Published in final edited form as:

J Community Health. 2014 August ; 39(4): 753–759. doi:10.1007/s10900-014-9823-0.

The Effect of Neighborhood and Individual Characteristics on Pediatric Critical Illness

David Epstein,

Department of Anesthesiology Critical Care Medicine, Keck School of Medicine, Children's Hospital Los Angeles, University of Southern California, 4650 Sunset Boulevard, MS #3, Los Angeles, CA 90027, USA

Michael Reibel,

Department of Geography and Anthropology, California State Polytechnic University – Pomona, Pomona, CA, USA

Jennifer B. Unger,

Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Myles Cockburn,

Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Loraine A. Escobedo,

Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

David C. Kale,

Department of Anesthesiology Critical Care Medicine, Keck School of Medicine, Children's Hospital Los Angeles, University of Southern California, 4650 Sunset Boulevard, MS #3, Los Angeles, CA 90027, USA

Jennifer C. Chang, and

Department of Anesthesiology Critical Care Medicine, Keck School of Medicine, Children's Hospital Los Angeles, University of Southern California, 4650 Sunset Boulevard, MS #3, Los Angeles, CA 90027, USA

Jeffrey I. Gold

Department of Anesthesiology Critical Care Medicine, Keck School of Medicine, Children's Hospital Los Angeles, University of Southern California, 4650 Sunset Boulevard, MS #3, Los Angeles, CA 90027, USA

Departments of Anesthesiology and Pediatrics, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

© Springer Science+Business Media New York 2014

Correspondence to: David Epstein, depstein@chla.usc.edu.

Conflict of interest The authors of this article have no relevant financial relationships or conflicts of interest as they relate to the research of this study.

David Epstein: depstein@chla.usc.edu

Abstract

The relationship between neighborhood/individual characteristics and pediatric intensive care unit (PICU) outcomes is largely unexplored. We hypothesized that individual- level racial/ethnic minority status and neighborhood-level low socioeconomic status and minority concentration would adversely affect children's severity of illness on admission to the PICU. Retrospective analyses (1/1/2007–5/ 23/2011) of clinical, geographic, and demographic data were conducted at an academic, tertiary children's hospital PICU. Clinical data included age, diagnosis, insurance, race/ethnicity, Pediatric Index of Mortality 2 score on presentation to the PICU (PIM2), and mortality. Residential addresses were geocoded and linked with 2010 US Census tract data using geographic information systems geocoding techniques. Repeated measures models to predict PIM2 and mortality were constructed using three successive models with theorized covariates including the patient's race/ethnicity, the predominant neighborhood racial/ethnic group, interactions between patient race/ethnicity and neighborhood race/ethnicity, neighborhood socioeconomic status, and insurance type. Of the 5,390 children, 57.8 % were Latino and 70.1 % possessed government insurance. Latino children ($\beta = 0.31$; $p < 0.01$), especially Latino children living in a Latino ethnic enclave ($\beta = 1.13$; $p < 0.05$), had higher PIM2 scores compared with non-Latinos. Children with government insurance ($\beta = 0.29$; $p < 0.01$) had higher PIM2 scores compared to children with other payment types and median neighborhood income was inversely associated with PIM2 scores ($\beta = -0.04$ per \$10,000/year of income; $p < 0.05$). Lower median neighborhood income, Latino ethnicity, Latino children living in a predominantly Latino neighborhood, and children possessing government insurance were associated with a higher severity of illness on PICU admission. The reasons why these factors affect critical illness severity require further exploration.

Keywords

Neighborhood; Geocoding; Pediatric; Intensive care; Health care disparities

Introduction

Among adults, health care disparities are well documented and are seen in examples such as renal transplantation, non small-cell cancer survival, referrals for cardiac catheterization, and survival after in-hospital cardiac arrest [1–5]. There are significantly fewer examples of health care disparities in the pediatric medical literature and even fewer regarding pediatric critical illness [6–10]. In a prior study of 80,739 patients, we found that, after controlling for severity of illness, being female, 1 month or 12 years of age, having an infectious or oncologic diagnosis, or “other” insurance type increased pediatric intensive care unit (PICU) mortality, but race/ethnicity did not [10]. While age, diagnosis, and gender were indisputable influences on outcomes in the PICU, investigation of additional covariates was warranted to further substantiate health care disparities in pediatric critical illness.

Neighborhood and individual characteristics, such as poverty, race/ethnicity, socioeconomic status (SES), education, health care literacy, English-language proficiency, acculturation,

and others, have been shown to affect health care outcomes in various settings and may act as barriers to optimal health care creating health care disparities in pediatric critical illness as well [11–16]. Nevertheless, the role of these geographic and sociodemographic factors as they relate to PICU outcomes is not well understood. One method that may help create a better understanding of these factors in a geographic context, as they related to the PICU, is geocoding. The geocoding process of placing data points for individuals into a spatial context and then modeling the effects of local social characteristics has been critical to providing ecological context to demographic phenomena and understanding social determinants of health [17, 18].

Prior studies have found correlations between a wide range of neighborhood social characteristics and health care outcomes [19–23]. Using the percentage of African American residents by ZIP code as the primary predictor variable, Rodriguez et al. [21] analyzed the time from day 90 of end-stage renal disease to death from any cause and time to first renal transplantation of adult dialysis patients. For both Caucasian and African American patients, renal transplantation was lowest in ZIP codes with 75 % African American residents compared to those with <10 % African American residents [21]. In the pediatric literature, Shipman et al. [20] found that primary care service areas in the US that had >3,000 children per child physician had greater poverty, lower median household income, and were more prevalent in rural areas compared to areas with <1,000 children per child physician. In Canada, it has been noted that there is a similar uneven distribution of primary care providers, despite the existence of universal insurance coverage [24, 25]. Guttman et al. [19] reviewed the distribution of children, primary care physicians, and counties in Ontario, Canada, and found that the lowest physician supply counties (>3,500 children per full-time equivalent child physician) had a significantly higher proportion of children with no primary care physician and newborns without follow-up compared with the highest-supply counties (1,500–1,999 children per full-time equivalent child physician). Furthermore, children living in the lowest physician supply counties were at a higher risk for all emergency department visits, low-acuity emergency department visits, emergency department visits and hospitalizations for asthma, and acute ambulatory care-sensitive condition hospitalizations compared to the highest-supply counties [19]. The lowest neighborhood income quintile appeared to place children at a higher risk for low-acuity emergency department visits, hospitalizations for asthma and diabetes, and acute ambulatory care-sensitive condition hospitalizations [19]. However, this study did not compare outcomes by racial/ethnic characteristics. Colvin et al. [22] further emphasized the effect of SES on mortality by showing an inverse linear association between SES and in-hospital pediatric mortality. In adult patients with critical illness, Mendu et al. [23] found that neighborhood poverty rate was associated with blood stream infection near critical care initiation. The adjusted risk of community-acquired bloodstream infection was 1.32 (95 % CI 1.11–1.56; $p = 0.002$) and 1.51 (95 % CI 1.04–2.20; $p = 0.03$) for patients from neighborhoods with 20–40 and >40 % poverty rates, respectively, compared to patients with a neighborhood poverty rate <5 %. Nonetheless, these studies do not address the impact of neighborhood and individual characteristics in the setting of children with critical illness.

The purpose of this study was to determine whether or how geographic location and SES affected a child's severity of illness on admission to the PICU and mortality, after adjusting for patient race/ethnicity, age, diagnosis, and insurance type. We also sought to examine the interaction between a child's race/ethnicity and the neighborhood race/ethnicity to determine whether racial/ethnic enclaves were protective or higher risk for poor PICU outcome. Given that prior research has shown the impact of SES, race/ethnicity, and racial/ethnic enclaves on health, we hypothesized that children who were racial/ethnic minorities and/or lived in low-SES or predominantly minority neighborhoods would have a greater severity of illness on admission to the PICU and a higher risk of mortality.

Materials and Methods

The present study was a retrospective data collection, integration, and analysis from hospital databases [electronic medical record, "KIDS", and the PICU databases at Children's Hospital Los Angeles (cardiothoracic ICU and general PICU databases)] and 2010 US Census data. The census data were selected from the 2010 decennial census SF1 files and 2010 5-year American Community Survey. The inclusion criteria were any child admitted to the PICU at Children's Hospital Los Angeles with a primary residence in Los Angeles County from January 1, 2007 through May 23, 2011. Patients from the general PICU database were accrued from January 1, 2007 through May 23, 2011 and those from the cardiothoracic ICU database were accrued from January 1, 2011 through May 23, 2011. Residential address data in "KIDS" were linked to the PICU and cardiothoracic databases which provided clinical data including age, gender, race/ethnicity, primary diagnosis, reason for admission, ICU admission and discharge date/time, scheduled versus unscheduled admission, readmission to the ICU, Pediatric Index of Mortality 2 (PIM2) score [26], operative status, insurance type, and mortality. The PIM2 describes how sick the child was at the time intensive care was started. Variables used to calculate the PIM2 include systolic blood pressure, papillary reactions to bright light, partial pressure of arterial oxygen, base excess in arterial or capillary blood, mechanical ventilation at any time during the first hour in the ICU, admission status (elective or non-elective), recovery from surgery or procedure, admitted following cardiac bypass, and high and low risk diagnoses (described in reference article) [26]. The insurance type was initially arranged into 4 groups. The first group, non-government insurance, was comprised of commercial/indemnity insurance and managed care. The second group, government insurance, was comprised of government, Medicaid, Medicaid/managed care, Medicare, Medicare/managed care, and National Health Service types of insurance. The third group, no insurance, was comprised of self-pay or charity care. The final group, "other", was comprised of patients with other insurance type, no fault (unidentified type of insurance, such as auto insurance), or blank entry. Because children with no insurance or "other" insurance were such a small percentage of the total group (22 and 9 cases, respectively), the no insurance and "other" insurance groups were added to the non-government insurance group for analysis, so that the logit model could contrast the largest group, government insurance, between all other insurance types that are not government related.

Residential addresses were geocoded and linked with 2010 US Census tract data, using geographic information systems (GIS) techniques [27]. Repeated measures linear and

logistic regression models to predict PIM2 and mortality were constructed using three successive models with theorized covariates including the patient's race/ethnicity, the neighborhood racial/ethnic group predominance (90th percentile racial/ethnic enclave), interactions between patient race/ethnicity and neighborhood race/ethnicity, neighborhood socioeconomic status, and insurance type. A 90th percentile racial/ethnic enclave was defined as the predominance of a neighborhood racial/ethnic group where that racial/ethnic group was at the 90th percentile for that specific racial/ethnic group concentration. Significance was set at $p < 0.05$. The study was approved by the local Institutional Review Board, also known as the Committee on Clinical Investigation, at Children's Hospital Los Angeles.

Results

Of the 5,720 patients obtained from the databases, 5,390 had complete clinical data and residential addresses (94 %). Of the 5,390 patients used for analysis, 316 (5.9 %) were obtained from the cardiothoracic ICU database and the remainder were obtained from the general PICU database. A majority of the patients were female, children ages 1–12 years (with an average age of 7.8 ± 6.4 years), Latino ethnicity, possessed government insurance, and had a primary respiratory diagnosis (Table 1).

According to the 2010 US Census, the US population is comprised of 63.8 % Non-Latino/Hispanic Caucasians, 16.4 % Hispanics or Latinos, 12.2 % Non-Latino/Hispanic African Americans, and 4.8 % Non-Latino/Hispanic Asian/Indian/Pacific Islanders [28]. In the US, 36.3 % of the population is classified as minority (reported race/ethnicity to be other than Non-Latino/Hispanic Caucasian alone) [28]. In contrast, California has the largest minority population in the US at 59.9 % [28]. This is even more apparent in Los Angeles where, according to the 2010 US Census, Los Angeles County is comprised of 47.7 % Latinos, 27.8 % Non-Latino/Hispanic Caucasians, 13.7 % Non-Latino Asian/Indian/Pacific Islanders, and 8.3 % Non-Latino African Americans [29]. Our cohort was consistent with the majority Latino population observed in Los Angeles County. In our study, the 90th percentile Latino enclave was defined as 89.0 % Latino proportion of a neighborhood population. The 90th percentile African American enclave was defined as 22.7 % African American proportion of a neighborhood population. The 90th percentile Asian/Indian/Pacific Islander enclave was defined as 35.0 % Asian/Indian/Pacific Islander proportion of a neighborhood population.

On average, Latino children ($\beta = 0.31$), Latino children living in a Latino ethnic enclave ($\beta = 1.13$), or children possessing government insurance ($\beta = 0.29$) had a relatively higher PIM2 risk of mortality. The median neighborhood income was inversely associated with PIM2 (Table 2). No variable tested was significantly associated with ICU mortality. The observed PICU mortality was low at 5.2 %.

Discussion

In this study, a lower median neighborhood income was associated with a higher initial severity of illness on presentation to the PICU. Latino ethnicity, Latino children living in a predominantly Latino neighborhood, and children possessing government insurance were

associated with a higher initial severity of illness on ICU admission. Nevertheless, mortality was not associated with these variables. Despite a lack of studies to compare to in the pediatric critical care literature, our results show similar geographic and socioeconomic effects on health care outcomes as prior investigations in other medical settings [19–23].

While our findings are supported by previous research in other non-PICU settings, the data suggest potential risk factors other than socioeconomic variables that warrant further investigation. In particular, understanding why Latino children living in Latino enclaves tend to be more critically ill upon arrival to the PICU than other racial/ ethnic minority groups living in other sorts of neighborhood social environments. Similar to other recent studies, this finding challenges the notion that ethnic enclaves are universally protective [30, 31]. Our findings suggest that living in socially isolated immigrant enclaves tends to result in greater morbidity upon PICU admission over and above the effect of patients' ethnicity and of controls for income and insurance type. Socioeconomic status is thus a significant determinant of health and mortality, but it is only one facet of a complex interplay of variables [32].

In social terms, this effect of locally concentrated immigrant social environments on health outcomes may result from low acculturation (low English language skills, little understanding of the health care system and available resources) translating into low information about specific care options that may be indicated [33]. Theoretically, low acculturation in immigrant enclaves is believed to be more than a simple aggregation of low acculturated individuals. Rather, low collective social capital in such neighborhoods creates a negative synergy in which local friends and neighbors are less able to help and advise each other. In other words, health care literacy is a network function; when geographically fixed social networks are systematically low in information, each member becomes further impoverished.

Other factors not examined by our study may further explain the low collective social capital of neighborhoods at risk for poor health outcomes as well. In the study referred to earlier by Rodriguez et al. [21] a lower level of education was more prominent in the lower socioeconomic neighborhoods. While the level of education often determines socioeconomic success, it also is a significant determinant in health care literacy. Parent/ caregiver health care literacy has been found to independently affect health outcomes [34, 35]. Understanding what one needs to do is necessary, however not entirely sufficient for adherence to medical recommendations.

Another factor that may be involved with the health care outcome in lower socioeconomic communities is physician access [19, 20, 36]. Shipman et al. [20] showed that primary care service areas in the US that had greater poverty, lower median household income, and were more prevalent in rural areas had a lower concentration of physicians. Shipman's study did not compare outcomes relative to the number of children per child physician in these primary care service areas, nor did it include other important covariates, such as insurance status and racial/ethnic characteristics; however, fewer available physicians in poorer areas resulting in health care inequity was reported by Guttmann et al. [19]. Even with a universal insurance model, as seen in Canada, there seemed to be no guarantee of equal access to

health care [19]. While socioeconomic variables affect health care, it may not be the only driver of health care disparities [32]. Regardless of the causes of health care disparities, it is important to define the actual measured health care indicators, which may vary depending upon the health care setting.

Our study, in conjunction with other ICU and non-ICU health care disparities research, highlights the need to reassess relevant PICU disparity outcome variables. In the reports by Mendu et al. mortality does not seem to be a useful outcome variable in the ICU setting. In the study from Mendu et al. [23] community-acquired bloodstream infection in the 96 h surrounding critical care initiation did not affect mortality. These findings were corroborated by an earlier study by Zager et al. [37] where no relationship was found between neighborhood poverty and mortality up to 1 year following critical care admissions. The specialized care delivered in the ICU seems proportional to the severity of illness and patients appear to survive or die based on the degree of physiologic derangement on arrival to the ICU, rather than race/ethnicity or socioeconomic status alone [9, 10, 37]. Because of the overall low observed mortality in children and children admitted to the ICU, a large number of ICU admissions is required to have selected variables show significant associations with mortality, yet even large numbers may not even be enough to explain mortality association patterns in children. This is emphasized by the study of the effect of SES on in-hospital pediatric mortality by Covin et al. [22] where death occurred in 0.84 % of all pediatric hospitalizations. Even after capturing data from 1,053,101 hospitalizations at 42 tertiary care, freestanding children's hospitals, association between lower SES and increased in-hospital pediatric mortality was only found in 4 of 9 definable hospital service lines (cardiac, gastrointestinal, neurologic, and neonatal) [22]. This places measures addressing morbidities (such as length of ICU or hospital stay, functional status upon discharge from the ICU or hospital, ICU or hospital cost, or utilization of life-sustaining resources) as possibly more significant and useful outcome measures in the ICU than mortality. Furthermore, because of the overall low mortality generated in ICUs and the vast number of variables both inside and outside of the ICU that may impact patient mortality, morbidities may be more suitable and realistically obtainable outcome measures than mortality.

Our retrospective study has several limitations. First, the study results depend upon collected data from multiple databases including 2 ICU databases, a hospital electronic medical record, and the US Census. To reduce bias, only records with all available desired study data were used. Of our total cohort of patients, only 6.0 % were not included because of incomplete data. In addition, the US Census data used is considered accurate and the parcel-based geocoding methods used are perhaps the most precise available. Another limitation of the study is that it was performed in a single, tertiary referral center with a different racial/ethnic patient composition than other PICUs in the US because of the large Latino population which the hospital serves. This may limit the ability to generalize our findings to all PICUs at the moment; however, considering the population trends in the US with an estimated 31.3 % of the total population being of Latino origin by 2050 [38], this study highlights the importance of assessing the future needs of the Latino population for all PICUs in the US. Modeling both the neighborhood and individual characteristics of critically ill children, as facilitated by geocoding, can help identify risk factors for poorer

health upon admission to ICUs—factors that may affect ICU outcomes, regardless of the type of hospital or racial/ethnic composition of the community.

Our study underscores the importance of neighborhood and individual characteristics' impact on medical outcomes in the PICU. The complex nature of the interactions between these characteristics and ICU outcomes subsequently introduces more questions than answers, regarding the best ICU outcome measures and causal factors for health care disparities in the ICU. Based on this study, future research should focus on potential risk factors, other than SES, in the Latino population and Latino enclaves to understand why these children are more critically ill upon arrival to the PICU. There may be a number of other important health care access barriers that affect pediatric ICU outcomes and may help explain the results of this study [11–16, 19, 20].

Conclusion

Health care disparities may be responsible for the morbidity and mortality of many critically ill children before they are even admitted to the PICU. Nevertheless, the investigation of health care disparities in pediatric critical care medicine is in its infancy and should include investigations not only within the ICU, but also beyond the ICU. The field of critical care medicine, both adult and pediatric, is still trying to identify risk factors for and develop measurements of health care disparities. Once these risk factors identified and measurements are determined, only then can pediatric critical care medicine engage in meaningful discussions about preventing health care disparities amongst all critically ill children.

Acknowledgments

This study was supported by a grant from the Southern California Clinical Translational Science Institute Los Angeles Basin (SC-CTSI LAB) Pilot Award (NIH/NCRR/NCATS SC CTSI—Grant Number UL1 RR031986).

Abbreviations

ICU	Intensive care unit
PICU	Pediatric intensive care unit

References

1. Institute of Medicine (U.S.). Committee on understanding and eliminating racial and ethnic disparities in health care. In: Smedley, BD.; Stith, AY.; Nelson, AR., editors. Unequal treatment confronting racial and ethnic disparities in health care. Washington, DC: The National Academies Press; 2003.
2. Epstein AM, Ayanian JZ, Keogh JH, et al. Racial disparities in access to renal transplantation—clinically appropriate or due to underuse or overuse? The New England Journal of Medicine. 2000; 343(21):1537–1544. 1532 p preceding 1537. [PubMed: 11087884]
3. Bach PB, Cramer LD, Warren JL, Begg CB. Racial differences in the treatment of early-stage lung cancer. The New England Journal of Medicine. 1999; 341(16):1198–1205. [PubMed: 10519898]
4. Schulman KA, Berlin JA, Harless W. The effect of race and sex on physicians' recommendations for cardiac catheterization. The New England Journal of Medicine. 1999; 340(8):618–626. [PubMed: 10029647]

5. Chan PS, Nichol G, Krumholz HM, et al. Racial differences in survival after in-hospital cardiac arrest. *JAMA*. 2009; 302(11):1195–1201. [PubMed: 19755698]
6. Flores G. Technical report—racial and ethnic disparities in the health and health care of children. *Pediatrics*. 2010; 125(4):e979–e1020. [PubMed: 20351000]
7. Haider AH, Efron DT, Haut ER, DiRusso SM, Sullivan T, Cornwell EE III. Black children experience worse clinical and functional outcomes after traumatic brain injury: an analysis of the National Pediatric Trauma Registry. *Journal of Trauma*. 2007; 62(5):1259–1262. discussion 1262–1253. [PubMed: 17495733]
8. Falcone RA Jr, Martin C, Brown RL, Garcia VF. Despite overall low pediatric head injury mortality, disparities exist between races. *Journal of Pediatric Surgery*. 2008; 43(10):1858–1864. [PubMed: 18926221]
9. Lopez AM, Tilford JM, Anand KJ, et al. Variation in pediatric intensive care therapies and outcomes by race, gender, and insurance status. *Pediatric Critical Care Medicine*. 2006; 7(1):2–6. [PubMed: 16395066]
10. Epstein D, Wong CF, Khemani RG, et al. Race/Ethnicity is not associated with mortality in the PICU. *Pediatrics*. 2011; 127(3):e588–e597. [PubMed: 21357333]
11. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Annals of Internal Medicine*. 2011; 155(2):97–107. [PubMed: 21768583]
12. Joshi S, Gaynor JJ, Bayers S. Disparities among Blacks, Hispanics, and Whites in time from starting dialysis to kidney transplant waitlisting. *Transplantation*. 2013; 95(2):309–318. [PubMed: 23325005]
13. Reitzel LR, Nguyen N, Zafereo ME, Li G, Wei Q, Sturgis EM. Neighborhood deprivation and clinical outcomes among head and neck cancer patients. *Health Place*. 2012; 18(4):861–868. [PubMed: 22445028]
14. Cerda M, Buka SL, Rich-Edwards JW. Neighborhood influences on the association between maternal age and birthweight: a multilevel investigation of age-related disparities in health. *Social Science and Medicine*. 2008; 66(9):2048–2060. [PubMed: 18313187]
15. Wisnivesky JP, Krauskopf K, Wolf MS, et al. The association between language proficiency and outcomes of elderly patients with asthma. *Annals of Allergy, Asthma & Immunology*. 2012; 109(3):179–184.
16. Peterson PN, Campagna EJ, Maravi M. Acculturation and outcomes among patients with heart failure. *Circulation Heart Failure*. 2012; 5(2):160–166. [PubMed: 22247483]
17. Reibel M. Geographic information systems and spatial data processing in demography: a review. *Population Research and Policy Review*. 2007; 26:601–618.
18. Comer KF, Grannis S, Dixon BE, Bodenhamer DJ, Wiehe SE. Incorporating geospatial capacity within clinical data systems to address social determinants of health. *Public Health Reports*. 2011; 126(Suppl 3):54–61. [PubMed: 21836738]
19. Guttmann A, Shipman SA, Lam K, Goodman DC, Stukel TA. Primary care physician supply and children's health care use, access, and outcomes: findings from Canada. *Pediatrics*. 2010; 125(6):1119–1126. [PubMed: 20498170]
20. Shipman SA, Lan J, Chang CH, Goodman DC. Geographic maldistribution of primary care for children. *Pediatrics*. 2011; 127(1):19–27. [PubMed: 21172992]
21. Rodriguez RA, Sen S, Mehta K, Moody-Ayers S, Bacchetti P, O'Hare AM. Geography matters: relationships among urban residential segregation, dialysis facilities, and patient outcomes. *Annals of Internal Medicine*. 2007; 146(7):493–501. [PubMed: 17404351]
22. Colvin JD, Zaniletti I, Fieldston ES, et al. Socioeconomic status and in-hospital pediatric mortality. *Pediatrics*. 2013; 131(1):e182–e190. [PubMed: 23248226]
23. Mendu ML, Zager S, Gibbons FK, Christopher KB. Relationship between neighborhood poverty rate and bloodstream infections in the critically ill*. *Critical Care Medicine*. 2012; 40(5):1427–1436. [PubMed: 22511126]
24. Pitblado, JR.; Pong, RW. Sudbury: Laurentian University Centre for Rural and Northern Health Research; 1999. Geographic distribution of physicians in Canada.

25. Watson, D.; Black, C.; Reid, R. Vancouver: UBC Centre for Health Services and Policy Research; 2006. Primary health care in BC: Physician supply, distribution and practice collocation (1996/97 to 2004/05).
26. Slater A, Shann F, Pearson G. PIM2: a revised version of the paediatric index of mortality. *Intensive Care Medicine*. 2003; 29(2):278–285. [PubMed: 12541154]
27. Goldberg, DW., editor. Texas A&M University Geoservices. <http://geoservices.tamu.edu>.
28. Overview of Race and Hispanic Origin. [Accessed December 5, 2013] United States Census Bureau. 2010. <http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf>.
29. Profile of General Population and Housing Characteristics. Los Angeles County, California: United States Census Bureau; 2010. Demographic Profile Data. 2010 http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1. [Accessed December 5, 2013]
30. Osypuk TL, Diez Roux AV, Hadley C, Kandula NR. Are immigrant enclaves healthy places to live? The multiethnic study of atherosclerosis. *Social Science and Medicine*. 2009; 69(1):110–120. [PubMed: 19427731]
31. Roy AL, Hughes D, Yoshikawa H. Intersections between nativity, ethnic density, and neighborhood SES: Using an ethnic enclave framework to explore variation in Puerto Ricans' Physical Health. *American journal of Community Psychology*. 2013 (Epub ahead of print).
32. Isaacs SL, Schroeder SA. Class—the ignored determinant of the nation's health. *New England Journal of Medicine*. 2004; 351(11):1137–1142. [PubMed: 15356313]
33. Mendoza FS. Health disparities and children in immigrant families: a research agenda. *Pediatrics*. 2009; 124(Suppl 3):S187–S195. [PubMed: 19861469]
34. DeWalt DA, Hink A. Health literacy and child health outcomes: a systematic review of the literature. *Pediatrics*. 2009; 124(Suppl 3):S265–S274. [PubMed: 19861480]
35. Sanders LM, Federico S, Klass P, Abrams MA, Dreyer B. Literacy and child health: a systematic review. *Archives of Pediatrics and Adolescent Medicine*. 2009; 163(2):131–140. [PubMed: 19188645]
36. van Doorslaer E, Masseria C, Koolman X. Inequalities in access to medical care by income in developed countries. *CMAJ*. 2006; 174(2):177–183. [PubMed: 16415462]
37. Zager S, Mendu ML, Chang D. Neighborhood poverty rate and mortality in patients receiving critical care in the academic medical center setting. *Chest*. 2011; 139(6):1368–1379. [PubMed: 21454401]
38. United States Population Projections: 2000 to 2050. [Accessed December 5 2013] United States Census Bureau. 2008. <http://www.census.gov/population/projections/files/analytical-document09.pdf>.

Table 1

Study population characteristics

	ICU Study Population (N = 5,390)
Gender (%)	
Male	46.0
Female	54.0
Age, mean $\pm$ SD (years)	7.82 $\pm$ 6.44
Age groups (%)	
Neonates (< 1 month)	2.9
Infant (1 month–1 year)	18.3
Child (1–12 years)	46.6
Adolescent (> 12 years)	32.3
PIM2 risk of mortality (mean $\pm$ SD)	2.3 $\pm$ 8.1
Race/ethnicity (%)	
Latino	57.8
Caucasian	19.3
African American	7.6
Asian/Indian/Pacific Islander	6.5
Other/Mixed/Unspecified	8.7
Insurance Type (%)	
Government	70.1
Non-Government	28.2
Other	1.1
None	0.6
Admission Type (%)	
Unscheduled	55.4
Scheduled	44.6
Length of Stay, mean $\pm$ SD (days)	
Physical	5.1 $\pm$ 8.5
Medical	5.0 $\pm$ 8.5
Mortality (%)	5.2
Primary Diagnosis (%)	
Respiratory	19.6
Oncologic	11.6
Cardiovascular	11.4
Neurologic	11.2
Orthopedic	10.9
Injury, Poisoning, and Adverse Events	10.4
Gastrointestinal	5.7
Infectious	4.4
Endocrinologic	1.0
Other	13.9

Table 2

Repeated Measures Models: Covariates of Log (PIM2)—Probability of Mortality

Variable	Model 1 Patient race/ethnicity only Coefficient	Model 2 Add race/ethnicity enclave flags Coefficient	Model 3 Add patient/enclave race/ethnicity interactions Coefficient
Intercept	−2.2367**	−2.1285**	−2.0686**
African American	0.1371	0.2275	0.3211
Latino	0.3680**	0.3837**	0.3054**
Asian/Indian/Pacific Islander	0.1596	0.2441	0.2056
Median Income (per \$10,000)	−0.02	−0.03	−0.04*
Government Insurance	0.2731**	0.2812**	0.2919**
H90_Percentile		−0.2223	−1.2137**
B90_Percentile		−0.3553*	−0.4024
A90_Percentile		−0.2771*	−0.2754
H_H90			1.1315*
B_H90			0.2240
A_H90			−1.5713
H_B90			0.07872
B_B90			−0.2361
A_B90			3.1408**
H_A90			0.07373
B_A90			−0.4008
A_A90			−0.07460

The very large and significant incremental risk effect for Asian/Indian/Pacific Islanders living in African American enclaves (A_B90) attaches to a subpopulation of five patients and should therefore be considered dubious

H90_Percentile 90th percentile Latino tract concentration; B90_Percentile 90th percentile African American tract concentration; A90_Percentile 90th percentile Asian/Indian/Pacific Islander tract concentration; H_H90 Latino patients living in an area with 90th percentile Latino tract concentration; B_H90 African American patients living in an area with 90th percentile Latino tract concentration; A_H90 Asian/Indian/Pacific Islander patients living in an area with 90th percentile Latino tract concentration; H_B90 Latino patients living in an area with 90th percentile African American tract concentration; B_B90 African American patients living in an area with 90th percentile African American tract concentration; A_B90 Asian/Indian/Pacific Islander patients living in an area with 90th percentile African American tract concentration; H_A90 Latino patients living in an area with 90th percentile Asian/Indian/Pacific Islander tract concentration; B_A90 African American patients living in an area with 90th percentile Asian/Indian/Pacific Islander tract concentration; A_A90 Asian/Indian/Pacific Islander patients living in an area with 90th percentile Asian/Indian/Pacific Islander tract concentration

*
 $p < 0.05$;

**
 $p < 0.01$