ED adherence to five core evidence-based treatment guidelines including: aspirin for acute coronary syndrome, door-to-balloon time for acute ST-elevation myocardial infarction, systemic thrombolysis for acute ischemic stroke,

---

Address for Correspondence: Stacy Trent, MD MPH, 777 Bannock Street, Mail Code 0108, Denver, CO, 80204, stacy.trent@dhha.org, (303) 602-5164 (office), (303) 602-5184 (fax).
Author Contributions:
Study Concept and Design – ST, EH, AG, JH
Acquisition of Data – ST
Analysis and Interpretation of Data – All Authors
Drafting of Manuscript – ST, NG
Critical Revision of Manuscript – All Authors
Statistical Expertise – ST, JH
Acquisition of Funding – ST, EH, AG, JH
Non-Author Contributors / Acknowledgements: Zachary J. Jarou, MD, Michael A. Johnson, MD PhD, Erica Ashley Morse, MD, and Michael Susalla, MD, all contributed to data acquisition.

Conflicts of Interest:
ST reports grant money to AHRQ and EMF to conduct research conceived and written by ST from Denver Health.
EH reports grant money to NHLBI to conduct research conceived and written by EH from Denver Health
AG reports grant money to NHLBI to conduct research conceived and written by AG from the University of Colorado
JH reports grant money to NIAID and NIDA to conduct research conceived and written by JH from Denver Health.

antibiotic selection for inpatient pneumonia, and early management of severe sepsis / septic shock. This study was performed at six hospitals in Colorado with heterogeneous and diverse practice environments. Hierarchical generalized linear modeling was used to estimate adjusted associations between ED adherence and patient sex and race/ethnicity while controlling for other patient, physician, and environmental factors that could confound this association.

Results: 1,880 patients were included in the study with a median age of 62 years (IQR 51-74). Males and non-Hispanic whites comprised 59% and 71% of the cohort respectively. While unadjusted differences were identified, our adjusted analyses found no significant association between ED guideline adherence and sex or race/ethnicity. Patients who did not receive guideline adherent care in the ED were significantly more likely to die while in the hospital (OR 2.0, 95% CI 1.3-3.2).

Conclusions: Long-standing, nationally reported evidence-based guidelines can help eliminate sex and race/ethnicity disparities in quality of care. When providers know their care is being monitored and reported, their implicit biases may be less likely to impact care.

INTRODUCTION

Evidence-based guidelines are often cited as a means to improve quality and decrease variation in care - making it more likely that patients will be cared for in the same manner regardless of where or by whom they are treated.[1] As such, one significant benefit of evidence-based guidelines is that they may improve patient outcomes and minimize disparities in care. Evidence of disparities in quality of care, including emergency care, is well documented in the literature.[2] Patient sex and race/ethnicity have been shown to be associated with disparate emergency care across a wide range of diagnoses including: chest pain and acute coronary syndrome, stroke, traumatic brain injury, headache, and pain management.[3–9] However, much of this literature is almost two decades old and predates landmark studies that have resulted in evidence-based treatment guidelines that have become standard of care for many diseases treated in the emergency department (ED).

Emergency care for acute coronary syndrome (ACS), ST-elevation myocardial infarction (STEMI), sepsis, acute ischemic stroke, and pneumonia is highly standardized due to the presence of publicly reported evidence-based guidelines for these diseases. As such, adherence to guideline recommended care for these diseases provides an ideal lens to reexamine disparities and inequities in the quality of emergency care. Given prior evidence of sex and race/ethnicity disparities in quality of emergency care, we hypothesize that sex and race/ethnicity disparities will continue to be present in the quality of emergency care. Thus, the primary objectives of this study are to assess whether ED adherence to core evidence-based treatment guidelines differ by patient sex and race/ethnicity and to assess the effect of ED guideline adherence on patient outcomes by sex and race/ethnicity.

METHODS

Study Design

We conducted a pre-planned secondary analysis of data from a multi-center retrospective observational study evaluating variation in ED adherence to five core evidence-based treatment guidelines including: aspirin for ACS, door-to-balloon time for acute STEMI, systemic thrombolysis for acute ischemic stroke, antibiotic selection for inpatient pneumonia, and early management of severe sepsis or septic shock.[10, 11] The institutional review boards at each participating hospital approved the study with a waiver of consent.

Study Setting and Population

This study was performed at six hospitals in Colorado with heterogeneous and diverse practice environments that represent the main types of EDs including: (1) an urban academic safety-net ED; (2) a suburban academic quaternary care ED; and (3) urban, suburban, and rural community EDs (Table S1). Each ED was staffed by board-certified or board-eligible emergency physicians at all times. While the safety-net and quaternary care hospitals share emergency medicine resident physicians, attending emergency physicians are unique to each hospital.

Consecutive adult patients were identified retrospectively by any hospital discharge ICD-9 codes for ACS (410.xx, 411.1), STEMI (410.xx, except 410.7), acute ischemic stroke (434), pneumonia (481-486.xx), or severe sepsis / septic shock (785.52, 995.92).[12–15] In the event that the same patient had multiple relevant ICD-9 codes (e.g. septic shock and pneumonia; STEMI and ACS), the ICD-9 code listed first was used. Investigators initially obtained a list of consecutive patients with these ICD-9 codes from the safety-net, quaternary care, and one community hospital with patient encounters occurring between January 2011 and December 2012. The study was then expanded to three additional community hospitals in order to increase generalizability. Investigators, similarly, obtained a list of consecutive patients from these hospitals with patient encounters occurring between January 2014 and December 2014.

Each chart was screened by a physician abstractor for inclusion using the following criteria: (1) a discharge diagnosis in the medical record of ACS, STEMI, acute ischemic stroke, pneumonia, severe sepsis / septic shock; (2) admission to the hospital from the ED; and (3) diagnosis or initiated treatment of the disease in the ED. Exclusion criteria were age <18 years, repeat visits by the same patients within each discharge diagnosis, and patients transferred from another facility as the initial management would not have occurred in the included EDs.

Data Collection

The following patient factors were collected from each hospital's administrative database: demographics (age, sex, and race/ethnicity), primary health insurance, primary language, and chief complaint, and admitting hospital unit (intensive care vs floor). Patient race/ethnicity was stratified into three primary groups: non-Hispanic white, Hispanic, and non-Hispanic black. All other race/ethnicity groups (e.g. Asian, Pacific Islander, and American Indian) were collapsed into an "Other" group. Patient chief complaints were stratified into three groups (typical, associated, and other) based on how typical the complaint was for the diagnosis. Stratification of chief complaints into three groups was defined by the lead and senior author based on frequency and specificity of the chief complaint for the diagnosis (Table S2). Additionally, the name of the primary emergency physician was collected along with his or her sex and years of experience - defined as the number of years of independent practice at the time the patient was seen (i.e. years following completion of residency training). Finally, we collected the following environmental characteristics: time of day, day of week, and hospital. Missing data were abstracted directly from the patient's medical record when available and when unavailable were recorded as missing. All remaining characteristics were obtained directly from the medical record.

Structured medical record abstraction was performed using established, standard methodology.[16–18] To maximize validity and reliability of the medical record abstraction process, we used the following methodologies: (1) physician abstractors, blinded to the purpose of the study, to ensure expert familiarity with medical records and documentation; (2) abstractors trained by the lead author using a set of test cases to standardize approaches; (3) use of a previously developed and refined closed-response data collection instrument; (4) performance of 10 pilot reviews, using actual cases sampled from each hospital but not included for analysis in order to gain familiarity with the process of abstraction for each hospital's medical record system; (5) re-abstraction of a 15% random sample of included cases to estimate inter-rater reliability of the primary outcome, with the intention of performing re-abstraction with adjudication of 100% of the cases if kappa was <0.8; and (6) routine oversight of the abstractor team by the lead author, who was also available throughout the data collection process to address questions and problems that occurred.[16, 17] Using a structured data collection form, abstractors documented the presence of all pre-specified variables necessary to assess adherence with each guideline as well as patient, physician, and environmental characteristics that had been shown to be associated with guideline adherence.[19–22]

The primary outcome was ED adherence (e.g. binary – yes/no) to the respective guideline for ACS, STEMI, acute ischemic stroke, inpatient pneumonia and sepsis as written or endorsed by the American Heart Association, American Stroke Association, the Infectious Disease Society of America/American Thoracic Society (IDSA/ATS), or the Surviving Sepsis Campaign (SSC), respectively.[23–27] Table 1 describes how ED adherence was determined for each guideline. Secondary outcome was in-hospital mortality (e.g. binary – yes/no).

Data Management and Statistical Analyses

All data management and statistical analysis were performed using SAS Enterprise Guide Version 7.1 (SAS Institute, Inc., Cary, NC). Descriptive statistics were calculated for all variables. Continuous data were reported as medians with interquartile ranges and categorical variables as proportions with 95% confidence intervals (CIs). Chi-square test was used to test the a priori hypothesis that a significant difference in ED adherence existed between sex or race/ethnicity groups. Additionally, we examined unadjusted race/ethnicity differences by collapsing all minority race/ethnicity groups to examine differences between non-Hispanic whites and minorities. Where applicable, a percent difference with 95% CIs were provided. A p-value < 0.05 was considered statistically significant. Inter-rater reliability on the outcome variable was assessed using Cohen's kappa. A random sample of 15% of included cases were reabstracted with near perfect agreement ($\kappa = 0.97$).

Unadjusted logistic regression was used to estimate the association of each patient, physician, and environmental variable with ED guideline adherence. Hierarchical generalized linear modeling using the SAS GLIMMIX Procedure was used to estimate adjusted associations between ED adherence and patient sex and race/ethnicity while adjusting for other patient, physician, and environmental factors that could confound this association. Models were developed by first creating a full model followed by dropping variables found to be collinear. Hospital was included as a random effect. Effect modification, using interaction terms, was assessed for chief complaint by sex, chief complaint by race/ethnicity, chief complaint by language, sex by race/ethnicity, insurance by race/ethnicity, physician sex by patient sex, and physician sex by patient race/ethnicity. Each interaction was assessed in a limited generalized linear mixed model that examined the effect of two independent variables and their interaction term on ED guideline adherence. Interaction terms were included in the full model if they were found to be significant in the limited model (p-value <0.05). Similarly a hierarchical generalized linear model was used to estimate the association between patient demographics (i.e. sex and race/ethnicity) and in-hospital mortality while adjusting for ED guideline adherence, insurance, admitting diagnosis, and admitting hospital unit (i.e. intensive care vs floor), which was used as a surrogate for illness severity. An unadjusted sensitivity analysis was used to assess the temporal relationship between in-hospital mortality and guideline adherence stratified by diagnosis. As this study is a pre-planned secondary analysis, a specific sample size estimation was not conducted.

RESULTS

A total of 1,880 patients were included in the study. Table 2 describes the characteristics of the patients. The median age was 62 years (IQR 51-74), and males comprised 59% of the cohort. Patients were primarily non-Hispanic white (71%), spoke English (89%), and were insured by Medicare (45%). Overall, ED adherence to these five core guidelines was 72.2% (95% CI: 70.2-74.2%). Adherence to each guideline differed significantly with adherence ranging from 96% (95% CI: 94-98%) for systemic thrombolysis for acute ischemic stroke to 50% (95% CI: 46-55%) for sepsis (p<0.001).

Table 3 describes unadjusted adherence by sex and race/ethnicity with each guideline broken down into the components comprising adherence. Females were less likely than males to receive aspirin or clopidogrel in the ED in the setting of ACS (p =0.03; difference = −10.1%, 95% CI: −19.7% to −1.1%), accounting for documentation of doses taken within 24 hours of arrival to the hospital (i.e. home or ambulance). After accounting for documented contraindications to anti-platelet agents (e.g. allergy, active bleeding, known platelet disorder), overall adherence to the ACS CPG was significantly different by sex (difference = −8.4%, 95% CI: −17.7% to −0.14%). Additionally, we found significant differences in the proportion of septic patients by race/ethnicity who received antibiotics within 3 hours of ED arrival (p =0.02). Compared to non-Hispanic whites, minorities as a group were less likely to receive antibiotics within 3 hours of ED arrival (difference = −13.5%, 95% CI: −22.7 to −4.5%). Lastly, while there was no significant difference between all four race/ethnicity groups, non-Hispanic whites were less likely than minorities as a group to receive guideline concordant antibiotics in the ED when being admitted for pneumonia (difference = −10.9%, 95% CI: −20.0% to −1.0%).

In Table S2, we further examined the association of patient sex and race/ethnicity on guideline adherence. We stratified patients into four sex and race/ethnicity categories (i.e. non-Hispanic white males, minority males, non-Hispanic white females, and minority females). We found no difference between ED guideline adherence and patient sex/race/ethnicity categories. However, we did find significant differences in receipt of components of the sepsis guideline. Minority males were 12.2% less likely (95% CI: −23.1 to −3.7%) to have lactate measured in the setting of severe sepsis/shock as compared to non-Hispanic white males. Similarly, minorities of both sexes were less likely to receive antibiotics as compared to non-Hispanic white males. Minority females were 17.2% less likely (95% CI: −29.4 to −5.2%) and minority males were 14.1% less likely (95% CI: −27.2 to −1.8%) to receive antibiotics within 3 hours of presentation of severe sepsis/shock.

In our adjusted model (Table 4), no significant associations between ED guideline adherence and patient sex or race/ethnicity were identified. Chief complaint was the only variable found to be significantly associated with ED guideline adherence. Patients were more likely to receive adherent care in the ED if they presented with chief complaints that were typical for the diagnosis. Random effect of hospital accounted for 8.6% of the variability of adherence seen in our study (ICC = 0.086). No interactions were included in the full model as none were found to be significant. However, all interactions and the *p*-value for the fixed effect of the interaction are listed in the footer of Table 4.

In our adjusted model of in-hospital mortality (Table 5), patients who did not receive guideline adherent care in the ED were significantly more likely to die while in the hospital (OR 2.0, 95% CI 1.3-3.2). Additionally, patient age and illness severity (i.e. admitting hospital unit) were significantly associated with in-hospital mortality. While females were no more likely to die than males, patients of Asian, Pacific Islander, and American Indian race/ethnicity (e.g. Other category) were significantly more likely to die in the hospital as compared to non-Hispanic whites (OR 2.7, 95% CI 1.2-6.1). Patients admitted with pneumonia were less likely to die while hospitalized than patients admitted for severe sepsis/septic shock (OR 0.1, 95% CI 0.03-0.5). Given that the pneumonia cohort does not include sepsis secondary to pneumonia, this finding is not surprising. Lastly, in Table S4 and Figure S1, we examined the temporal relationship of inhospital mortality and ED guideline adherence. In-hospital mortality was significantly associated with ED guideline adherence later in the hospital course.

DISCUSSION

In our multicenter study of adherence to core evidence-based guidelines in 6 diverse EDs in Colorado, we did not identify sex or race/ethnicity disparities in ED guideline adherence. Patient chief complaint was the only independent variable significantly associated with ED guideline adherence. Patients who presented with complaints that were typical for the diagnosis were more likely to received guideline adherent care in the ED than patients who presented with complaints that were less typical of the diagnosis. Additionally, we found that lack of guideline adherent care in the ED was associated with in-hospital mortality. To our knowledge, this is the first study to examine whether sex and race/ethnicity disparities exist in the emergent treatment of multiple core diseases in the ED. In addition, our study provides a more contemporary analysis of sex and race/ethnicity disparities in the emergent treatment of these disease as much of the published literature on these topics are more than a decade old.

Evidence of health and healthcare disparities by sex and race/ethnicity are well documented in the literature.[2] However, literature on disparities in the quality of evidence-based emergency care are less prevalent and often bundled within care that spans both emergency department and inpatient care, making it difficult to extrapolate where differential care occurs. The primary example of disparate emergency care in the U.S. is seen in cardiovascular care where decades of data from the *Get With the Guidelines* registry have shown a persistent, yet improving, gap in door-to-balloon times for females with STEMI as compared to males.[28–30] In sepsis, one single-center study in the U.S. has shown that females with sepsis were more likely to have delays to antibiotics as compared to males.[31, 32] In stroke, data from the National Inpatient Sample shows that minorities are less likely than non-Hispanic whites to receive tPA in the setting of acute ischemic stroke. However, this disparity does not adjust for a patient's eligibility for tPA. 10, 33, 34 Lastly in pneumonia, non-Hispanic blacks have been shown to be less likely to receive guideline-adherent antibiotics in the ED as compared to non-Hispanic whites, but this finding did not persist after adjusting for case-mix.[35]

Our study adds to the literature on disparities in quality of care by providing a more contemporary and broader look at disparities in quality of emergency care across multiple diseases by sex and race/ethnicity. Several reasons could explain our findings. First, in contrast to studies utilizing national or claims databases, our study allowed for the identification of patient factors (e.g. patient eligibility and patient preferences) that impact guideline adherence. Although large national databases provide a wealth of information on a large cohort of patients, they often emphasize breadth over depth of information, resulting in findings that appropriately identify health and healthcare disparities but cannot assess for disparities in quality of care. If patients are not eligible for specific treatments due to contraindications that are stipulated in the guideline or if patients decline care for personal reasons, then guideline adherent care has still been provided to the patient. Without chart review, these patient factors are almost impossible to consider. Second, our study examined for disparities in quality of emergency care in the context of diseases with objective, evidence-based treatment guidelines. This contrasts with studies that have shown disparities in the ED for conditions where more subjective judgment is involved such as headache and pain.[5, 6, 36] Our findings likely reflect a growing acceptance and knowledge of these guidelines leading to improvements in care and reduction in disparities.

While our study found no sex or race/ethnicity disparities in the quality of emergency care provided for these 5 core diseases, this does not mean that health and health care disparities for these diseases do not exist. Centuries of structural sexism and racism have led to numerous disadvantages in the social determinates of health, access to and use of health care for females and minorities – often resulting in delays in both preventive and acute care that impact outcomes. An important finding from our study may be that long-standing, nationally reported guidelines can help eliminate sex and race/ethnicity disparities in quality of care. When a clear standard of care has been established and physicians know their care is being monitored and reported, even if in aggregate, their implicit biases may be less likely to impact care. While we did not identify race/ethnicity or sex disparities in guideline adherence in our adjusted model, we did find significant unadjusted differences in various components of these guidelines, which necessitate further research with larger sample sizes.

LIMITATIONS

Several limitations should be considered when interpreting our results. First, the use of discharge ICD-9 codes to identify ED patients is limited because hospital discharge diagnoses may not be relevant to the reasons for admission from the ED. Consequently, using discharge ICD-9 codes was coupled with direct chart review to ensure the sample only represented patients with the diagnoses of interest, who were admitted to the hospital from the ED specifically for these diagnoses. However, we may have missed some sepsis patients who were not coded as such. Additionally, including hospital admission as an inclusion criterion may have excluded patients who died in the ED, had an unknown disposition, or were discharged from the ED. Limiting patients to those who were admitted helped limited chart reviews to patient who were most likely to truly have the disease and in whom the guideline recommended care could actually have been enacted. Second although we abstracted a comprehensive list of potential patient, physician, and environmental factors that have been shown to be associated with guidelines in other studies, additional variables, such as physician race/ethnicity, may have been left out of the model, a known limitation of retrospective and particularly secondary analyses. We used admitting hospital unit as a proxy for illness severity. The use of a more robust illness severity score may have resulted in a more specific variable for illness severity. While we abstracted comorbidities specific to each disease, we did not abstract a comprehensive comorbidity index that could have been applied across all these diseases, which is an important missing variable in our in-hospital mortality model. Lastly, this study only includes hospitals in Colorado. Although we included multiple different hospital types with unique provider groups and hospital systems, patients and practice patterns may not be generalizable to other states.

CONCLUSIONS

In our retrospective, multi-center study of ED patients presenting for 5 core diseases with established, evidence-based treatment guidelines, we found no sex or race/ethnicity disparities in guideline adherence. Moreover, use of guideline adherent care in the ED was associated with decrease in in-hospital mortality. These findings suggest that guidelines, particularly publicly reported ones, can help mitigate disparities and improve outcomes for all patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported, in part, by the Agency for Healthcare Research and Quality (F32HS022400), the Emergency Medicine Foundation (EMF), and the Department of Emergency Medicine at the University of Colorado School of Medicine to Dr. Trent

REFERENCES

1. Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. BMJ. 1999;318(7182):527–30. doi: 10.1136/bmj.318.7182.527 [PubMed: 10024268]
2. Institute of Medicine Committee on U, Eliminating R, Ethnic Disparities in Health C. In: Smedley BD, Stith AY, Nelson AR, editors. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Washington (DC): National Academies Press (US). Copyright 2002 by the National Academy of Sciences.All rights reserved; 2003.
3. Venkat A, Hoekstra J, Lindsell C, Prall D, Hollander JE, Pollack CV Jr., et al.The impact of race on the acute management of chest pain. Acad Emerg Med. 2003;10(11):1199–208. doi:10.1111/j.1553-2712.2003.tb00604.x [PubMed: 14597496]
4. Bradley EH, Herrin J, Wang Y, McNamara RL, Webster TR, Magid DJ, et al.Racial and Ethnic Differences in Time to Acute Reperfusion Therapy for Patients Hospitalized With Myocardial Infarction. JAMA. 2004;292(13):1563–72. doi:10.1001/jama.292.13.1563 [PubMed: 15467058]
5. Singhal A, Tien YY, Hsia RY. Racial-Ethnic Disparities in Opioid Prescriptions at Emergency Department Visits for Conditions Commonly Associated with Prescription Drug Abuse. PLoS One. 2016;11(8):e0159224. doi:10.1371/journal.pone.0159224 [PubMed: 27501459]
6. Harris B, Hwang U, Lee WS, Richardson LD. Disparities in use of computed tomography for patients presenting with headache. Am J Emerg Med. 2009;27(3):333–6. doi:10.1016/j.ajem.2008.03.041 [PubMed: 19328379]
7. Johnston SC, Fung LH, Gillum LA, Smith WS, Brass LM, Lichtman JH, et al.Utilization of intravenous tissue-type plasminogen activator for ischemic stroke at academic medical centers: the influence of ethnicity. Stroke. 2001;32(5):1061–8. doi:10.1161/01.str.32.5.1061 [PubMed: 11340210]
8. Mochari-Greenberger H, Xian Y, Hellkamp AS, Schulte PJ, Bhatt DL, Fonarow GC, et al.Racial/Ethnic and Sex Differences in Emergency Medical Services Transport Among Hospitalized US Stroke Patients: Analysis of the National Get With The Guidelines-Stroke Registry. J Am Heart Assoc. 2015;4(8):e002099. doi:10.1161/jaha.115.002099 [PubMed: 26268882]
9. Bazarian JJ, Pope C, McClung J, Cheng YT, Flesher W. Ethnic and racial disparities in emergency department care for mild traumatic brain injury. Acad Emerg Med. 2003;10(11):1209–17. doi:10.1111/j.1553-2712.2003.tb00605.x [PubMed: 14597497]
10. Trent SA, Johnson MA, Morse EA, Havranek EP, Haukoos JS. Patient, provider, and environmental factors associated with adherence to cardiovascular and cerebrovascular clinical practice guidelines in the emergency department. Am J Emerg Med. 2017. doi:10.1016/j.ajem.2017.12.062
11. Trent SA, Jarou ZJ, Havranek EP, Ginde AA, Haukoos JS. Variation in Emergency Department Adherence to Treatment Guidelines for Inpatient Pneumonia and Sepsis: A Retrospective Cohort Study. Acad Emerg Med. 2018. doi:10.1111/acem.13639
12. McCormick N, Bhole V, Lacaille D, Avina-Zubieta JA. Validity of Diagnostic Codes for Acute Stroke in Administrative Databases: A Systematic Review. PLoS One. 2015;10(8):e0135834. doi:10.1371/journal.pone.0135834 [PubMed: 26292280]
13. McCormick N, Lacaille D, Bhole V, Avina-Zubieta JA. Validity of myocardial infarction diagnoses in administrative databases: a systematic review. PLoS One. 2014;9(3):e92286. doi:10.1371/journal.pone.0092286 [PubMed: 24682186]
14. Drahos J, Vanwormer JJ, Greenlee RT, Landgren O, Koshiol J. Accuracy of ICD-9-CM codes in identifying infections of pneumonia and herpes simplex virus in administrative data. Ann Epidemiol. 2013;23(5):291–3. doi:10.1016/j.annepidem.2013.02.005 [PubMed: 23522903]

15. Jolley RJ, Sawka KJ, Yergens DW, Quan H, Jette N, Doig CJ. Validity of administrative data in recording sepsis: a systematic review. Crit Care. 2015;19:139.doi: 10.1186/s13054-015-0847-3 [PubMed: 25887596]

16. Gilbert EH, Lowenstein SR, Koziol-McLain J, Barta DC, Steiner J. Chart reviews in emergency medicine research: Where are the methods?Ann Emerg Med. 1996;27(3):305–8. [PubMed: 8599488]

17. Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. Ann Emerg Med. 2014;64(3):292–8. doi:10.1016/j.annemergmed.2014.03.025 [PubMed: 24746846]

18. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, et al.The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–7. doi:10.1016/S0140-6736(07)61602-X [PubMed: 18064739]

19. Pham JC, Kelen GD, Pronovost PJ. National study on the quality of emergency department care in the treatment of acute myocardial infarction and pneumonia. Acad Emerg Med. 2007;14(10):856–63. doi:10.1197/j.aem.2007.06.035 [PubMed: 17898249]

20. Mikkelsen ME, Gaieski DF, Goyal M, Miltiades AN, Munson JC, Pines JM, et al.Factors associated with nonadherence to early goal-directed therapy in the ED. Chest. 2010;138(3):551–8. doi:10.1378/chest.09-2210 [PubMed: 20173053]

21. Halm EA, Atlas SJ, Borowsky LH, Benzer TI, Metlay JP, Chang YC, et al.Understanding physician adherence with a pneumonia practice guideline: effects of patient, system, and physician factors. Arch Intern Med. 2000;160(1):98–104. [PubMed: 10632310]

22. Meurer WJ, Majersik JJ, Frederiksen SM, Kade AM, Sandretto AM, Scott PA. Provider perceptions of barriers to the emergency use of tPA for acute ischemic stroke: a qualitative study. BMC Emerg Med. 2011;11:5. doi:10.1186/1471-227X-11-5 [PubMed: 21548943]

23. Amsterdam EA, Wenger NK, Brindis RG, Casey DE, Ganiats TG, Holmes DR, et al.2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes. A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2014;130(25):e344–e426. doi:10.1161/cir.0000000000000134

24. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al.2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2018;49(3):e46–ell0. doi:10.1161/STR.0000000000000158 [PubMed: 29367334]

25. Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean NC, et al.Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis. 2007;44Suppl 2:S27–72. doi:10.1086/511159 [PubMed: 17278083]

26. American Thoracic S, Infectious Diseases Society of A. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005;171(4):388–416. doi:10.1164/rccm.200405-644ST [PubMed: 15699079]

27. Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al.Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. Intensive Care Med. 2017. doi:10.1007/s00134-017-4683-6

28. Roswell RO, Kunkes J, Chen AY, Chiswell K, Iqbal S, Roe MT, et al.Impact of Sex and Contact-to-Device Time on Clinical Outcomes in Acute ST-Segment Elevation Myocardial Infarction-Findings From the National Cardiovascular Data Registry. J Am Heart Assoc. 2017;6(1). doi:10.1161/JAHA.116.004521

29. Stehli J, Martin C, Brennan A, Dinh DT, Lefkovits J, Zaman S. Sex Differences Persist in Time to Presentation, Revascularization, and Mortality in Myocardial Infarction Treated With Percutaneous Coronary Intervention. J Am Heart Assoc. 2019;8(10):e012161. doi:10.1161/jaha.119.012161 [PubMed: 31092091]

30. Krumholz HM, Herrin J, Miller LE, Drye EE, Ling SM, Han LF, et al.Improvements in door-to-balloon time in the United States, 2005 to 2010. Circulation. 2011;124(9):1038–45. doi:10.1161/CIRCULATIONAHA.111.044107 [PubMed: 21859971]

31. Madsen TE, Napoli AM. The DISPARITY-II study: delays to antibiotic administration in women with severe sepsis or septic shock. Acad Emerg Med. 2014;21(12):1499–502. doi:10.1111/acem.12546 [PubMed: 25424151]
32. Madsen TE, Simmons J, Choo EK, Portelli D, McGregor AJ, Napoli AM. The DISPARITY Study: do gender differences exist in Surviving Sepsis Campaign resuscitation bundle completion, completion of individual bundle elements, or sepsis mortality?Journal of critical care. 2014;29(3):473.e7. doi:10.1016/jjcrc.2014.01.002
33. Aparicio HJ, Carr BG, Kasner SE, Kallan MJ, Albright KC, Kleindorfer DO, et al.Racial Disparities in Intravenous Recombinant Tissue Plasminogen Activator Use Persist at Primary Stroke Centers. J Am Heart Assoc. 2015;4(10):e001877. doi:10.1161/jaha.115.001877 [PubMed: 26467999]
34. Hsia AW, Edwards DF, Morgenstern LB, Wing JJ, Brown NC, Coles R, et al.Racial disparities in tissue plasminogen activator treatment rate for stroke: a population-based study. Stroke. 2011;42(8):2217–21. doi:10.1161/strokeaha.111.613828 [PubMed: 21719765]
35. Mayr FB, Yende S, D'Angelo G, Barnato AE, Kellum JA, Weissfeld L, et al.Do hospitals provide lower quality of care to black patients for pneumonia?Crit Care Med. 2010;38(3):759–65. doi:10.1097/CCM.0b013e3181c8fd58 [PubMed: 20009756]
36. Tamayo-Sarver JH, Hinze SW, Cydulka RK, Baker DW. Racial and ethnic disparities in emergency department analgesic prescription. Am J Public Health. 2003;93(12):2067–73. doi:10.2105/ajph.93.12.2067 [PubMed: 14652336]

Author Manuscript

Author Manuscript

Author Manuscript

Table 1:

Description of ED Quality Measures

Quality Measures	Numerator	Denominator
Acute Coronary Syndrome		
Aspirin Given in ED	Aspirin given in ED OR Plavix given in ED if patient has allergy to Aspirin OR documentation of Aspirin or Plavix taken within 24 hours OR documented contraindication OR patient refusal	Patients in whom ED provider suspected ACS and ordered an ECG and troponin AND the patient had an abnormal troponin or ischemic ECG changes in ED OR patient was primarily admitted from ED for ACS, chest pain or rule-out ACS.
ST Elevation Myocardial Infarction		
Time to PCI	PCI within 90 minutes of arrival to a STEMI receiving center OR PCI within 120 minutes of arrival to a STEMI referral center OR documented contraindication OR patient refusal	All ED patients with ST-elevation on ECG concerning for acute MI
Acute Ischemic Stroke		
Time to Thrombolytics	tPA administered within 4.5 hours of symptom onset OR documented contraindication OR patient refusal	All ED patients with symptoms of an acute ischemic stroke
Inpatient Pneumonia		
Guideline Concordant Parenteral Antibiotics	Parenteral antibiotics given in ED OR documented contraindication OR patient refusal	All ED patients with radiographic documentation of pneumonia on ED chest xray or CT OR ED treatment due to documented clinical suspicion for pneumonia*
Sepsis		
3 Hour Surviving Sepsis Bundle	Lactate measured AND Blood cultures obtained before antibiotics AND Antibiotics given AND 30mL/kg IV fluid given (if lactate > 4 or SBP < 90 or MAP < 65) within 3 hours of ED arrival	All ED patients with 2 SIRS criteria, suspected infection, and at least one marker of end organ dysfunction

Abbrev: ED=emergency department; ACS=acute coronary syndrome; ECG=electrocardiogram;

PCI=percutaneous coronary intervention; MI=myocardial infarction; tPA=tissue plasminogen activator; CT=computerized tomography; SBP = systolic blood pressure; MAP = mean arterial pressure; SIRS=systemic inflammatory response syndrome

*does not include antibiotics given for COPD exacerbation without pneumonia

Table 2:

Patient, Physician, and Environmental Characteristics and Their Unadjusted Associations with ED Adherence to Clinical Practice Guidelines

Characteristics (N=1880)	n (%)	ED Adherence (n=1358) n (%)	Unadjusted OR (95% CI)
Age (years)			
18-39	146 (7.8)	95 (65.1)	0.8 (0.5-1.3)
40-59	679 (36.1)	490 (72.2)	1.0 (0.7-1.3)
60-79	760 (40.4)	557 (73.3)	Ref
≥ 80	295 (15.7)	216 (73.2)	1.0 (0.7-1.4)
Gender			
Male	1113 (59.2)	818 (73.5)	Ref
Female	767 (40.8)	540 (70.4)	0.9 (0.7-1.1)
Race/Ethnicity			
Non-Hispanic White	1184 (63.0)	844 (71.3)	Ref
Hispanic	411 (21.9)	302 (73.5)	1.1 (0.8-1.5)
Non-Hispanic Black	212 (11.3)	158 (74.5)	1.1 (0.8-1.6)
Other	70 (3.7)	51 (72.9)	1.2 (0.6-2.2)
Missing	3 (0.2)	3 (100)	-- --
Language			
English	1668 (88.7)	1204 (72.2)	Ref
Spanish	168 (8.9)	118 (70.2)	0.9 (0.6-1.3)
Other	44 (2.3)	36 (81.8)	2.0 (0.8-4.9)
Primary Health Insurance			
Medicare	849 (45.2)	608 (71.6)	0.9 (0.6-1.2)
Medicaid	253 (13.5)	167 (66.0)	0.8 (0.5-1.2)
Uninsured	390 (20.7)	290 (74.4)	1.0 (0.7-1.5)
Commercial	346 (18.4)	263 (76.0)	Ref
Other Source	42 (2.2)	30 (71.4)	0.8 (0.3-1.8)
Time of Day			
Morning (6a-11:59am)	570 (30.3)	432 (75.8)	Ref
Afternoon (Noon-5:59pm)	679 (36.1)	476 (70.1)	**0.7 (0.6-0.98)**
Evening (6pm-11:59pm)	427 (22.7)	309 (72.4)	0.9 (0.6-1.3)
Night (Midnight-5:59am)	204 (10.9)	141 (69.1)	0.8 (0.5-1.2)
Day of Week			
Weekday	1235 (65.7)	897 (72.6)	Ref
Weekend (Fri 6pm-Mon 6am)	645 (34.3)	461 (71.5)	0.9 (0.7-1.2)
Chief Complaint			
Typical for Disease	1040 (55.3)	861 (81.7)	Ref
Associated with Disease	664 (35.3)	400 (59.6)	**0.4 (0.3-0.5)**
Other	176 (9.3)	97 (62.6)	**0.5 (0.3-0.7)**
ED Physician Experience			
0-4 Years	698 (37.1)	515 (73.7)	Ref

Characteristics (N=1880)	n (%)	ED Adherence (n=1358) n (%)	Unadjusted OR (95% CI)
5-9 Years	510 (27.1)	355 (69.6)	0.9 (0.7-1.3)
10-14 Years	430 (22.9)	317 (73.7)	1.1 (0.8-1.6)
≥15 Years	241 (12.8)	171 (71.0)	1.0 (0.6-1.5)
Missing	1 (0.1)	1 (100)	-- --
ED Physician Sex			
Male	1218 (64.8)	862 (70.8)	Ref
Female	661 (35.2)	495 (74.9)	1.2 (0.9-1.6)
Missing	1 (0.1)	1 (100)	-- --
Hospital Type			
Quaternary	585 (31.1)	442 (75.5)	Ref
Community	710 (37.8)	499 (70.3)	**0.6 (0.4-0.9)**
Safety-net	585 (31.1)	417 (71.3)	0.7 (0.4-1.1)

Abbreviations: OR = odds ratio; CI = confidence interval

Table 3:

Unadjusted Guideline Adherence by Sex and Race/Ethnicity

	Sex		Race/Ethnicity			
	Men (n=1113) %(95% CI)	**Women (n=767) %(95% CI)**	**NH-White (n=1184) %(95% CI)**	**Hispanic (n=411) %(95% CI)**	**NH-Black (n=212) %(95% CI)**	**Other (n=70) %(95% CI)**
All Patients (N=1880)						
% Adherence	73.4 (70.7-75.9)	70.5 (67.2-73.7)	71.1 (68.5-73.6)	73.5 (69.0-77.5)	75.9 (69.8-81.2)	71.4 (60.0-80.7)
ACS (n=351)						
% Adherence[†]	**85.8 (80.7-89.7)**	**77.3 (69.0-84.0)**	82.9 (77.4-87.3)	81.8 (71.8-88.9)	84.8 (71.8-92.4)	83.3 (43.7-97.0)
ASA/Plavix Given[†]	**83.2 (77.9-87.5)**	**73.1 (64.5-80.3)**	80.2 (74.4-84.9)	77.9 (67.5-85.7)	80.4 (66.8-89.4)	83.3 (43.7-97.0)
Contraindicated	2.6 (1.2-5.5)	4.2 (1.8-9.5)	2.7 (1.2-5.8)	3.9 (1.3-10.8)	4.4 (1.2-14.5)	0 (0-39.0)
Patient Refused	0 (0-1.6)	0 (0-3.1)	0 (0-1.7)	0 (0-4.8)	0 (0-7.7)	0 (0-39.0)
STEMI (n=351)						
% Adherence	74.4 (68.9-79.2)	68.0 (57.0-77.3)	73.3 (67.2-78.6)	72.0 (61.4-80.5)	67.9 (49.3-82.1)	80.0 (49.0-94.3)
D2B <90 min	61.5 (55.7-67.1)	55.1 (44.1-65.7)	60.5 (54.1-66.7)	59.8 (48.9-69.7)	60.7 (42.4-76.4)	50.0 (23.7-76.3)
Cath Contraindicated	4.8 (2.8-7.9)	6.4 (2.8-14.1)	5.7 (3.4-9.5)	2.4 (0.7-8.5)	3.6 (0.6-17.7)	20.0 (5.7-51.0)
Patient Refused	1.5 (0.6-3.7)	5.1 (2.0-12.5)	2.2 (0.9-5.0)	3.7 (1.3-10.2)	0 (0-12.1)	0 (0-27.8)
PCI Contraindicated	6.6 (4.2-10.2)	1.3 (0.2-6.9)	4.8 (2.7-8.4)	6.1 (2.6-13.5)	3.6 (0.6-17.7)	10.0 (1.8-40.4)
Ischemic Stroke (n=351)						
% Adherence	96.0 (91.9-98.0)	96.6 (92.8-98.5)	96.9 (93.3-98.6)	94.5 (87.8-97.6)	96.4 (87.9-99.0)	100 (77.2-100)
tPA Given	14.5 (10.0-20.5)	17.4 (12.6-23.7)	16.8 (12.1-22.7)	13.2 (7.7-21.7)	16.1 (8.7-27.8)	23.1 (8.2-50.3)
Contraindicated	79.2 (72.5-84.6)	78.1 (71.5-83.5)	78.5 (72.2-83.8)	78.0 (68.5-85.3)	80.4 (68.2-88.7)	76.9 (49.7-91.8)
Refused tPA	2.3 (0.9-5.8)	1.7(0.6-4.8)	2.1 (0.8-5.3)	3.3 (1.1-9.3)	0 (0-6.4)	0 (0-22.8)
Inpatient Pneumonia (n=414)						
% Adherence[‡]	63.5 (56.8-69.7)	64.5 (57.7-70.8)	**60.5 (54.7-66.0)**	**70.8 (58.8-80.4)**	**71.7 (57.5-82.7)**	**72.7 (51.9-86.9)**
Sepsis (n=413)						
% Adherence	51.8 (45.3-58.2)	48.7 (41.7-55.8)	51.9 (45.9-57.9)	50.0 (40.2-59.8)	44.4 (29.5-60.4)	42.1 (23.1-63.7)
Lactate 3Hr	91.1 (86.6-94.2)	93.7 (89.2-96.3)	94.3 (90.8-96.5)	89.6 (81.9-94.2)	83.3 (68.1-92.1)	94.7 (75.4-99.1)

	Sex		Race/Ethnicity			
	Men (n=1113) %(95% CI)	**Women (n=767) %(95% CI)**	**NH-White (n=1184) %(95% CI)**	**Hispanic (n=411) %(95% CI)**	**NH-Black (n=212) %(95% CI)**	**Other (n=70) %(95% CI)**
Blood Cultures 3Hr	82.1 (76.6-86.6)	81.5 (75.3-86.4)	82.8 (77.8-86.9)	81.3 (72.3-87.8)	77.8 (61.9-88.3)	79.0 (56.7-91.5)
Antibiotics 3Hr *	75.0 (68.9-80.2)	68.8 (61.9-75.0)	**77.1 (71.6-81.8)**	**66.7 (56.8-75.3)**	**58.3 (42.2-72.9)**	**57.9 (36.3-76.9)**
30cc/kg IVF 3Hr	68.4 (60.2-75.6)	68.9 (59.5-77.1)	67.5 (60.0-74.1)	76.6 (62.8-86.4)	73.3 (48.1-89.1)	45.5 (21.3-72.0)

Abbreviations: CI = confidence interval; NH = non-Hispanic; ACS = acute coronary syndrome; ASA = aspirin; STEMI = ST-elevation myocardial infarction;

D2B = door to balloon;Cath = catheterization; PCI = percutaneous coronary intervention; Hr = hour

† Statistically significant difference by sex in proportion receiving ACS adherent care (chi square; p=0.046) and aspirin/clopidogrel (chi square; p=0.03)

‡ Statistically significant difference by race (whites vs minorities) in proportion receiving guideline adherent antibiotics (chi square; p=0.03)

* Statistically significant difference by race in proportion receiving antibiotics within 3 hours in setting of severe sepsis/shock (chi square; p=0.02)

Table 4.

Generalized Linear Effects Model of ED Guideline Adherence

Characteristics (N=1876)[‡]	Adjusted OR (95% CI)
Age	1.00 (0.99-1.01)
Female Sex	0.9 (0.7-1.1)
Race/Ethnicity	
Non-Hispanic White	Ref
Hispanic	1.3 (0.8-2.0)
Non-Hispanic Black	1.1 (0.6-1.9)
Other	0.8 (0.3-1.8)
Language	
English	Ref
Spanish	0.8 (0.5-1.3)
Other	2.6 (0.8-8.2)
Primary Health Insurance	
Medicare	0.9 (0.6-1.3)
Medicaid	0.8 (0.5-1.3)
Uninsured	0.8 (0.6-1.3)
Commercial	Ref
Other Source	0.7 (0.3-1.7)
Time of Day	
Morning (6a-11:59am)	Ref
Afternoon (Noon-5:59pm)	0.7 (0.6-1.0)
Evening (6pm-11:59pm)	0.9 (0.7-1.3)
Night (Midnight-5:59am)	0.8 (0.5-1.2)
Chief Complaint	
Typical for Disease	Ref
Associated with Disease	0.3 (0.2-0.5)
Other	0.5 (0.3-0.8)
Female Physician Sex	1.2 (0.9-1.6)
Hospital Type	
Quaternary	Ref
Community	0.6 (0.4-1.0)
Safety-net	0.7 (0.4-1.2)

Abbreviations: OR = odds ratio,confidence interval; Ref =reference

[‡]4 patients were excluded from the model - 3 for missing race/ethnicity and 1 for missing physician sex. Interactions evaluated but not included in model: Complaint*Race/Ethnicity (p=0.14), Complaint*Sex (p=0.96), Complaint*Language (did not converge), Complaint*Insurance (p=0.88), Sex*Race/Ethnicity (p=0.38), Physician_Sex*Patient_Sex (p=0.08), Physician_Sex*PatientRace/Ethnicity (p=0.06)

Table 5:

Multivariable Model of In-Hospital Mortality, adjusted for clustering by hospital

N = 1875[†]	N (%)	In-Hospital Mortality (n, %)	Adjusted OR (95% CI)
Age[*]	62 (15.8)	100 (5.3)	**1.02 (1.005-1.04)**
Sex			
Male	1109 (59.2)	68 (6.1)	Ref
Female	766 (40.9)	31 (4.1)	0.7 (0.4-1.0)
Race/Ethnicity			
Non-Hispanic White	1183 (63.1)	63 (5.3)	Ref
Hispanic	410 (21.9)	20 (4.9)	0.8 (0.5-1.4)
Non-Hispanic Black	212 (11.3)	7 (3.3)	0.6 (0.3-1.4)
Other	70 (3.7)	9 (12.9)	**2.7 (1.2-5.9)**
Insurance			
Private	344 (18.3)	12 (12.0)	Ref
Medicare	849 (45.2)	50 (50.0)	1.9 (0.9-3.9)
Medicaid	253 (13.5)	15 (15.0)	**2.7 (1.2-5.9)**
Uninsured	389 (20.7)	21 (21.0)	**2.2 (1.01-4.7)**
Other	42 (2.2)	2 (2.0)	1.5 (0.3-7.3)
Admitting Disease			
Acute Coronary Syndrome	351 (18.7)	17 (4.8)	0.7 (0.4-1.4)
Acute Ischemic Stroke	351 (18.7)	14 (4.0)	0.9 (0.4-1.8)
Pneumonia	414 (22.1)	2 (0.5)	**0.1 (0.03-0.5)**
Severe Sepsis/Shock	413 (22.0)	38 (9.2)	Ref
STEMI	346 (18.5)	28 (8.1)	0.8 (0.4-1.3)
Admitting Hospital Unit			
Floor	977 (52.1)	14 (1.4)	Ref
ICU	898 (47.9)	85 (9.5)	**5.6 (3.0-10.3)**
Guideline Adherent ED Care			
Yes	1353 (72.2)	58 (4.3)	Ref
No	522 (27.8)	41 (7.9)	**1.9 (1.2-3.0)**

Abbrev: OR=odds ratio; CI=confidence interval; Ref=reference; ED=emergency department; STEMI = ST-elevation Myocardial Infarction; ICU = intensive care unit

[†]5 patients removed from model due to lack of race/ethnicity data (3) or in-hospital mortality data due to transfer to another hospital (2)

[*]Age is presented as mean (standard deviation)