ISSN: 2469-5858

Dahya and Bishop-Royse. J Geriatr Med Gerontol 2018, 4:049
DOI: 10.23937/2469-5858/1510049
Volume 4 | Issue 2
Open Access

Journal of
Geriatric Medicine and Gerontology

RESEARCH ARTICLE

The Sociodemographic Characteristics of Patients Who Experience Postdischarge Adverse Events

***Vishal Dahya*[1*] *and Jessica Bishop-Royse*[2]**

[1]*Summa Cardiovascular Institute, Summa Health System, USA*

[2]*DePaul University, USA*

***Corresponding author:** *Vishal Dahya, Summa Cardiovascular Institute, Summa Health System, 525 E. Market St. Akron, OH 44309, USA, E-mail: vdahya@mail.usf.edu*

Abstract

In the decade since the publication of Institute of Medicine reports on patient safety, much remains unknown about the patient-level characteristics that may increase or decrease vulnerabilities to postdischarge adverse events. We reviewed the patient safety literature to determine whether specific sociodemographic groups are vulnerable to postdischarge adverse events. We found substantial inconsistencies in how postdischarge adverse events were defined, which was largely driven by innovations and developments in research methodology that have occurred since the publication of the IOM reports. Additionally, we found the literature to be inconclusive on which patients represent the greatest vulnerabilities for postdischarge adverse events. We suggest that the field could benefit from standardized definitions of what constitutes an adverse event, as well as adequately powering studies in order to achieve statistical significance for the influence of sociodemographic characteristics on patient experience of poor patient safety.

Keywords

Patient safety, Postdischarge adverse events, Readmission, Sociodemographic characteristics, Age, Race, SES

Introduction

It has been over a decade since the publication of two seminal works on patient safety including the IOM Reports *To Err Is Human* [1] and *Crossing the Quality Chasm* [2]. These reports were among the first to highlight the need for a national agenda to improve patient safety and reduce adverse events in the U.S. health care system. Moreover, recent interest in improving patient outcomes in order to decrease costs associated with the Affordable Care Act puts patient safety in the American healthcare system at the forefront research on health services.

Early work in this area focused on adverse events during hospitalizations, estimating an incidence rate between 2.9%-3.7% [3,4]. Adjusting for inflation, estimates of the national cost of total healthcare by Johnson, et al. [5] would top $115 billion a year in the United States. Moreover, these costs do not account for lost productivity or disabilities that occur when patients experience adverse events. Recent studies have underscored the need to consider adverse events after hospital discharge. Forster, et al. [6] documented the incidence rate for postdischarge adverse events as 19%, five times higher than that for in-hospital events. Using Forster's estimate of the incidence rate of adverse events and Johnson's estimates for cost, it's possible that the US healthcare system may be spending $575 (inflation adjusted) billion per year on postdischarge adverse events.

Much remains unknown about the degree to which some social and demographic groups experience unequal risk of postdischarge adverse events. Sociologists and demographers have long understood the role of non-medical influences of health, documenting differences in mortality, overall health, disability, mental illness, active life expectancy, and chronic disease across social and demographic groups [7,8]. In as much as medical sociology is predicated on the idea that social conditions fundamentally influence health and disease

Citation: Dahya V, Bishop-Royse J (2018) The Sociodemographic Characteristics of Patients Who Experience Postdischarge Adverse Events. J Geriatr Med Gerontol 4:049. doi.org/10.23937/2469-5858/1510049

Accepted: June 14, 2018: **Published:** June 16, 2018

[9], it seems plausible that social conditions shape the health of patients before they ever present to hospitals, predisposing some to increased vulnerability of postdischarge adverse events. This may mean that some patient groups bear a disproportionate amount of the risk for poor patient safety outcomes.

Moreover, patient characteristics, such as socioeconomic status, social support, and mental health may predispose some types of patients towards vulnerability in terms of postdischarge adverse events. Excess risk of poor outcomes may be driven by socioeconomic disparities through inequalities in health insurance and healthcare access. Further, important components of patient safety, such as health literacy and compliance with discharge instructions, may be related to educational differences among patients who experience postdischarge adverse events and those who do not.

There are several reasons why much about the characteristics of patients who experience postdischarge adverse events is unknown. First, the medical literature tends to place greater emphasis on understanding the medical and physiological influences on health. This is understandable, given the wide variety of definitions and variable operationalizations employed in the social science and medical literature, not only for items such as socioeconomic status, but also increasingly as of late, gender and race [10,11]. These construct issues become increasingly difficult to confront when considering that many patient safety studies are not adequately powered to register socio-demographic differences in the risk of poor patient outcomes, because they often include only 400-700 participants.

Complicating matters further is the discrepancy in the patient safety literature regarding what qualifies as an adverse event. The bulk of patient safety literature has relied heavily on analyses of administrative data generated by hospitals, government reporting agencies, and insurance companies (e.g. Iezzoni 1999) [12]. At first pass, these exceptionally rich and detailed data may seem well-suited to such an endeavor. However, computerized monitoring of adverse events is attractive because it is inexpensive and creates a high yield of adverse events. However, it is less sensitive to medication errors (ADEs) and potential ADEs, which constitute a substantial proportion of adverse events [13]. Moreover, these data preclude determining the patient characteristics of interest beyond how often patients died or were readmitted, because they cannot account for medical management of patient cases, which is the issue that adverse events hinge on. The result has been confusion about what constitutes an "adverse event".

Without consideration of the medical management of a particular case, which can only be determined with physician review and adjudication, events that appear in administrative data, such as readmissions, emergency department (ED) visits, and mortality are indistinguishable from "adverse events" as defined by Brennan, et al. [4], Forster, et al. [6,14]. This is vital, as not all readmissions, ED visits, and deaths are due to poor medical management. In some cases, these events occur to patients who have had appropriate and exceptional care.

The methodology offered by Forster, et al. [6,14] and Brennan, et al. [4] is integral to understanding the role of patient safety for postdischarge adverse events. This consists of a two-stage sampling process: A chart review of patient records combined with an adjudication or assessment to determine what characteristics were influential in the adverse event. The methods employed by Forster, et al. [6,14] improved upon those used by Brennan, et al. [4] in the Harvard Medical Practice Study (HMPS). While the studies undertaken by Forster, et al. established the importance of the postdischarge period for patient safety Brennan, et al's., HMPS [4] provided the methodological standard by which adverse events should be considered.

The two-stage process offered by Forster, et al. [6,14] and Brennan and colleagues [4] represent the most rigorous methodology for examining the adverse patient outcomes from a quality of care perspective. Their method of collecting primary data on new or worsening symptoms through patient interviews combined with medical record reviews and adjudications by physician reviewers identifies the instances when death, ED visits, adverse drug reactions, and readmissions were due to medical management. Unfortunately, these studies are often restricted (due to logistical and funding constraints) to sample sizes below the threshold needed to support analysis of socio-demographic differences in patient risk of adverse events [15,16]. Moreover, publication biases towards significant results documented by some [17-19] may result in these results not being emphasized or discussed at length.

Forster's approach departed from previous attempts at estimating adverse events by stipulating that not all negative events following a hospitalization were due to negligence, poor management of patients, and miscommunication among healthcare professionals. In defining postdischarge adverse events as "injuries caused by medical management, rather than by the underlying disease or condition of the patient", Forster and colleagues changed the standard of how adverse events were considered. By acknowledging that "medical management" had to be an integral component of the definition of adverse events, it is possible to locate within the patient case file the factors that may be associated with poor patient outcomes.

Materials and Methods

In this article we examine the socio-demographic predictors from patient safety studies to determine whether there is increased risk of adverse events after discharge in certain patient populations. We began

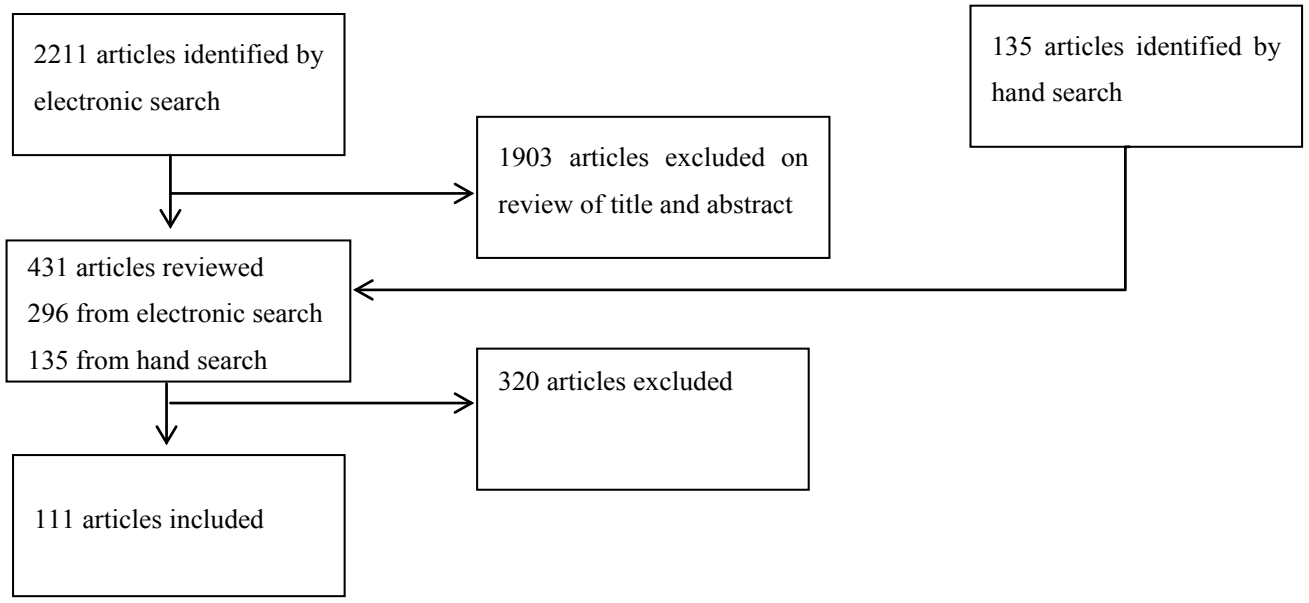

Figure 1: Collected, excluded and included citations.

our evidence acquisition with literature searches on PubMed Central, limiting our search to English-language articles published from 1958 to April 2014. Additionally, we hand searched reference lists of relevant articles, using the following criteria, originally utilized by Tsilimingras and Bates [20]:

1. Studies that examined adverse events and medical errors after discharge from the hospital to home
2. Discontinuities in transition care (e.g. abnormal test results after hospital discharge)
3. Discharge planning from the hospital to home
4. Interdisciplinary, care transition, nurse team coordination, and home-based interventions after discharge from the hospital to home
5. Medication reconciliation

Additionally, our keyword searchers were as follows:

1. Postdischarge/ambulatory/outpatient/general practice/clinic adverse events and medical errors
2. Nurse team coordinator/home-based intervention/care transition intervention/multidisciplinary intervention/with and without heart failure
3. Discharge planning from the hospital to home/postdischarge/outpatient
4. Discontinuities in transition care/abnormal test results/postdischarge/outpatient/ambulatory
5. Medication reconciliation

We reviewed articles that meet the methodological criteria offered by Forster and colleagues, as well as those that did not. We reported findings from studies that included variables such as age, sex, race/ethnicity, socioeconomic status (SES), mental health, social support, and comorbidities.

We identified 2211 articles in our initial search of the PubMed database, of which 296 were included for full review (see Figure 1). Hand searches of reference lists of other relevant articles produced an additional 135 articles for full review. After excluding 320 articles that did meet inclusion criteria or for being duplicates, 111 were ultimately included in our review.

Results

Age

Despite its ease of collection and interpretation, the patient safety literature has not universally documented the relationship between age and risk of postdischarge adverse events. Some studies demonstrated no statistically significant differences in patient age and risk of adverse events [6,21]. There may be a reason to exercise caution in the interpretation of the lack of age effects suggested by these studies. The non-relationships reported by Forster, et al. and Gandhi, et al. [6,21] may be an artifact of their analyses being underpowered. Because their articles represented a time and resource heavy methodology that improved upon prior patient safety research (many of which relied on analyses of administrative data), their studies included fewer participants. This may have precluded them from establishing statistical power for analyses on age on other socio-demographic characteristics.

Other research has identified a positive relationship between age and likelihood of postdischarge adverse events, particularly adverse drug reactions, increased healthcare utilization, and mortality [4,14,22-29]. In considering age, it is important to note that much of the excess risk for older patients is related to medication use.

Several studies found that elderly patients have a higher risk for ADEs than younger patients [26,30-34].

Increased vulnerability of the elderly for adverse drug events has been documented widely as a cause for concern; with several studies urging caution in prescribing for elderly patients [35-46]. Comparing patients older than 30 years of age to those younger than 30, Benkirane, et al. [8] found that the former had a lower risk for ADEs than the latter. One in six hospital admissions among older adults were due to an adverse drug event, many of which were common and preventable [24,47].

Some studies on health care utilization as an outcome have reported conflicting results. Iezzoni, et al. [48] found increased odds of older patients developing medical complications, which require increased healthcare utilization. Other research has shown that elderly patients were more likely to require an emergency department visit or readmission after discharge [29,49-58].

Findings are inconsistent, as other research has documented no such association [59,60] or that younger patients the greater risk of adverse events. This was the case for Ryvicker, et al. [61], who identified less risk of 60-day readmission for older patients than for younger ones, using the Care Transition Measure algorithm.

Several studies examined the relationship between age and mortality as an adverse event. Consistently, these studies demonstrated positive associations between age and death following discharge from the hospital [52,62-64]. The reasons for the excess mortality of older patients following discharge are unknown. It is possible that this relationship reflects the increased vulnerability with age that is demonstrated universally in population studies.

The influence of age on postdischarge adverse events might been understood in the context of the physiological alterations caused by aging that affect the therapy options available to physicians [65-67]. It may be that older age influences sensitivity to alterations in homeostasis caused by medical care, where older patients may be more greatly affected by changes in diet and sleep routine that occur during hospitalization. This would make them particularly vulnerable during the postdischarge period. Others have suggested that the increased risk of adverse events for this population is related to rates of noncompliance with discharge instructions for medications or diet, inadequate patient education and discharge planning, as well as poor social support [68].

Sex

The results on the influence of gender for adverse events have been inconsistent. Several patient safety studies documented no relationship between sex and risk of postdischarge adverse events [4,6,21,33,69]. With the exception of Brennan, et al. [4] and Bates, et al. [33], the majority of these studies utilized relatively small samples; comprising fewer than 700 participants and finding no statistical association between sex and risk of adverse events. However, as Freiman, et al. [70] cautioned, not detecting a relationship isn't the equivalent of detecting no relationship; some studies may simply be underpowered and not reliable for reporting on the impact of gender. We assert that the greater number of participants utilized by Brennan, et al. [4] and Bates, et al. [33], n = 7743 and 2019, respectively, provides ample evidence that at least some portion of the medical literature found no statistical no association between gender and likelihood to experience an adverse event.

Studies utilizing patient populations outside the US found some gender differences in AES. Davis, et al. [22] found that 36% of AEs for women and 38.5% of AES for men scored a four or higher in a 10-question item on preventability in a retrospective review of 6579 randomly sampled records from generalist admissions in Australia in 1998. In two other studies, Jarvinen, et al. [64] and Benkirane, et al. [71] found a higher risk of ADEs for women. However, Trifiro, et al. [32] found no such association.

For adverse events associated with health service utilization, conclusions about the role of gender were mixed. Some have suggested no gender-related excess risk of increased health service utilization, ED visits, or readmissions following discharge [59,60,72]. Others, however, documented gender differences in health service utilization.

Women were less likely than men to complete follow-up appointments after discharge [73], which may increase their risk of experiencing a postdischarge adverse event when compared to men. Budnitz, et al. [26] found that women were more likely than men to have ED visits for ADEs. Men and women seem to differ in their lengths of stay, where Philbin, et al. [74] determined that women stayed in hospital 9.8 days, compared to 9.2 days for men. Further, Babyan, et al. [75] found higher readmission rates for patients with ischemic heart failure in women, but not for men.

Conversely, other research has reported excess risk of higher rates of healthcare utilization for men than for women. Boult, et al. [51] and Krumholz, et al. [76] found that men were more likely to be readmitted following discharge than women. This was confirmed by Silverstein, et al. [58], who determined men had higher risk of readmission within 30 days of index hospitalization.

Regarding mortality, Philbin, et al. [77] suggested that female congestive heart failure patients (CHF) were less likely to die following discharge than male patients. This was confirmed later by Salaszar, et al. [62] who documented lower odds of mortality for female patients than for male patients.

Race/Ethnicity

The results on the influence of race and ethnicity on

adverse events have been inconsistent. Several patient safety studies documented no relationship between sex and risk of postdischarge adverse events [4,6,21,69]. This was the case for adverse drug events, where Bates, et al. [33], found no substantial contribution of race or ethnicity for explaining risk of ADEs.

Certain racial and ethnic differences have been identified in health service utilization. Pines, et al. [72] found that African-American and white patients had similar odds of having a re-admission, but Krumholz, et al. [76] suggested it was whites who had the excess odds of being readmitted, compared to non-whites. Kind, et al. [54] found that African-American patients were more likely to experience one or more complicated transitions and return to the emergency department when compared to white patients. This was reflected in later studies by Silverstein, et al. [58] and Philbin, et al. [77], the latter of which found blacks had higher odds of re-admission following discharge than whites. Philbin and colleagues [77] also documented longer length of stays for blacks and whites, suggesting that blacks tended to return to the hospital after whites and were likely sicker and in worse health, which would require longer stays in hospital. Studies published by Friedman, et al. and Kassin, et al. [59,60] failed to find significant increased risk of readmission on the basis of race.

Regarding mortality, some studies have documented a higher risk of 30-day postdischarge mortality for African-Americans [78] and higher odds of complications for whites [48]. Others however, came to different conclusions, finding that blacks had lower rates of mortality in the postdischarge period [74].

Socioeconomic Status (SES)

Lower SES has been consistently related to increased healthcare utilization in several studies. Both Weissman, et al. and Marcantonio, et al. [79,80] documented increased risk of hospital readmission for individuals with lower SES. Others studies documented higher odds of early readmission for less educated and low income patients [49,56,81]. Among heart failure patients in New York, Philbin, et al. [82] found that low income was a positive predictor for readmission. Coleman, et al. [83] found that patients with higher SES were more likely to experience uncomplicated transitions of care, moving from higher to lower intensity care. This is in contrast to their lower SES peers, where patients experienced complicated transitions, moving from lower to higher intensity care.

Socioeconomic status may be causally related to healthcare utilization. In considering education as a proxy for SES, less educated individuals have less understanding of postdischarge instructions, which may place them at greater risk of hospital readmission and additional ED visits. This was documented by Davis, et al. [84], who investigated the role of patient understanding and prescription label instructions. They found that patients with low levels of literacy were more likely to misinterpret medication instructions. The implications for this are stark; the IOM cited poor patient comprehension and subsequent medication misuse as integral in medication errors and other negative health outcomes (2006) [85].

In terms of mortality risk, findings have been consistent. Long-term mortality risk was shown to be higher for low SES patients compared to higher SES patients by as much as 1-7.5 years after discharge [86,87]. This suggests that there are real consequences for social inequality on patient safety.

Family social support

Findings on the influence of social support on postdischarge adverse events are mixed. Gall and Bull [88] found that 30% of patients discharged from hospitals would have been unable to take care of themselves once home. Preyde and Chapman [89] found that elderly patients faced a number of challenges upon discharge, including difficulty with personal and household activities. In this vulnerable state, social support from friends, family, and neighbors ensures that patients adhere to postdischarge instructions and care. Some studies have shown that lacking this kind of support increases the odds of return visits to the ED and readmissions increased health service utilization [51,81,90,91].

However, other research has shown that some social support actually increases the risk of readmission. For example, in their 2010 study, Hasan and colleagues documented excess readmissions for married patients, compared to those who were not married (2010) [92]. What this may suggest is that social support has multidimensional effects on the health of recently discharged hospital patients.

Krumholz [93] suggested that many patients suffer from a transient condition called “post-hospital syndrome”, which is a state of acquired, continued vulnerability extending into the postdischarge period. This condition afflicts patients who have been subject to disruptions in their normal sleep, food, and medication routines. Social support may be an important component of recovery for recently discharged patients who arrive home suffering from post-hospital syndrome as well as the lasting effects of what caused their hospitalization in the first place.

Spouses become advocates when their partners are not well. Patients with adequate social support may be more likely to seek out increased healthcare utilization because they are urged to do so by their advocates. If this were true, one would expect rebound rises in readmission rates after 30 days, which Hasan, et al. [92] did not find. It may be that the benefits of social support for patients in the postdischarge period is its influence on components of mental health, like self-efficacy may have a strong influence in the health and recovery of patients in the postdischarge period.

It is possible social support is not as important for post-discharge adverse events as functional ability. There is a well-established relationship between self-management skills/abilities and outcomes such as healthcare utilization [94], and mortality [95]. Much of this research suggests that individuals with functional decline, unmet functional need, cognitive impairment, and deficits in self-management skills tend to experience higher levels of disability and healthcare utilization [49,52,81,90,96].

It is possible that social support is merely an indicator of functional status whereby patients with greater independence and functional ability require less social support and vice versa. These two considerations of the role of social support for risk of postdischarge adverse events may explain why some studies demonstrate positive effects and others negative effects. However, other than increased risk of postdischarge health care utilization, there is a lack of direct evidence for the impact of lack of social supports on postdischarge adverse events. Therefore, it is impossible to know the true relationship between social support and postdischarge adverse events.

Mental health

Relatively few studies have investigated the influence of mental health on risk of adverse events. One reason for this is the multi-dimensional impact that poor mental health has on physical health, primarily through behavior and lifestyle factors. An important component of patient safety; health seeking behavior, is influenced by mental health. This requires patients be aware of changes in their physical health, in order to report to physicians that they are experiencing problems they are experiencing after discharge from the hospital. Robson, et al. [97] suggested that serious mental illness impacts patient health and likelihood of readmission through help-seeking behavior. Others, such as Jeste, et al. [98] noted that patients with some types of mental illness are less likely to report physical symptoms they experience. Other symptoms of serious mental illness like schizophrenia have symptoms that mask the symptoms of medical mismanagement like pain, which can indicate an adverse event such as a medication error [99]. For example, cognitive impairments due to medication might be indistinguishable from those impairments that occur naturally in patients with schizophrenia [100].

Other studies such as Drake, et al. [101] and Sullivan, et al. [102], focused on the influence of mental illness and substance abuse on healthcare utilization, finding substance abuse to be an independent risk factor for rehospitalization. Yellowlees [103] suggested that the needs for caring for these types of patients may exceed capabilities of the healthcare system and that appropriate targeted resources and assertive, continuous case management would be key to reducing readmissions among this population.

More recently, Davydow, et al. [104] investigated neuropsychiatric disorders and potentially preventable hospitalizations, finding that patients with depression, cognitive impairments without dementia, and dementia were independently associated with potentially preventable hospitalizations in older Americans. This expanded previous research by Burke, Donze, and Schnipper (2013), who found that patients who were prescribed anxiolytics (drugs that inhibit anxiety) and those prescribed two or more outpatient psychiatric medications had increased odds of all-cause readmission. Individuals with depression and substance abuse diagnoses were less likely to be readmitted following discharge.

Comorbidities

Findings on the influence of poor chronic health related to adverse events were also inconclusive. Using Charlson morbidity index scores, Forster, et al. [6] found that patients with poorer chronic health, as measured by more comorbidities did not have a higher risk of experiencing a postdischarge adverse event. Similar conclusions were reached by van Walraven, et al. [105], who used the Charlson scores in conjunction with other indicators to index probability to predict early death or readmission after discharge. More recently, Donze, et al. [106,107], found that while comorbidity rates did not predict early readmission, certain health conditions were related to potentially avoidable readmission, including cancer, heart failure, and chronic renal failure.

Others, however, have documented the influence of poor overall health on risk of adverse events, finding that less healthy patients had increased odds of adverse outcomes such as higher mortality and more health care utilization, including complicated transitions, readmissions, and frequent emergency department visits [54,62,72,76,108]. We conclude that there is much that is still unknown about the relationship between comorbidities and risk of adverse events, since patient safety literature is inconsistent.

Conclusion

From a socio-demographic perspective, much is unknown about the characteristics of patients who experience postdischarge adverse events. Considering the four main types of patient safety indicators (adverse events, adverse drug events, increased healthcare utilization, and mortality), we have documented inconsistent and conflicting results across most characteristics we examined (see Table 1). Findings for postdischarge mortality reflect what is known about the health of various demographic groups, such as higher mortality rates among the elderly, males, those with greater morbidity, and likely African Americans and those of lower SES. We find the most consistent results were those for SES, where we found that higher SES was associated with lower risk less healthcare utilization and lower mortality.

Table 1: Summary of findings from literature review.

Variable	AE	ADE	Utilization	Mortality
Age	Inconsistent	Consistent +	Conflicting	Consistent +
Gender	None	Inconsistent	Inconsistent	Consistent M
Race	None	NA	Inconsistent	Consistent AA
SES	None	NA	Consistent -	Consistent -
Social Support	NA	NA	Consistent -	NA
Comorbidity	Inconsistent	NA	Consistent +	Consistent +

Consistent: Most or all studies show a relationship in the same direction between that variable and outcome

+: Positive relationship between variable and outcome (e.g., greater age and higher ADE risk)

-: Negative relationship between variable and outcome (e.g., lower SES and higher health care utilization)

M: Higher risk (e.g., mortality) among males

AA: Higher risk (e.g., mortality) among African Americans

Inconsistent: Some studies show relationship in one direction, others show no relationship

Conflicting: Some studies show relationship in one direction, others show relationship in opposite direction

NA: No studies available for that variable-outcome relationship

However, as previously noted, much of the patient safety research is not adequately powered to support statistical analysis of the socio-demographic characteristics of patients who experience postdischarge adverse events. We contend that this presents missed opportunities to decrease postdischarge adverse events through greater understanding of the risks that increase patient vulnerabilities to such events. Understanding socio-demographic groups at greatest risk of poor patient safety outcomes, will allow the patient safety community to begin quantifying the variables that predict response to interventions meant to reduce postdischarge adverse events.

We assert that there are two main ways to improve the state of research on socio-demographic characteristics of patients who experience postdischarge adverse events. The first is by increasing study populations in primary data collection efforts. As we have noted previously, the threshold for establishing causal associations among sociodemographic variables and medical characteristics is quite high. We contend that researchers using an interdisciplinary approach to the problem of patient safety are likely to adequately power their studies in order to determine the effect that sociodemographic characteristics have on postdischarge adverse events.

Our second suggestion involves the continued utilization of administrative and patient data to develop sophisticated algorithms for detecting trends and patterns in patient outcomes. Obviously, such endeavors should utilize sociodemographic data to determine whether readmissions, ED visits, adverse drug events, and deaths are related to poor patient safety. Analyses using these data would allow for the creation of "profiles of risk" that index patients in terms of vulnerabilities they represent following discharge from the hospital.

The first of these may not feasible for many investigators doing patient safety research. This is due to the high cost of conducting primary research with participant interview and chart review by expert adjudicators. The latter requires more consistent risk estimates based findings from adequately powered patient safety studies.

Until these are more widely available, it may be necessary to take a "big data" approach to this problem, combining multiple datasets across various realms in patients' lives. Innovative analytical solutions to this problem may require not only the medical and medication related data already available from large healthcare systems, but also that which may be gleaned from other data sources.

As noted previously, many of the studies that rigorously defined postdischarge adverse events were small in terms of study populations, and may have been not powered adequately to demonstrate significantly statistical differences among various demographic groups. Additionally, this review is limited by the wide range of variable definitions across studies. We found that definitions of exposure variables and outcomes differed greatly, precluding the use of meta-analysis to summarize the findings. Chaudhry, et al. [63] noted great difficulty in considering definitions of errors suggesting that the lack of consensus regarding definitions of "error", "adverse event", and "near miss" made direct comparisons of their rate of errors with those in other studies difficult. Standardized definitions and operationalization of key variables would assist in such future endeavors.

References

1. (2002) Institute of Medicine (US) Committee on Quality of Health Care in America. In: Kohn LT, Corrigan JM, Donaldson MS, To Err is Human: Building a Safer Health System.
2. (2001) Institute of Medicine (US) Committee on Quality of Health Care. Crossing the quality chasm: A new health system for the 21st century. National Academies Press.
3. Thomas EJ, Studdert DM, Newhouse JP, Brett ZW, Howard KM, et al. (1999) Costs of Medical Injuries in Utah and Colorado. Inquiry 36: 255-264.
4. Brennan TA, Leape LL, Laird NM, Hebert L, Localio AR, et al. (2004) Incidence of adverse events and negligence in hospitalized patients: Results of the Harvard Medical Practice Study I. 1991. Qual Saf Health Care 13: 145-151.

5. Johnson WG, Brennan TA, Newhous JP, Leape LL, Lawthers AG (1992) The economic consequences of medical injuries: Implications for a no-fault insurance plan. JAMA 267: 2487-2492.
6. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW (2003) The incidence and severity of adverse events affecting patients after discharge from the hospital. Ann Intern Med 138: 161-167.
7. Marmot MG (2006) Status syndrome: A challenge to medicine. JAMA 295: 1304-1307.
8. Rogers RG, Hummer RA, Nam CB (1999) Living and Dying in the USA: Behavioral, Health, and Social Differentials of Adult Mortality. Elsevier.
9. Link BG, Phelan J (1995) Social conditions as fundamental causes of disease. J Health Soc Behav 35: 80-94.
10. Bhalla R, Yongue BG, Currie BP (2012) Standardizing race, ethnicity, and preferred language data collection in hospital information systems: Results and implications for healthcare delivery and policy. J HealthC Qual 34: 44-52.
11. Hasnain-Wynia R, Pierce D, Pittman MA (2004) Who, when, and how: The current state of race, ethnicity, and primary language data collection in hospitals.
12. Iezzoni LI, Mackiernan YD, Cahalane MJ, Phillips RS, Davis RB, et al. (1999) Screening inpatient quality using post-discharge events. Med Care 37: 384-398.
13. Gandhi TK, Seger DL, Bates DW (2000) Identifying drug safety issues: from research to practice. Int J Qual Health Care 12: 69-76.
14. Forster AJ, Clark HD, Menard A, Dupuis N, Chernish R, et al. (2004) Adverse events among medical patients after discharge from hospital. CMAJ 170: 345-349.
15. Kadam P, Bhalerao S (2010) Sample size calculation. Int J Ayurveda Res 1: 55-57.
16. Kagawa-Singer M (2006) Population science is science only if you know the population. J Cancer Educ 21: S22-S31.
17. Easterbrook P, Gopalan R, Berlin J, Matthews D (1991) Publication bias in clinical research. Lancet 337: 867-872.
18. Dickersin K, Chan S, Chalmers TC, Sacks HS, Smith Jr H (1987) Publication bias and clinical trials. Control Clin Trials 8: 343-353.
19. Begg, CB, Berlin JA (1989) Publication bias and dissemination of clinical research. J Natl Cancer Inst 81: 107-115.
20. Tsilimingras D, Bates DW (2008) Addressing postdischarge adverse events: A neglected area. Jt Comm J Qual Patient Saf 34: 85-97.
21. Tejal K Gandhi, Saul N Weingart, Joshua Borus, Andrew C Seger, Josh Peterson M, et al. (2003) Adverse drug events in ambulatory care. N Engl J Med 348: 1556-1564.
22. Davis P, Lay-Yee R, Briant R, Ali W, Scott A, et al. (2003) Adverse events in New Zealand public hospitals II: Preventability and clinical context. N Z Med J 116: 624.
23. Rothschild JM, Bates DW, Leape LL (2000) Preventable medical injusires in older patients. Arch Intern Med 160: 2717-2728.
24. Beijer HJM, de Blaey CJ (2002) Hospitalisations caused by adverse drug reactions (ADR): A meta-analysis of observational studies. Pharm World Sci 24: 46-54.
25. Mangoni AA, Jackson SH (2004) Age-related changes in pharmacokinetics and pharmacodynamics: Basic principles and practical applications. Br J Clin Pharmacol 57: 6-14.
26. Budnitz DS, Pollack DA, Weidenbach KN, Mendelsohn AB, Schroeder TJ, et al. (2006) National surveillance of emergency department visits for outpatient adverse drug events. JAMA 296: 1858-1866.
27. Van der Hooft CS, Jong GW, Dieleman JP, Verhamme KM, van der Cammen TJ, et al. (2005) Inappropriate drug prescribing in older adults: The updated 2002 Beers criteria--a population-based cohort study. Br J Clin Pharmacol 60: 137-144.
28. Cresswell KM, Fernando B, McKinstry B, Sheikh A (2007) Adverse drug events in the elderly. Br Med Bull 83: 259-274.
29. Hastings SN, Oddone EZ, Fillenbaum G, Sloane RJ, Schmader KE (2008) Frequency and predictors of adverse health outcomes in older Medicare beneficiaries discharged from the emergency department. Med Care 46: 771-777.
30. Stuck AE, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, et al. (1994) Inappropriate medication use in community-residing older persons. Arch Intern Med 154: 2195-2200.
31. Straand J, Rokstad KS (1999) Elderly patients in general practice: Diagnoses, drugs and inappropriate prescriptions. A report from the Møre & Romsdal Prescription Study. Fam Pract 16: 380-388.
32. Trifirò G, Calogero G, Ippolito FM, Cosentino M, Giuliani R, et al. (2005) Adverse drug events in emergency department population: A prospective Italian study. Pharmacoepidemiol Drug Saf 14: 333-340.
33. Bates DW, Miller EB, Cullen DJ, Burdick L, Williams L, et al. (1999) Patient risk factors for adverse drug events in hospitalized patients. ADE prevention study. Arch Intern Med 159: 2553-2560.
34. Classen DC, Pestonik SL, S Evans, Burke JP (1991) Computerized surveillance of adverse drug events in hospital patients. JAMA 266: 2847-2851.
35. Beers MH (1997) Explicit criteria for determining potentially inappropriate medication use by the elderly. An update. Arch Intern Med 157: 1531-1536.
36. Akazawa M, Imai H, Igarashi A, Tsutani K (2010) Potentially inappropriate medication use in elderly Japanese patients. Am J Geriatr Pharmacother 8: 146-160.
37. Buck MD, Atreja A, Brunker CP, Jain A, Suh TT, et al. (2009) Potentially inappropriate medication prescribing in outpatient practices: Prevalence and patient characteristics based on electronic health records. Am J Geriatr Pharmacother 7: 84-92.
38. Budnitz DS, Shehab N, Kegler SR, Richards CL (2007) Medication use leading to emergency department visits for adverse drug events in older adults. Ann Intern Med 147: 755-765.
39. Chen YC, Hwang SJ, Lai HY, Chen TJ, Lin MH, et al. (2009) Potentially inappropriate medication for emergency department visits by elderly patients in Taiwan. Pharmacoepidemiol Drug Saf 18: 53-61.
40. Gallagher P, O'Mahony D (2008) STOPP (Screening Tool of Older Persons' potentially inappropriate Prescriptions): Application to acutely ill elderly patients and comparison with Beers' criteria. Age Ageing 37: 673-679.
41. Lin HY, Liao CC, Cheng SH, Wang PC, Hsueh YS (2008) Association of potentially inappropriate medication use with adverse outcomes in ambulatory elderly patients with chronic diseases: Experience in a Taiwanese medical setting. Drugs Aging 25: 49-59.

42. Lindley CM, Tully MP, Paramsothy V, Tallis RC (1992) Inappropriate medication is a major cause of adverse drug reactions in elderly patients. Age Ageing 21: 294-300.

43. Meurer WJ, Potti TA, Kerber KA, Sasson C, Macy ML, et al. (2010) Potentially inappropriate medication utilization in the emergency department visits by older adults: Analysis from a nationally representative sample. Acad Emerg Med 17: 231-237.

44. Sikdar KC, Dowden J, Alaghehbandan R, MacDonald D, Peter P, et al. (2012) Adverse drug reactions in elderly hospitalized patients: a 12-year population-based retrospective cohort study. Ann Pharmacother 46: 960-971.

45. Unroe KT, Pfeiffenberger T, Riegelhaupt S, Jastrzembski J, Lokhnygina Y, et al. (2010) Inpatient medication reconciliation at admission and discharge: A retrospective cohort study of age and other risk factors for medication discrepancies. Am J Geriatr Pharmacother 8: 115-126.

46. Viswanathan H, Bharmal M, Thomas J 3rd (2005) Prevalence and correlates of potentially inappropriate prescribing among ambulatory older patients in the year 2001: Comparison of three explicit criteria. Clin Ther 27: 88-99.

47. Gurwitz JH, Field TS, Harrold LR, Rothschild J, Debellis K, et al. (2003) Incidence and preventability of adverse drug events among older persons in the ambulatory setting. JAMA 289: 1107-1116.

48. Iezzoni LI, Daily J, Heeren T, Foley SM, Fisher ES, et al. (1994) Identifying complications of care using administrative data. Med Care 32: 700-715.

49. Arbaje AI, Wolff JL, Yu Q, Powe NR, Anderson GF, et al. (2008) Postdischarge environmental and socioeconomic factors and the likelihood of early hospital readmission among community-dwelling Medicare beneficiaries. Gerontologist 48: 495-504.

50. Corrigan JM, Martin JB (1992) Identification of factors associated with hospital readmission and development of a predictive model. Health Serv Res 27: 81-101.

51. Boult C, Dowd B, McCaffrey D, Boult L, Hernandez R, et al. (1993) Screening elders for risk of hospital admission. J Am Geriatr Soc 41: 811-817.

52. Sager Ma, Rudberg Ma, Jalaluddin M, Franke T, Inouye SK, et al. (1996) Hospital admission risk profile (HARP): Identifying older patients at risk for functional decline following acute medical illness and hospitalization. J Am Geriatr Soc 44: 251-257.

53. Bigby J, Dunn J, Goldman L, Adams JB, Jen P, et al. (1987) Assessing the preventability of emergency hospital admissions. A method for evaluating the quality of medical care in a primary care facility. Am J Med 83: 1031-1036.

54. Kind AJ, Smith MA, Frytak JR, Finch MD (2007) Bouncing back: Patterns and predictors of complicated transitions 30 days after hospitalization for acute ischemic stroke. J Am Geriatr Soc 55: 365-373.

55. Halfon P, Eggli Y, van Melle G, Chevalier J, Wasserfallen JB, et al. (2002) Measuring potentially avoidable hospital readmissions. J Clin Epidemiol 55: 573-587.

56. Kark E, Hopp C (1970) A follow-up study of patients discharged from a Jerusalem hospital. Med Care 8: 510-522.

57. Hamner JB, Ellison KJ (2005) Predictors of hospital readmission after discharge in patients with congestive heart failure. Heart Lung 34: 231-239.

58. Silverstein MD, Qin H, Mercer SQ, Fong J, Haydar Z (2008) Risk factors for 30-day hospital readmission in patients ≥ 65 years of age. Proc (Bayl Univ Med Cent) 21: 363-372.

59. Friedman JM, Jensen GL, Smiciklas-Wright H, McCamish MA (1997) Predicting early nonelective hospital readmission in nutritionally compromised older adults. Am J Clin Nutr 65: 1714-1720.

60. Kassin MT, Owen RM, Perez SD, Leeds I, Cox JC, et al. (2012) Risk factors for 30-day hospital readmission among general surgery patients. J Am Coll Surg 215: 322-330.

61. Ryvicker M, McDonald MV, Trachtenberg M, Peng TR, Sridharan S, et al. (2013) Can the care transitions measure predict rehospitalization risk or home health nursing use of home healthcare patients? J HealthC Qual 35: 32-40.

62. Salazar A, Bardés I, Juan A, Olona N, Sabido M, et al. (2005) High mortality rates from medical problems of frequent emergency department users at a university hospital tertiary care centre. Eur J Emerg Med 12: 2-5.

63. Brown HA, Sullivan MC, Gusberg RG, Dardik A, Sosa JA, et al. (2013) Race as a predictor of morbidity, mortality, and neurologic events after carotid endarterectomy. J Vasc Surg 7: 1325-1330.

64. Järvinen O, Huhtala H, Laurikka J, Tarkka MR (2003) Higher age predicts adverse outcome and readmission after coronary artery bypass grafting. World J Surg 27: 1317-1322.

65. Hanlon JT, Fillenbaum GG, Burchett B, Wall WE Jr, Service C, et al. (1992) Drug-use patterns among black and nonblack community-dwelling elderly. Ann Pharmacother 26: 679-685.

66. Livingston MG, Livingston HM (1999) New antidepressants for old people? BMJ 318: 1640-1641.

67. Pretorious RW, Gataric G, Swedlund SK, Miller JR (2013) Reducing the risk of adverse drug events in older adults. Am Fam Physician 87: 331-336.

68. Rich MW, Vinson JM, Sperry JC, Shah AS, Spinner LR, et al. (1993) Prevention of readmission in elderly patients with congestive heart failure: Results of a prospective, randomized pilot study. J Gen Intern Med 8: 585-590.

69. Chaudhry SI, Olofinboba KA, Krumholz HM (2003) Detection of errors by attending physicians on a general medicine service. J Gen Intern Med 18: 595-600.

70. Freiman, JA, Chalmers TC, Smith H, Kuebler RR (1978) The importance of beta, the type II error and sample size in the design and interpretation of the randomized control trial. Survey of 71 “negative” trials. N Engl J Med 299: 690-694.

71. Benkirane R, Pariente A, Achour S, Ouammi L, Azzouzi A, et al. (2009) Prevalence and preventability of adverse drug events in a teaching hospital: A cross-sectional study. East Mediterr Health J 15: 1145-1155.

72. Pines JM, Mongelluzzo J, Hilton JA, Hollander JE, Shofer FS, et al. (2010) Postdischarge adverse events for 1-day hospital admissions in older adults admitted from the emergency department. Ann Emerg Med 56: 253-257.

73. Moore C, McGinn T, Halm E (2007) Tying up loose ends: Discharging patients with unresolved medical issues. Arch Intern Med 167: 1305-1311.

74. Philbin EF, DiSalvo TG (1998) Influence of race and gender on care process, resource use, and hospital-based outcomes in congestive heart failure. Am J Cardiol 82: 76-81.

75. Babayan ZV, McNamara RL, Nagajothi J, Kasper RK, Armenian HK, et al. (2003) Predictors of cause-specific hospital readmission in patients with heart failure. Clin Cardiol 26: 411-418.

76. Krumholz HM, Parent EM, Tu N, Vaccarino V, Wang Y, et

al. (1997) Readmission after hospitalization for congestive heart failure among Medicare beneficiaries. Arch Intern Med 157: 99-104.

77. Philbin EF, DiSalvo TG (1999) Prediction of hospital readmission for heart failure: Development of a simple risk score based on administrative data. J Am Coll Cardiol 33: 1560-1566.

78. Brown JR, Conley SM, Niles NW (2013) Predicting readmission or death after acute ST-Elevation myocardial infarction. Clin Cardiol 36: 570-575.

79. Weissman JS, Stern RS, Epstein AM (1994) The impact of patient socioeconomic status and other social factors on readmission: A prospective study in four massachusetts hospitals. Inquiry 31: 163-172.

80. Marcantonio ER, McKean S, Goldfinger M, Kleefield S, Yurkofsky M, et al. (1999) Factors associated with unplanned hospital readmission among patients 65 years of age and older in a Medicare managed care plan. Am J Med 107: 13-17.

81. Lledó R, Martín E, Jiménez C, Roca R, Gil A, et al. (1997) Characteristics of elderly inpatients at high risk of needing supportive social and health care services. Eur J Epidemiol 13: 903-907.

82. Philbin EF, Dec GW, Jenkins PL, DiSalvo TG (2001) Socioeconomic status as an independent risk factor for hospital readmission for heart failure. Am J Cariol 87: 1367-1371.

83. Coleman EA, Min S, Chomiak A, Kramer AM (2004) Post-hospital care transitions: Patterns, complications, and risk identification. Health Serv Res 39: 1449-1465.

84. Davis TC, Federman AD, Bass PF 3rd, Jackson RH, Middlebrooks M, et al. Improving patient understanding of prescription drug label instructions. J Gen Intern Med 24: 57-62.

85. Institute of Medicine (US) (2006) Committee on Identifying and Preventing Medication Errors. Preventing Medication Errors. National Academies Press.

86. Rathore SS, Masoudi FA, Wang Y, Curtis JP, Foody JM, et al. (2006) Socioeconomic status, treatment, and outcomes among elderly patients hospitalized with heart failure: Findings from the National Heart Failure Project. Am Heart J 152: 371-378.

87. Cserép Z, Losoncz E, Balog P, Szili-Török T, Husz A, et al. (2012) The impact of preoperative anxiety and education level on long-term mortality after cardiac surgery. J Cardiothorac Surg 7: 86.

88. Gall S, Bull J (2004) Clinical risk: Discharging patients with no-one at home. Gastroenterol Nurs 27: 111-114.

89. Preyde M, Chapman T (2007) Psychosocial profile of elderly patients discharged from a community hospital. Soc Work Health Care 45: 77-95.

90. Vinson JM, Rich MW, Sperry JC, Shah AS, McNamara T (1990) Early readmission of elderly patients with congestive heart failure. J Am Geriatr Soc 38: 1290-1295.

91. Franklin JL, Kittredge LD, Thrasher JH (1975) A Survey of factors related to mental hospital readmissions. Psychiatric Services 26: 749-751.

92. Hasan O, Meltzer DO, Shaykevich SA, Bell CM, Kaboli PJ, et al. (2010) Hospital readmission in general medicine patients: A prediction model. J Gen Intern Med 25: 211-219.

93. Krumholz HM (2013) Post-hospital syndrome--an acquired, transient condition of generalized risk. N Engl J Med 368: 100-102.

94. Wolinsky FD, Arnold CL (1988) A different perspective on health and health services utilization. Annu Rev Gerontol Geriatr 8: 71-101.

95. Hirvensalo M, Rantanen T, Heikkinen E (2000) Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population. J Am Geriatr Soc 48: 493-498.

96. Inouye SK, Viscoli CM, Horwitz RI, Hurst LD, Tinetti ME (1993) A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. Ann Intern Med 119: 474-481.

97. Robson D, Gray R (2006) Serious mental illness and physical health problems: A discussion paper. Int J Nurs Stud 44: 457-466.

98. Jeste DV, Gladsjo JA, Lindamer LA, Lacro JP (1996) Medical comorbidity in schizophrenia. Schizophr Bull 22: 413-430.

99. Dworkin RH (1994) Pain insensitivity in schizophrenia: A neglected phenomenon and some implications. Schizophr Bull 20: 235-248.

100. Phelen M, Stradins L, Morrison S (2001) Physical health of people with severe mental illness. BMJ 322: 443-444.

101. Drake RE, Wallach MA (1989) Substance abuse among the chronic mentally ill. Hosp Community Psychiatry 40: 1041-1046.

102. Sullivan G, Wells KB, Morgenstern H, Leake B (1995) Identifying modifiable risk factors for rehospitalization: A case control study of seriously mentally ill persons in Mississippi. Am J Psychiatry 152: 1749-1756.

103. Kent S, Yellowlees P (1994) Psychiatric and social reasons for frequent rehospitalization. Hosp Community Psychiatry 45: 347-350.

104. Davydow DS, Zivin K, Katon WJ, Pontone GM, Chwastiak L, et al. (2014) Neuropsychiatric disorders and potentially preventable hospitalizations in a prospective cohort study of older Americans. J Gen Intern Med 29: 1362-1371.

105. Van Walraven C, Dhalla IA, Bell C, Etchells E, Stiell IG, et al. (2010) Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. CMAJ 182: 551-557.

106. Donze J, Aujesky D, Williams D, Schnipper JL (2013) Potentially avoidable 30-day hospital readmissions in medical patients: Derivation and validation of a prediction model. JAMA Intern Med 173: 632-638.

107. Donze J, Lipsitz S, Bates DW, Schnipper JL (2013) Causes and patterns of readmissions in patients with common comorbidities: retrospective cohort study. BMJ 347: 7171.

108. Hastings SN, Purser JL, Johnson KS, Sloane RJ, Whitson HE (2008) Frailty predicts some but not all adverse outcomes in older adults discharged from the emergency department. J Am Geriatr Soc 56: 1651-1657.