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Marcum, Zachary
Liu, Christine
Jing, Bocheng
et al.

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Trends in Blood Pressure Diagnosis, Treatment, and Control among VA Nursing Home Residents, 2007–2018

Michelle C Odden, PhD[1,2], **Yongmei Li, PhD**[1], **Laura A. Graham, PhD**[3], **Michael A. Steinman, MD**[4,5], **Zachary A. Marcum, PharmD, PhD**[6], **Christine K. Liu, MD, MS**[2,7], **Bocheng Jing, MS**[5], **Kathy Z. Fung, MS**[5], **Carmen A Peralta, MD MAS**[8,9], **Sei J Lee, MD, MAS**[4,5]

[1.]Department of Epidemiology and Population Health, Stanford University, Stanford, CA

[2.]Geriatric Research Education and Clinical Center, VA Palo Alto Health Care System, Palo Alto, CA

[3.]Health Economics Resource Center, VA Palo Alto Health Care System, Palo Alto, CA

[4.]Division of Geriatrics, Department of Medicine, University of California San Francisco, San Francisco, CA

[5.]Geriatrics, Palliative, and Extended Care Service Line, San Francisco VA Medical Center, San Francisco, CA

[6.]Department of Pharmacy, University of Washington, Seattle, WA

[7.]Department of Medicine, Division of Primary Care and Population Health, Stanford University, Stanford CA

[8.]Kidney Health Research Collaborative, University of California San Francisco and San Francisco VA Medical Center, San Francisco, CA

[9.]Cricket Health, Inc

Abstract

Background: Inadequate treatment of high blood pressure (BP) can lead to preventable adverse events in nursing home residents, while excessive treatment can lead to associated harms.

Methods: Data were extracted from the VA electronic health record and Bar Code Medication Administration system on 40,079 long-term care residents aged ≥65 years from October 2006 through September 2018 (FY2007–2018). Hypertension prevalence at admission was identified by ICD code(s) in the year prior, and antihypertensive medication use was defined as administration ≥50% of days. BP measures were averaged over 2-year epochs.

Corresponding Author: Michelle C. Odden, PhD, Associate Professor, Dept. of Epidemiology & Pop. Health, Stanford University School of Medicine, 1701 Page Mill Road, Palo Alto, CA 94304, (650) 721-0230, modden@stanford.edu, @michelleodden.

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Results: The age-standardized prevalence of hypertension diagnosis at admission increased from 75.2% in FY2007–2008 to 85.1% in FY2017–2018 (p-value for trend <0.001). Rates of BP treatment and control among residents with hypertension at admission declined slightly over time (p-values for trend <0.001) but remained high (80.3% treated in FY2017–2018; 80.1% with average BP <140/90 mmHg). The age-adjusted prevalence of chronic low BP (average <90/60 mmHg) also declined from 11.1% in FY2007–2008 to 4.7% in FY2017–2018 (p-value for trend <0.001). Persons identified as Black race or Hispanic ethnicity and those with a history of diabetes, stroke, and renal disease were less likely to have average BP <140/90 mmHg.

Conclusions: Hypertension is well controlled in VA nursing homes, and recent trends of less intensive BP control were accompanied by lower prevalence of chronic low BP. Nonetheless, some high-risk populations have average BP levels >140/90 mmHg. Future research is needed to better understand the benefits and harms of BP control in nursing home residents.

Keywords

epidemiology; hypertension; blood pressure; prevalence

Introduction

Hypertension is a major modifiable risk factor for adverse cardiovascular outcomes, progression of kidney disease, and dementia.[1] Substantial literature exists on trends in hypertension awareness, treatment, and BP control in community dwelling individuals. For example, a recent study reported that levels of BP control in United States (U.S.) adults with hypertension, defined as <140/90 mmHg, increased throughout the early part of the millennium and reached a peak of 53.8% in 2013–2014 before declining to 43.7% in 2017–2018.[2] Trends in awareness were similar; the age-adjusted estimated proportion who reported that they were aware they had hypertension increased from 69.9% (95% CI, 65.9%−73.8%) in 1999–2000 to 84.7% (95% CI, 82.3%−87.1%) in 2013–2014 and then declined to 77.0% (95% CI, 73.5%−80.6%) in 2017–2018. These estimates are important for monitoring the health of the population and identifying inequities, as well as evaluating the effectiveness of risk factor control strategies.

In contrast, there is a paucity of data on hypertension diagnosis and management in nursing home residents. Appropriate hypertension management is a cornerstone of public health prevention and under treatment can lead to preventable adverse events, while over treatment can lead to treatment-associated harms. Previous epidemiologic studies have focused on the prevalence of hypertension diagnosis and lacked measures of BP control. For example, in one of the largest studies of nursing home residents, Gambassi and colleagues found that nearly 32% of approximately 300,000 patients admitted to long-term care between 1992–1994 had a diagnosis of hypertension, and 70% of those with hypertension were treated, although measured BP levels were unavailable.[3] The prevalence of hypertension diagnosis was higher in a 2004 study of 13,507 nursing home residents; 53% had a diagnosis of hypertension, and 84% of hypertensive residents had at least one antihypertensive medication prescribed, but measured BP levels were also unavailable.[4] Whether and how hypertension prevalence, treatment, and control has changed in nursing home residents over the past decade is unknown.

Optimal control of BP in older adults residing in nursing homes, who often have multiple chronic conditions, dementia, and diminished functional status, remains unclear.[5] Guidelines for the management of hypertension include cautionary statements or suggestions for higher BP targets in those who are frail or have a limited life expectancy.[6–9] In addition, there is growing interest in deprescribing of antihypertensive medications, which is a reduction in the number or dose of antihypertensive drugs.[5, 10–12] To better understand the potential population-level benefits of guidelines for the management of BP in nursing home residents, we first need a better understanding of the epidemiology of hypertension prevalence, treatment, and BP control in this population.

In this study, we describe the prevalence, pharmacologic treatment, and control of hypertension over time among older adults residing in VA nursing homes, which are known as community living communities (CLCs). We aim to characterize whether hypertension management has changed in nursing homes over the past decade. A secondary aim is to identify factors associated with BP levels <140/90 mmHg to identify populations who may have inadequate BP control. This study was conducted in a retrospective cohort of over 40,000 Veterans long-term CLC residents in the period October 2006 through September 2018.

Methods

Study Population

We constructed a retrospective cohort of residents in VA CLCs. Residents were included if they were admitted to a CLC ward between October 1, 2006, and September 29, 2018 (FY2007 – FY2018). Residents were excluded if they 1) had a CLC stay <90 days to exclude those undergoing post-acute rehabilitation; 2) were <65 years at admission; 3) had an acute hospital stay lasting >30 days during their CLC stay (those with hospital stays ≤ 30 days were included); or 4) had no BP measures recorded. CLCs provide both long-term and short-term care; the restriction to 90 or more days was intended to identify residents who received long-term care. Follow-up was censored at discharge, death, entry into hospice, or on September 30, 2018. This study received institutional review board approval with a waiver of informed consent from Stanford University and the VA Palo Alto Health Care System.

To evaluate differences over time, we divided the cohort into two-year fiscal year epochs: 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018. The open cohort design of our analysis was left censored at admission at or after October 1, 2006; therefore, the first epoch did not include any residents with a stay longer than two years. All subsequent epochs were open cohorts and thus residents could contribute to more than one epoch, although the majority (91.7%) contributed to one or two epochs.

Measures

The VA supports a network-wide national electronic health record with a master patient index that links all patients receiving care at all VA facilities. The primary data source for this study was the VA Corporate Data Warehouse (CDW) and CLC stays were

identified using validated methods.[13] The CDW is a comprehensive national repository of data from the electronic medical record at all VA facilities and several other VA clinical and administrative systems.[14] This repository provides detailed information on almost all data elements ascertained as part of clinical care at VA facilities since October 1999. This includes information on all inpatient and outpatient episodes of care within the VA, including related diagnoses and procedures, vital signs, laboratory values, and medications.[15–17]

Data on antihypertensive medication use were captured from the Bar Code Medication Administration (BCMA) system, which provide a granular assessment of each medication administered at a VA facility including in the CLC as well as any acute care hospital stays. Data include not only the date and time of administration but also the route, amount, and nurse notes regarding the medication administration. We evaluated BCMA medications to obtain information on medications that were administered and not just prescribed, but not given. Antihypertensive medications were identified by VA Drug Classification Code. We included orally administered beta-blockers, calcium channel blockers, angiotensin converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARB), diuretics, central alpha-blockers, vasodilators, and potassium-sparing diuretics.

The CDW Patient domain was used to determine patient age, gender, race, and ethnicity at the time of the CLC admission. CLC region was identified as one of five geographic regions of the U.S. based on aggregated Veterans Affairs Integrated Service Network (VISN) catchment areas: Pacific, Continental, Midwest, Southeast, and North Atlantic regions.[18] Diagnosis codes were obtained from the CDW Inpatient and Outpatient domains. Chronic conditions were identified using ICD-9-CM and ICD-10-CM diagnosis codes one year prior to and during the nursing home stay.[19] Body mass index was calculated based on recorded height and weight in the CDW. Data on cognitive function were obtained from the Medicare Minimum Data Set, which changed from 2.0 to 3.0 on October 1st, 2010. We used the Cognitive Function Scale to combine the cognitive assessment tools from MDS 2.0 and 3.0 into a single, integrated, 4-level assessment of cognitive function: cognitively intact, mildly impaired, moderately impaired, and severely impaired.[20]

Hypertension measures

A diagnosis of hypertension was identified based on ICD-9-CM codes 401.X-405.X and ICD-10-CM codes I10-I15. Hypertension at admission was defined as one or more code for hypertension in the CDW Inpatient or Outpatient domains in the year prior to admission; all residents had at least one code (not necessarily hypertension) during this time point, indicating that they interacted with the VA health care system and thus had the possibility of being diagnosed. We used two alternative definitions of hypertension defined in the year prior to admission: one or more code for hypertension or two or more measures of BP ≥ 140/90mmHg and two or more codes for hypertension.

Antihypertensive treatment was assessed based on the proportion of days on which any antihypertensives were received in each 2-year epoch. We identified the number of days Veterans resided in the nursing home in the respective epoch, based on their admission and discharge dates, and divided the days of antihypertensive use by the days of nursing home

stay. BP treatment was defined as use of one or more antihypertensive medication at least 50% of days spent in the nursing home stay in each 2-year epoch.

For BP control, we first examined BP values and removed implausible observations including diastolic value> systolic value, systolic value <40 mmHg or >270 mmHg, or diastolic value <10 mmHg or >170 mmHg. For patients with baseline hypertension, we averaged BP measures each week and then averaged over each 2-year epoch.

BP control was defined using three thresholds: 1) 140/90 mmHg, the guideline recommended by members of the 7th Joint National Committee[21] which is the current Healthcare Effectiveness Data and Information Set (HEDIS) quality guideline, 2) 130/80 mmHg, the ACC/AHA guideline[8], and 3) 150/90 mmHg, the ACP/AAFP guideline[9]. Chronic low BP was defined as an average BP <90/60 mmHg.

Statistical Analysis

To facilitate comparison of prevalence rates over time, we used direct age-standardization with Veterans admitted in FY2007-FY2008 as the standard population with the following age distribution: 65–69 (11.9%), 70–74 (15.3%), 75–79 (20.8%), 80–84 (26.3%), 85–89 (19.7%), and 90+ (6.0%) years.

To assess the time trend in prevalence rates, we used linear regression with binary outcomes (i.e., hypertension diagnosis, antihypertensive treatment, and BP control) and a time variable as a covariate. The time variable had consecutive values between 1 and 6, respectively representing 6 fiscal year epochs from FY2007-FY2008 to FY2017-FY2018. To assess factors associated with antihypertensive treatment and BP control, we used Poisson regression with robust variance estimator. We fit two sets of models, the first included demographic characteristics and the second added chronic health conditions. Data analyses were performed using SAS version 9.4 and Stata version 15.0.

Results

There were 40,079 Veterans who resided in a VA CLC for 90 days or longer between October 1, 2006, and September 30, 2018. The mean age at admission was 78 ± 8.5 years and 2.4% (n=952) were women. The population was majority White (74.3%), with 16.0% Black, 1.3% Asian/Pacific Islander, 0.5% American Indian, and 8.1% multiple races or missing race; 4.7% were of Hispanic ethnicity. The median length of stay in the CLC was 200 days (IQR 123–477). The other characteristics of the cohort at admission are described in Table 1.

The age-standardized prevalence of a diagnosis of hypertension at admission increased over time from 75.2% in FY2007–08 to 85.1% in FY2017–2018 (p-value for trend <0.001). (Table 2) The age-standardized rate of use of antihypertensive medication use also decreased over time from 87.2% in FY2007–2008 to 80.3% in FY2017–2018 (p-value for trend <0.001). (Table 2) When we expanded the definition of hypertension at admission to include undiagnosed hypertension identified by 2 or more measures of BP ≥ 140/90 mmHg in the year prior to admission, the prevalence of hypertension increased to over 95% in FY2017–

2018 (Supplemental Table 1). When we used a more conservative definition of 2 or more ICD codes in the year prior to admission, the prevalence of hypertension was lower (70.4% in FY2017–2018) and nearly constant over time. (Supplemental Table 2) The proportion of those who were on antihypertensive medication among those with hypertension decreased over time when using a definition of hypertension that included undiagnosed hypertension, and remained constant when we use the more conservative definition of 2 or more ICD codes in the prior year. (Supplemental Tables 1 and 2)

Rates of BP control among residents with hypertension at admission declined slightly over time (all p-values for trend <0.001). (Figure 1) Control of systolic BP below 150 mmHg exceeded 90% at all time points and dropped slightly from 95.1% in FY2007–08 to 94.3% in FY2017–2018 (p-value for trend <0.001). Control below the systolic BP threshold of 140 mmHg exceeded 80% at all time points and dropped from 83.4% to 80.2%; control below 130 mmHg dropped from 58.3% to 55.4% (both p-values for trend <0.001). Control of diastolic BP below 80 mmHg exceeded 90% at all time points. The prevalence of low diastolic BP (<60 mmHg) fell from 11.1% in FY2007–2008 to 4.7% in FY2017–2018 (p-value for trend <0.001). Rates of BP control compared with guideline recommendations were driven primarily by control of systolic BP (Figure S1). Rates of chronically low BP defined as <90/60 mmHg were driven primarily by low diastolic BP (Figure S1); the age-adjusted rate of systolic BP <90 mmHg remained well below 1% throughout follow-up.

Older age, year, and Hispanic ethnicity were associated with lower likelihood of medication use in demographic-adjusted models, and Black race was associated with higher likelihood of antihypertensive medication use. (Table 3) In fully-adjusted models, a history of cancer or dementia was associated with lower likelihood of medication use, whereas diabetes, stroke, heart failure, renal disease, and myocardial infarction were associated with higher likelihood of antihypertensive medication use.

In demographic-adjusted models, female gender, Black race, Hispanic ethnicity, and year were associated with lower likelihood of having BP <140/90 mmHg. (Table 4) In fully adjusted models, older age, diabetes, stroke, and renal disease were additionally associated with lower likelihood of controlled BP, whereas heart failure, cancer, and history of myocardial infarction were associated with higher likelihood of BP <140/90 mmHg.

Discussion

In this cohort study of more than 40,000 VA nursing home residents, we found that the prevalence of a hypertension diagnosis at the time of nursing home admission increased approximately 0.8% per year from 2007 to 2018, affecting more than 80% of residents. However, there were modest trends towards less antihypertensive medication use over this same period, and a decline in BP control at guideline levels. This change was accompanied by a decrease in chronic low BP in VA nursing home residents, declining by over 50% from 11.1% in FY2007–2008 to 4.7% in FY2017–2018.

Our study reports a higher prevalence of hypertension diagnosis compared with prior population-based studies of nursing homes in the U.S.,[3, 4] and we uniquely contribute

findings on BP control in this medically complex patient population. The increase in hypertension diagnoses over time suggests that screening and awareness are increasing in the VA health care system, although it could also be due to the pressure to document control of mild hypertensive disease to align with pay for performance measures.[22] The comparison with previous studies also lends support for the hypothesis that hypertension diagnosis is increasing over time, although these differences could also be due to differences in the characteristics of the study populations, or the method in which hypertension diagnoses were assessed. We used inpatient and outpatient records to capture hypertension diagnoses up to one year prior, compared with MDS or survey methods used in previous studies.[3, 4] Our findings are consistent with previous literature that demonstrates a high prevalence of antihypertensive treatment in nursing home residents, and we add to the literature by reporting data on BP control. Our estimates of BP control rates in the present study of VA nursing home residents were superior to community-dwelling adults. BP control <140/90 mmHg in U.S. adults peaked at 53.8% in 2013–2014 and declined to 43.7% in 2017–2018 based on data from the National Health and Nutrition Examination Survey (NHANES).[2] In our study, BP control <140/90 mmHg exceeded 80% throughout follow-up, although we note that ascertainment of hypertension and measurement of BP were different in NHANES and the present study.

Despite a high prevalence of BP control <140/90 mmHg, our findings also indicate a trend towards less intensive BP control, which may reflect an increased interest in medication reduction and deprescribing.[10–12] Although many residents benefit from BP control, less intensive intervention appears to be associated with lower prevalence of chronic hypotension in our study. Long-term care residents have been systematically excluded from randomized trials of BP lowering, and there are increased concerns about diminished effectiveness and greater adverse events due to frailty and multimorbidity in these individuals. In 2017, there were two major BP guidelines published that both acknowledged the lack of evidence in patients with dementia, diminished functional status, and those who reside in long-term care facilities.[8, 9] The targets for BP lowering were strikingly different in these two guidelines, with the ACC/AHA recommending a more intensive BP target of 130/80 mmHg,[8] and the ACP/AAFP recommending a target of 150/90 mmHg.[9] Nonetheless, they both highlighted that more research in long-term care residents and those with dementia is needed in order to better understand the benefits and potential unintended consequences of low blood pressure in this population.

Although the majority of residents had BP controlled below BP guideline levels, some residents had high BP. Persons identified in their health records as being of Black race or Hispanic ethnicity were less likely to have BP controlled <140/90 mmHg and those identified as Hispanic ethnicity were also less likely to be on antihypertensive medication. These differences are consistent with what has been observed in the community-dwelling population,[2] and likely reflect the structural inequities by race/ethnicity in the U.S. Older age was also associated with lower likelihood of treatment or control, although this may be due to concerns about comorbid frailty and other chronic conditions, which may modify the benefit-to-harm balance. Most chronic conditions were associated with a greater likelihood of treatment and control. Exceptions included cancer and dementia, which were associated with lower likelihood of antihypertensive medication use, perhaps due to limited life

expectancy. Diabetes, stroke, and renal disease were all associated with a lower likelihood of controlled BP; stroke and renal disease are consequence of high BP, so these patient populations may represent potential targets for interventions to improve BP control.

This is the first large-scale study of trends in hypertension prevalence, treatment, and control in nursing home residents in the U.S. Nonetheless, there are limitations that should be considered when interpreting the results. Primarily, the VA population of nursing home residents is different than the general U.S. population of nursing home residents; most notably, VA nursing home residents are predominantly male. Moreover, the Veterans Health Administration is a large, integrated health care system, which contrasts with the commonly fragmented long-term care options in the community. Taken together, our findings likely may not generalize to other long-term care facilities. We used ICD codes to identify residents with hypertension and may have missed undiagnosed hypertension or inadvertently included white coat hypertension. Our primary definition of hypertension at admission required only one ICD code for hypertension in the year prior to increase the sensitivity of our definition. Nonetheless, some misclassification likely remains, and we used two alternative definitions of hypertension in sensitivity analyses which alter the prevalence of hypertension. An additional limitation of this research is that BP levels represent nursing home as well as clinic measures and may include measurement error when compared to measures taken in a highly controlled setting, such as a randomized controlled trials. Despite that, these BP measures are what are used by clinicians and patients to make treatment decisions, so our results reflect real world clinical practice.

In summary, hypertension in common and BP is well-controlled in VA nursing home residents. There are modest trends towards reduction in antihypertensive medication use and BP control across the last decade. More research is needed to understand the benefits and potential unintended harms of BP control as well as antihypertensive deprescribing in nursing home residents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments:

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The funders of the study had no role in the design of the study, data analysis, interpretation of findings, or writing of the manuscript.

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Key Points

- The age-standardized prevalence of hypertension diagnosis at nursing home admission increased over the past decade to 85% in 2017–2018.
- Rates of blood pressure treatment and control among residents with hypertension at admission declined slightly over time but remained over 80%.
- Persons identified as Black race or Hispanic ethnicity and those with a history of diabetes, stroke, and renal disease were less likely to have blood pressure controlled to guideline levels.

Why Does this Paper Matter?

Blood pressure control is a cornerstone of cardiovascular prevention, and this is the first large study to examine trends in U.S. nursing home residents.

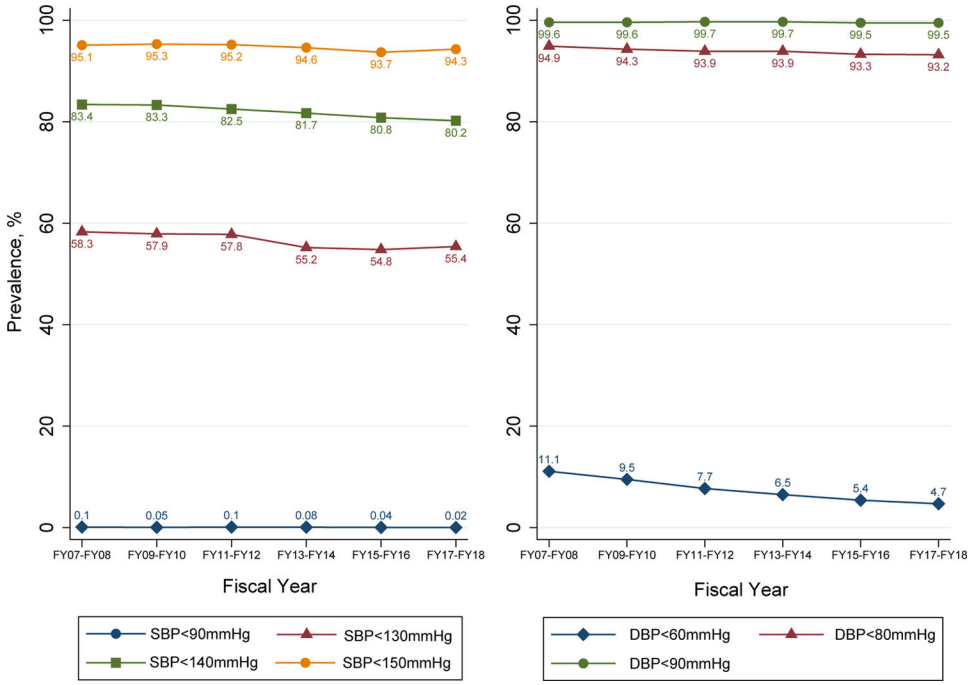

Figure 1:

Age-standardized Rates of BP Control among Patients with Hypertension at Admission, a) Systolic BP (left), b) Diastolic BP (right)

Table 1:

Characteristics of long-term VA nursing home residents in FY2007–2018

Characteristic	Mean (SD) or N (%) (N=40,079)
Age at NH admission (years)	78.2 (8.5)
Age groups	
65–69 years	8,600 (21.5%)
70–74 years	6,684 (16.7%)
75–79 years	6,455 (16.1%)
80–84 years	7,506 (18.7%)
85–89 years	6,828 (17.0%)
90+ years	4,006 (10.0%)
Female	952 (2.4%)
Race	
White	29,758 (74.3%)
Black	6,404 (16.0%)
Asian/Pacific Islander	499 (1.3%)
American Indian	186 (0.5%)
Multiple races	309 (0.8%)
Missing/Unknown	2,923 (7.3%)
Ethnicity	
Not Hispanic	37,087 (90.0%)
Hispanic	1,852 (4.6%)
Missing/Unknown	2,140 (5.3%)
Fiscal year of NH Admission	
FY2007-FY2008	7,177 (17.9%)
FY2009-FY2010	6,653 (16.6%)
FY2011-FY2012	6,459 (16.1%)
FY2013-FY2014	6,650 (16.6%)
FY2015-FY2016	6,982 (17.4%)
FY2017-FY2018	6,158 (15.4%)
Region	
Continental	5,127 (12.8%)
Midwest	9,599 (24.0%)
North Atlantic	12,323 (30.8%)
Pacific	6,576 (16.4%)
Southeast	6,345 (15.8%)
Missing	109 (0.3%)
NH length of stay (days), median (IQR)	200 (123–477)
Systolic BP (1st week, average)	127.3 (15.4)
Diastolic BP (1st week, average)	69.5 (8.1)
Baseline comorbidities:	

Characteristic	Mean (SD) or N (%) (N=40,079)
Hypertension	31,676 (79.0%)
Diabetes	17,491 (43.6%)
Coronary heart disease	16,506 (41.2%)
Cerebrovascular disease	12,761 (31.8%)
Heart failure	12,965 (32.4%)
Atrial fibrillation	10,096 (25.2%)
Renal failure	11,819 (29.5%)
Acute kidney injury	9,170 (22.9%)
Sleep apnea	3,884 (9.7%)
Cognitive function (CFS)	
1	8,883 (22.2%)
2	14,530 (36.3%)
3	8,705 (21.7%)
4	7,097 (17.7%)
Missing	864 (2.2%)
BMI at NH admission	28.1 (9.0)
BMI categories	
18.5–24.9	11,824 (29.5%)
<18.5	1,432 (3.6%)
25.0–29.9	12,358 (30.8%)
30+	11,321 (28.3%)
Missing	3,144 (7.8%)

Table 2.

Prevalence of hypertension and antihypertensive medication use among those diagnosed at admission

NH admission year	# Patients with hypertension at admission*	# Patients admitted	Prevalence of Hypertension†	Prevalence of Antihypertensive Medication Use†‡
FY2007-FY2008	5,397	7,177	75.2%	84.2%
FY2009-FY2010	5,131	6,653	77.0%	83.7%
FY2011-FY2012	5,060	6,459	78.7%	83.2%
FY2013-FY2014	5,188	6,650	78.4%	82.6%
FY2015-FY2016	5,693	6,982	81.9%	80.2%
FY2017-FY2018	5,207	6,158	85.1%	79.0%

*Hypertension at admission was defined as one or more ICD codes in the year prior to admission

†Age-standardized rates were calculated using direct standardization based on residents admitted in FY2007-FY2008, with age categories: 65–69 (11.9%), 70–74 (15.3%), 75–79 (20.8%), 80–84 (26.3%), 85–89 (19.7%), 90+ (6.0%).

‡Defined as use of antihypertensive mediation ≥50% of the time in the CLC, among those diagnosed

Table 3:

Factors associated with antihypertensive medication use among residents with baseline hypertension (n=31,676)

	Demographic Adjusted Model		Fully Adjusted Model	
	IRR (95% CI)	**p-value**	**IRR (95% CI)**	**p-value**
Age (years)				
65–69	Reference		Reference	
70–74	0.99 (0.98–1.01)	0.383	1.00 (0.98–1.01)	0.588
75–79	0.99 (0.97–1.01)	0.210	1.00 (0.98–1.02)	0.872
80–84	0.98 (0.96–0.99)	0.008	1.00 (0.98–1.01)	0.744
85–89	0.95 (0.93–0.96)	<0.001	0.98 (0.96–0.99)	0.013
90+	0.92 (0.90–0.94)	<0.001	0.95 (0.93–0.97)	<0.001
Female	1.01 (0.97–1.04)	0.770	1.02 (0.99–1.06)	0.217
Race				
White	Reference		Reference	
Black	1.02 (1.01–1.03)	0.007	1.02 (1.01–1.03)	0.006
Asian, Pac Islander	1.02 (0.97–1.07)	0.546	1.00 (0.96–1.05)	0.874
Am. Indian	0.98 (0.90–1.06)	0.583	0.96 (0.89–1.05)	0.385
Multi-races	1.04 (0.98–1.10)	0.168	1.04 (0.98–1.10)	0.159
Missing	1.01 (0.98–1.03)	0.597	1.02 (0.99–1.04)	0.241
Ethnicity				
Non-Hispanic	Reference		Reference	
Hispanic/Latino	0.98 (0.95–1.01)	0.117	0.97 (0.95–1.00)	0.040
Missing	0.96 (0.93–0.99)	0.019	0.97 (0.94–1.00)	0.041
Time	0.980 (0.976–0.983)	<0.001	0.974 (0.970–0.977)	<0.001
Region				
Continental	Reference		Reference	
Midwest	1.06 (1.04–1.08)	<0.001	1.05 (1.03–1.07)	<0.001
North Atlantic	1.01 (0.99–1.03)	0.170	1.01 (0.99–1.03)	0.131
Pacific	0.96 (0.94–0.98)	0.001	0.96 (0.94–0.98)	0.001
Southeast	1.04 (1.01–1.06)	0.001	1.03 (1.01–1.05)	0.001
Missing	1.15 (1.07–1.23)	<0.001	1.14 (1.06–1.22)	<0.001
BMI categories				
18.5–24.9			Reference	
<18.5			Yongmei to fill in	
25.0–29.9				
30+				
Missing				
Diabetes			1.11 (1.10–1.13)	<0.001
Stroke			1.05 (1.03–1.06)	<0.001
Heart failure			1.17 (1.16–1.18)	<0.001
Renal disease			1.03 (1.02–1.05)	<0.001

	Demographic Adjusted Model		Fully Adjusted Model	
	IRR (95% CI)	p-value	IRR (95% CI)	p-value
Sleep apnea			1.00 (0.98, 1.01)	0.923
Cancer			0.91 (0.90–0.92)	<0.001
Dementia			0.95 (0.94–0.96)	<0.001
MI			1.04 (1.03–1.06)	<0.001

Table 4:

Factors associated with BP control (<140/90mmHg) among residents with baseline hypertension (n=31,676)

	Demographic Adjusted Model		Fully Adjusted Model	
	IRR (95% CI)	**p-value**	**IRR (95% CI)**	**p-value**
Age (years)				
65–69	Reference		Reference	
70–74	0.99 (0.98–1.01)	0.265	0.99 (0.98–1.00)	0.179
75–79	0.99 (0.98–1.00)	0.174	0.99 (0.97–1.00)	0.101
80–84	0.99 (0.97–1.00)	0.077	0.98 (0.97–1.00)	0.008
85–89	0.99 (0.97–1.00)	0.059	0.97 (0.96–0.99)	0.001
90+	0.99 (0.97–1.00)	0.092	0.97 (0.95–0.99)	0.001
Female	0.92 (0.88–0.95)	<0.001	0.91 (0.87–0.94)	<0.001
Race				
White	Reference		Reference	
Black	0.91 (0.90–0.92)	<0.001	0.92 (0.91–0.94)	<0.001
Asian, Pac Islander	0.98 (0.94–1.02)	0.248	0.99 (0.95–1.03)	0.696
Am. Indian	1.02 (0.96–1.08)	0.466	1.04 (0.98–1.10)	0.224
Multi-races	0.95 (0.90–1.01)	0.092	0.96 (0.91–1.02)	0.181
Missing	0.98 (0.96–1.00)	0.120	0.98 (0.96–1.00)	0.109
Ethnicity				
Non-Hispanic	Reference		Reference	
Hispanic/Latino	0.96 (0.94–0.98)	<0.001	0.97 (0.95–0.99)	0.003
Missing	0.97 (0.95–1.00)	0.021	0.97 (0.94–0.99)	0.008
Time	0.990 (0.987–0.993)	<0.001	0.993 (0.991–0.996)	<0.001
Region				
Continental	Reference		Reference	
Midwest	0.99 (0.98–1.01)	0.454	1.00 (0.98–1.01)	0.651
North Atlantic	0.98 (0.97–1.00)	0.034	0.98 (0.97–1.00)	0.022
Pacific	1.01 (1.00–1.03)	0.093	1.01 (1.00–1.03)	0.095
Southeast	1.01 (0.99–1.03)	0.160	1.01 (1.00–1.03)	0.089
Missing	0.93 (0.84–1.03)	0.158	0.94 (0.85–1.03)	0.190
BMI categories				
18.5–24.9			Reference	
<18.5			1.00 (0.98, 1.03)	0.77
25.0–29.9			0.99 (0.98, 1.03)	0.18
30+			1.00 (0.99, 1.02)	0.54
Missing			0.99 (0.97, 1.01)	0.23
Diabetes			0.94 (0.93–0.95)	<0.001
Stroke			0.97 (0.96–0.97)	<0.001
Heart failure			1.02 (1.01–1.03)	<0.001
Renal disease			0.90 (0.89–0.91)	<0.001
Sleep apnea			1.01 (0.99, 1.02)	0.38

	Demographic Adjusted Model		Fully Adjusted Model	
	IRR (95% CI)	**p-value**	**IRR (95% CI)**	**p-value**
Cancer			1.02 (1.01–1.03)	<0.001
Dementia			1.01 (1.00–1.02)	0.216
MI			1.03 (1.01–1.04)	<0.001