

# Healthcare disparities in the perioperative setting: An analysis of the National Anaesthesia Clinical Outcomes Registry

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## RESEARCH

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## ABSTRACT

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### Background

There are numerous studies which indicate healthcare disparities exist in the United States.

### Aims

This study aims to investigate healthcare disparities in perioperative setting.

### Methods

The National Anaesthesia Clinical Outcomes Registry (NACOR) was analysed for the impact of socioeconomic status and gender on perioperative adverse outcomes in elective, non-obstetrical cases. Socioeconomic status was initially divided into six income groups using Thompson & Hickey class modifications and subsequently classified into three income group classification (lower, middle, and upper). Three adverse outcomes were studied: intraoperative cardiac arrest, unplanned ICU admissions, and mortality.

### Results

A total of 1,800,506 non-emergency, non-obstetrical cases in NACOR documented the presence or absence of an adverse outcome. In these cases, 43.42 per cent were males and 56.58 per cent were females. The incidences of adverse outcomes per 10,000 were 8.64 for unplanned ICU admissions, 7.86 for intraoperative cardiac arrest not leading to death and 2.37 for intraoperative cardiac arrest leading to death. Patients in the upper socioeconomic group had significantly fewer adverse outcomes than patients in lower group for unplanned ICU admissions (OR 0.41, 95 per cent CI 0.28–0.59), cardiac arrest not leading to death (OR 0.21; 95 per cent CI 0.13–0.33), and cardiac arrest leading to death (OR 0.41 95 per cent CI 0.21–0.79). The lower class group was found to have more intraoperative cardiac arrests not leading to death than the middle class group. There was no statistical significance between the lower and middle income groups when analysing unplanned ICU admissions and mortality.

### Conclusion

Our study has found that healthcare disparities do exist in the perioperative setting.

### Key Words

Perioperative Setting, Socioeconomic status, Healthcare disparities

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### What this study adds:

#### 1. What is known about this subject?

There are numerous studies which have shown that healthcare disparities exist in United States in certain fields.

#### 2. What new information is offered in this study?

Healthcare disparities do exist in the perioperative setting.

#### 3. What are the implications for research, policy, or practice?

Our findings help increase awareness in the medical community of potential healthcare disparities in the

perioperative setting and hopefully encourage discussion amongst healthcare providers.

## Background

In recent years, the health care system in the United States has become increasingly scrutinized due to high costs, a large number of uninsured citizens, and evidence of health disparities. Health care disparities have been documented in several areas of medicine such as diabetes care, cancer screening, cardiovascular screening, and kidney transplant management.<sup>1–3</sup> These disparities have resulted in increased levels of morbidity and mortality.<sup>2,3</sup> The federal government has supported research that identifies healthcare disparities and ways to improve them and has released several National Healthcare Quality and Disparities Reports released by the Agency for Healthcare Research and Quality (AHRQ).<sup>1,4–9</sup>

Social class, income level, race/ethnicity, and education level impact health status as well as the use of health services. Lower income people received poorer quality of care than high income people for 85 per cent of core measures and better quality of care for 8 per cent of core measures as determined by the AHRQ. (<http://www.ahrq.gov/qual/nhdr06/nhdr06.htm>. Accessed on November 14, 2015) Patients with a low socioeconomic status were more likely to have a coronary bypass surgery at a high volume hospital and have a higher mortality rates than patients from a high socioeconomic status.<sup>10</sup>

Some research has been done to determine if healthcare disparities exist in the perioperative setting, and how they may affect patient care and outcomes. Racial disparities were found in the treatment plans after acute myocardial infarction, and an analysis of post-operative cardiac rehabilitation also revealed a disparity in referrals between blacks and whites.<sup>4,11</sup> Thus, disparities due to race in perioperative setting can lead to poorer overall healthcare outcomes. However there is little research on a possible relationship between healthcare disparities due to socioeconomic status and perioperative adverse outcomes. The goal of this study is to investigate the association between socioeconomic status (SES) and perioperative adverse outcomes in elective, non-obstetrical cases.

## Method

### Ethics Statement

This project was approved by the Institutional Review Board at Albert Einstein School of Medicine. All data were obtained from the National Anaesthesia Clinical Outcomes

Registry (NACOR). The information associated with patients was de-identified prior to analysis.

### Study Design and Outcome Measures

This retrospective cohort study was performed using the NACOR, a database that collects administrative and clinical information from anaesthesia practices of perioperative cases.<sup>12–14</sup> Demographic data include patient age, ASA physical status, current procedural terminology codes, gender, and practice and patient location. Inclusion criteria include adults from 19 years old and up who underwent surgical procedures in the U.S. from 2010 to 2012. Obstetric surgeries were excluded. The SES of all patients was obtained by linking residential zip codes to the median family income for that zip code, as reported in the 2010 U.S. census

(<http://www.psc.isr.umich.edu/dis/census/Features/tract2zip/index.html>. Accessed on November 14, 2015).

SES was initially divided into six income groups using Thompson & Hickey's class modifications which are a variation of Warner's class model. It is based on household median annual income.<sup>15</sup> Groups include poverty (below US\$23,050), working class (US\$23,051–US\$32,499), lower middle class (US\$32,500–US\$60,000), middle class (US\$60,001–US\$99,999), upper middle class (US\$100,000–US\$150,000), and upper class (more than US\$150,000). (<http://money.usnews.com/money/personal-finance/articles/2012/09/13/where-do-you-fall-in-the-american-economic-class-system>. Accessed on November 14, 2015)

Because of the normal distribution of the income groups where there were far fewer poverty and upper class cases to compare, we re-categorized the socioeconomic groups into three categories. Poverty and working class patients were combined into the lower socioeconomic group; patients of the lower middle class and middle class were placed in the middle socioeconomic group; and the upper socioeconomic class group included those in the upper middle and upper classes.

Three clinical adverse outcomes were measured: intraoperative cardiac arrest, unplanned ICU admissions, and mortality. The definition of perioperative cardiac arrest may not be uniformly defined across institutions despite the guidance of the Standard Nomenclature for Medicine terminology set and the American Society of Anaesthesiologists Committee on Performance and Outcome Measures. The definition of cardiac arrest in practice realistically includes any unexpected episode of

cardiopulmonary resuscitation (open or closed chest) in the operating room (OR) or in the post-anaesthesia care unit (PACU) (stage 1 or 2). Mortality in this setting refers to death in the immediate perioperative period, during OR or PACU care.

### Statistical Analyses

We provided descriptive analysis for both overall as well as gender groups for age, median income, ASA physical status, location of residents by US region, and adverse events. Differences among socio-economic groups by adverse event were analysed using Pearson Chi-square and by logistic regression, controlling for patient age and ASA PS. All samples were entered into a Stata database (Version 13, StataCorp. College Station, TX, USA).

### Results

The dataset consisted of 1,800,506 non-emergency, non-obstetrical cases in NACOR with documentation of the presence or absence of an adverse outcome (Figure 1). Overall, under half (43.42 per cent) were males. The overall median income was US\$51,764, which is also similar to the medium socioeconomic group. The rates of the three adverse outcomes when analysed showed unplanned ICU admissions 8.64:10,000, intraoperative cardiac arrest not leading to death 7.86:10,000 and mortality 2.37:10,000. Demographic information can be found in Table 1.

Certain procedures were associated with adverse outcomes. The most frequent procedures which resulted in unplanned ICU admissions were total knee arthroplasty (2.04 per cent), total hip arthroplasty (1.71 per cent), and laparoscopic cholecystectomy (1.71 per cent). Intraoperative cardiac arrests not leading to death were associated with total knee arthroplasty (4.41 per cent), total hip arthroplasty (3.90 per cent), and shoulder arthroscopy with a rotator cuff repair procedures (2.01 per cent). Intraoperative cardiac arrest leading to death frequently occurred during exploratory laparotomy/ exploratory celiotomy with or without biopsy (13.47 per cent), craniotomy/ craniectomy for hematoma evacuation (2.33 per cent), and emergency cases (1.81 per cent).

When risk-stratified by socioeconomic groups, the lower income group was statistically more likely to suffer a cardiac arrest not resulting in death, unplanned ICU admission and mortality than the upper income group (Table 2). Adjusted logistic regression suggests a similar pattern across the socioeconomic groups, although there was less of a statistical difference between the lower and middle socioeconomic groups (Table 3). There was no statistical

significance between the lower and middle income groups when analysing unplanned ICU admissions and mortality.

### Discussion

Our study demonstrated that healthcare disparities may exist based on the socioeconomic class of patients with lower income groups having more perioperative adverse outcomes than higher income groups. The middle income patients were more likely to have adverse outcomes as compared to the upper income groups. In certain categories, both middle income and lower income groups have a similar rate of adverse outcomes as compared to the upper income groups. Orthopaedic surgeries on lower extremities and general surgeries were the case types most commonly associated with perioperative cardiac arrests.

Worldwide millions of people die annually with US estimates of 1.7 per cent for 30 day mortality.<sup>16</sup> Perioperative mortality has been stated to be 1,176 per million.<sup>17</sup> Single centre studies have found a 24 hour perioperative mortality of 7 per 10,000 cases as well as 1 per 1,400 cases.<sup>18,19</sup> This study found a cardiac arrest associated with mortality rate of 2 per 10,000 cases which was lower perhaps due to our concentration on the immediate perioperative period. A national survey found that overall mortality was three times higher in the lowest income group compared to the highest.<sup>20</sup> An analysis of mortality after major cancer surgery found similar results as our study, where patients from a lower SES had a larger increase in mortality than those patients from a higher SES.<sup>21</sup>

Cardiac arrest, not leading to death, was also less likely to occur to those in the upper income group despite risk stratification. Our results are similar to out-of-hospital cardiac arrests where the incidence of sudden cardiac arrest in the lowest socioeconomic quartile was nearly double of those in the highest quartile.<sup>22</sup> In addition, an Oregon Study found that the incidence of cardiac arrest was higher in the lowest to the highest SES [RR 2.7, 95 per cent CI 1.8–4].<sup>23</sup> In contrast, the National Surgical Quality Improvement Project did not identify SES as a risk factor for complications after surgery.<sup>24</sup>

Interest in SES stems from the fact that healthcare disparities exist in several specialties and mortality rates in industrialized countries are directly related to poverty and the degree of income inequality.<sup>18</sup> In the transplant literature, unrelated donors and recipients have an average higher SES than related donors and recipients.<sup>19</sup> Patients with a lower SES may be associated with a higher mortality

rate after CABG than those with a higher SES status. Candidates for cardiac operations from a lower SES were associated with a significantly lower preoperative quality of life and increased risk-adjusted mortality.<sup>16,17</sup> Our study is the first to examine multiple surgical specialties and found that those from a low SES were more likely to have adverse outcomes. Another interesting finding from our study showed that there was little difference between the middle class group and lower class group when analysing the rates of perioperative adverse outcomes like ICU admissions. Often much attention is spent on analysing a patient's physiological condition pre-operatively; psychological stresses are another risk factor that should not be ignored.

Although there is evidence that being unemployed and the length of unemployment affect health status, benefits for the unemployed may buffer the adverse effects on health.<sup>20</sup> People in the middle class group may have more stress than the unemployed and working class due to their job obligation, job security and limited social support. Chronic stress suppresses the immune function<sup>25</sup> and diminishes the capability to respond to further stresses such as surgery. Researchers indicated that greater anxiety prior to surgery is associated with a complicated postoperative recovery.<sup>26</sup> They found that surgery had a significant but short-lived adverse impact on the physical and mental subjective health status of patients with post-traumatic stress disorder (PTSD) peaking shortly after surgery and resolving within 1 month. The patients with PTSD were at greater risk of mortality.<sup>27</sup> Traditionally, a preoperative measurement to predict adverse outcomes from surgery is only based on physical health comorbidities. We believe that utilizing physical health comorbidity as a solo measurement is an insufficient preoperative risk predictor. The social determinants of health should be another tool used to predict those patients who at greater risk of perioperative complications.<sup>28</sup>

Limitations of this study include the number of variables used to risk-stratify the patients. This study did not evaluate the impact of race and ethnicity.<sup>15,29,30</sup> Epigenetic factors may impact the relationship between early life environmental factors and race-based health disparities.<sup>30,31</sup> Based on findings from the Centres for Medicare & Medicaid Services Hospital Quality Initiative, there are institutions which do not provide high quality healthcare. This study did not investigate if adverse outcomes were associated with institutions known for providing low quality healthcare.

## Conclusion

Our study has found that healthcare disparities do exist in the perioperative setting. SES may play a factor in this process. Future studies should investigate if buffers can be instituted to mitigate the possible negative impact of SES and other social determinants of health may have on perioperative care.

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## PEER REVIEW

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## CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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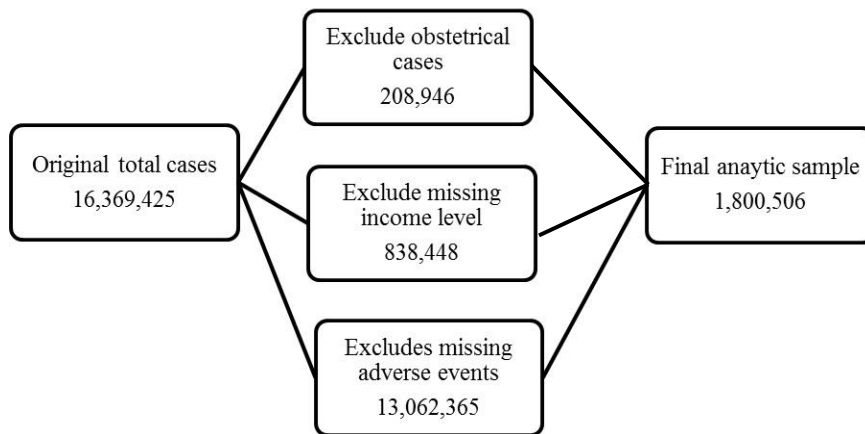
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## ETHICS COMMITTEE APPROVAL

Institutional Review Board at Albert Einstein College of Medicine.

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**Figure 1: Exclusions to NACOR database**



**Table 1: Demographic information**

|   | All N(%)        | Males N(%)      | Females N(%)      |
|---|-----------------|-----------------|-------------------|
| Total   | 18,00,506       | 781,867 (43.42) | 1,018,639 (56.58) |
| Mean age  | 56.65           | 57.68           | 55.85             |
| Median age  | 58              | 59              | 56                |
| <b>Age categories</b>                               |                 |                 |                   |
| 19-49   | 585,856 (32.54) | 226,269 (28.94) | 359,587 (35.30)   |
| 50-64   | 582,036 (32.33) | 263,580 (33.71) | 318,456 (31.26)   |
| 65-79   | 477,074 (26.50) | 224,423 (28.70) | 252,651 (24.80)   |
| 80+   | 155,540 (8.64)  | 67,595 (8.65)   | 87,945 (8.63)     |
| Median income                                       | 51,764          | 52,216          | 51,382            |
| <b>Median income categories</b>                     |                 |                 |                   |
| Lower   | 27,9116.62)     | 27,911 (6.37)   | 27,898 (6.82)     |
| Middle  | 52,059 (88.25)  | 52,297 (88.12)  | 51,775 (88.36)    |
| Upper   | 111,022 (5.12)  | 111,023 (5.51)  | 111,022 (4.82)    |
| <b>ASA</b>  |                 |                 |                   |
| PS1   | 371,637 (20.64) | 156,623 (20.03) | 215,014 (21.11)   |
| PS2   | 730,202 (40.56) | 283,486 (36.26) | 446,716 (43.85)   |
| PS3   | 570,126 (31.66) | 268,352 (34.32) | 301,774 (29.63)   |
| PS4   | 125,500 (6.97)  | 71,593 (9.16)   | 53,907 (5.29)     |
| PS5   | 3,041 (0.17)    | 1,813 (0.23)    | 1,228 (0.12)      |
| <b>Location</b>                                     |                 |                 |                   |
| Northeast   | 387,351 (21.51) | 168,999 (21.61) | 218,352 (21.44)   |
| Midwest   | 663,534 (36.85) | 285,316 (36.49) | 378,218 (37.13)   |
| South   | 584,018 (32.44) | 254,695 (32.58) | 329,323 (32.33)   |
| West  | 165,603 (9.20)  | 72,857 (9.32)   | 92,746 (9.10)     |
| Unplanned ICU admissions§                           | 8.64            | 9.42            | 8.06              |
| Intraoperative Cardiac Arrest Not Leading To Death§ | 7.86            | 8.6             | 7.3               |
| Intraoperative Cardiac Arrest Leading To Death§     | 2.37            | 2.9             | 1.96              |

§ Incidences of outcome events are based on per 10,000 cases.

**Table 2: Adverse events in association with socio-economic groups**

| Adverse Event§                                     | Socioeconomic Lower | Groups Middle | Upper | p value |
|--|---------------------|---------------|-------|---------|
| Unplanned ICU admissions                           | 9.98                | 8.82          | 3.79  | <.01    |
| Intraoperative Cardiac Arrest Not Leading To Death | 10.46               | 7.99          | 2.31  | <.01    |
| Intraoperative Cardiac Arrest Leading To Death     | 3.61                | 2.35          | 1.19  | <.01    |

§Incidences of outcome events are based on per 10,000 cases

Pearson chi-square findings for adverse events are as follows: unplanned ICU admissions = 28.17; intraoperative cardiac arrest not leading to death = 46.19; intraoperative cardiac arrest leading to death = 13.11

**Table 3: Logistic regression of adverse events based on socio-economic groups**

| Adverse Event                                      | Odds Ratio | Standard Error | p-value | 95% CI    |
|--|------------|----------------|---------|-----------|
| Unplanned ICU admissions                           |            |                |         |           |
| Middle class                                       | 0.94       | 0.09           | 0.52    | 0.79-1.13 |
| Upper class  | 0.41       | 0.08           | <0.01   | 0.28-0.59 |
| Intraoperative Cardiac Arrest Not Leading To Death |            |                |         |           |
| Middle class                                       | 0.71       | 0.06           | <0.01   | 0.59-0.84 |
| Upper class  | 0.21       | 0.05           | <0.01   | 0.13-0.33 |
| Intraoperative Cardiac Arrest Leading To Death     |            |                |         |           |
| Middle class                                       | 0.79       | 0.12           | 0.12    | 0.58-1.07 |
| Upper class  | 0.41       | 0.14           | <0.01   | 0.21-0.79 |

Reference group for all adverse events is the lower socioeconomic class.

Logistic regression analyses controlled for patient age and patient ASA physical status