New ACC/AHA Blood Pressure Guidelines and the Operational Readiness of Naval Aviators and Aircrew

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INTRODUCTION: Hypertension, also known as high blood pressure, is the "silent killer" and may lead to more severe conditions if left unmanaged. Hypertension in service members of the U.S. military has the potential to negatively impact readiness. The aim of this study was to assess the potential impact to readiness of active duty Naval aviators and aircrew under the new 2017 ACC/AHA blood pressure guidelines.

METHODS: This cross-sectional study used the Military Health System Data Repository for 2015. The population included all active duty Naval aviators and aircrew. The absolute number and proportion of those with hypertension were compared based on previous Joint National Committee 7 and 2017 ACC/AHA guidelines. Impact to readiness was calculated based on lost work days and the number of individuals with hypertension that fit the criteria to be medically grounded according to the U.S Naval Aeromedical Reference and Waiver Guide.

RESULTS: Hypertension diagnoses will increase by 2904 individuals (599%) in the 23,492 Naval aviators and aircrew included in the population. Impact to readiness will result in an estimate of 510 lost work days.

CONCLUSION: The 2017 ACC/AHA hypertension guidelines will lead to a dramatic increase in hypertension diagnoses in this population. Depending on the U.S. Navy disposition on hypertension, the impact can be minor or substantial, but the early opportunity for care made available with the 2017 ACC/AHA guidelines may provide long-term benefits of a healthy fighting force worth the immediate impact to readiness.

KEYWORDS: aerospace medicine, military, U.S Navy, standards, occupational health, workforce, data analysis.

Johnson MC, Banaag AL, Condie KJ, Servies TE, Pérez Koehlmoos TL. *New ACC/AHA blood pressure guidelines and the operational readiness of Naval aviators and aircrew*. Aerosp Med Hum Perform. 2019; 90(4):409–414.

Hypertension is often called the "silent killer" because individuals with high blood pressure (BP) usually do not have symptoms. However, if left unmanaged, hypertension can lead to cardiovascular disease, stroke, and heart failure. More than 410,000 American deaths a year are attributed to high BP as a primary or contributing cause. This amounts to greater than 1000 deaths every day.[1] Prehypertension and hypertension are major public health concerns. Approximately 60% of American adults have prehypertension or hypertension. The prevalence of hypertension has increased by approximately 10% during the past decade.[13]

The American College of Cardiology (ACC) and the American Heart Association (AHA) recently issued new BP guidelines—the first since 2003—that lower the threshold for diagnosis of hypertension. These new guidelines replace the Joint National Committee 7 (JNC 7) guidelines. The guidelines eliminate the category of Prehypertension and classify patients as Elevated (BP readings of 120–129 systolic mmHg and less than 80 mmHg diastolic) or Stage 1 hypertension (130–139 or 80–89). While previous guidelines classified 140/90 mmHg as Stage 1 hypertension, this level is classified as Stage 2 hypertension under the new guidelines.[14] **Table I** compares the JNC 7 pre-2017 BP guidelines and the new 2017 ACC/AHA guidelines.[14]

The new definition is expected to result in an increase in the prevalence of hypertension by 46% of the U.S. adult population, with the greatest impact expected among younger individuals. According to the authors of the guidelines, the prevalence of high BP is expected to triple among men under age 45 and

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This manuscript was received for review in July 2018. It was accepted for publication in January 2019.

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DOI: https://doi.org/10.3357/AMHP.5229.2019

Table I. BP Classification (JNC 7 and 2017 ACC/AHA Guidelines).

SBP		DBP	JNC 7	2017 ACC/AHA
<120	and	<80	Normal BP	Normal BP
120–129	and	<80	Prehypertension	Elevated BP
130–139	or	80–89	Prehypertension	Stage 1 hypertension
140–159	or	90–99	Stage 1 hypertension	Stage 2 hypertension
160–180	or	100–120	Stage 2 hypertension	Stage 2 hypertension
>180	and/or	>120	Stage 2 hypertension	Crisis

Systolic (SBP) and diastolic (DBP) blood pressure limits for classification under JNC 7 and 2017 ACC/AHA guidelines.

double among women under 45.[7] The change in guidelines is touted to increase hypertension awareness and encourage lifestyle modification, but prevalence and impact on military and naval aviation readiness have not been explored.

Naval aviation is the dominant maritime aviation fighting force and no other service or community can deliver equivalent capabilities in support of national interests. Delivering readiness is the pre-eminent focus of the Navy and Marine Corps.[8] The health of Naval aviators and aircrew are an essential component to ensure a forward, engaged, and ready force.

Currently the U.S. Navy Aeromedical Reference and Waiver Guide (ARWG) states that, among Naval aviators and aircrew, hypertension is a disqualifying medical condition and requires a waiver to continue flying.[11] Furthermore, antihypertensives are considered disqualifying, but some are waiverable. Waiver approval is a multistep process that can take anywhere from a couple of weeks to greater than a year (depending on necessity to fly) and will not be considered until after 30 d of treatment if the member's hypertension is controlled on a stable dosage of medication without evidence of side effects.[11] This study investigates the effect of the new 2017 ACC/AHA guidelines on the prevalence of hypertension and readiness in Naval aviation.

METHODS

This cross-sectional study used fiscal year 2015 claims data on all active duty Naval aviators and aircrew from the Military Health System's Data Repository (MDR). The MDR is a centralized data repository that receives and validates data from the Department of Defense's (DoD) worldwide network, which provides health benefits to active duty service members, retirees, and their dependents. It is also a network that affords its members the ability to seek healthcare in both military (direct care) and civilian (purchased care) treatment facilities.

Using fiscal year 2015 data, we identified Naval aviators and aircrew using the Department of Defense occupation code which included all pilots, navigators, and aircrew. Furthermore, among this population, we queried by ICD-9-CM hypertension diagnosis codes (401.0, 401.1, 401.9) and first medical appointment BP readings of the year. Patient demographics such as age, gender, and rank were also collected. The study protocol was approved by the Institutional Review Board (IRB) of the Uniformed Services University of the Health Sciences (USUHS).

Demographic characteristics were summarized using frequency/percent for categorical variables and averages ± SD for continuous variables. Prevalence was calculated as the frequency of individuals meeting the criteria for hypertension (numerator) divided by count of all Naval aviators and aircrew (denominator). To estimate the proportion of individuals diagnosed with hypertension, subjects were classified as hypertensive if their encounter matched on ICD-9 hypertension diagnosis codes (401.0, 401.1, 401.9). To estimate the proportion of individuals who could potentially meet clinical criteria for hypertension, subjects were classified according to their BP readings at the first medical appointment of the year using JNC 7 BP guideline categories and 2017 ACC/AHA BP guideline categories, respectively.

Since not all subjects with a single high BP measurement would ultimately meet the criteria for a clinical diagnosis of hypertension, the number of additional hypertension diagnoses was estimated under the new guidelines by applying an adjustment factor. This factor aided in accounting for apparent and white coat hypertension (potential confounder/effect modifier). This adjustment factor was calculated by dividing the number of individuals diagnosed with hypertension (numerator) by the number of individuals who qualified as having hypertension (Stage 1 and 2) by BP readings (denominator) using JNC 7 guidelines. To arrive at the estimated number of individuals with a clinical diagnosis of hypertension under the 2017 ACC/AHA guidelines, the number of individuals with hypertension according to BP readings were multiplied by the adjustment factor.

To compare prevalence of hypertension under JNC 7 and 2017 ACC/AHA guidelines, percent increase and absolute increase were calculated. Absolute change was calculated by subtracting the number of individuals diagnosed with hypertension under JNC 7 guidelines from the number of individuals diagnosed under 2017 ACC/AHA guidelines. Percent change was calculated by dividing the absolute change (numerator) by the number of individuals diagnosed under JNC 7 guidelines (denominator) and multiplied by 100.

Impact to readiness was quantified through lost work days following the current disposition defined by the ARWG under the Naval Aerospace Medical Institute (NAMI). This disposition demands a medical waiver and the individual prohibited to fly for only those with hypertension who require pharmacological treatment.[11] To estimate impact to readiness, absolute change of all individuals with a hypertension diagnosis was multiplied by 0.6% to represent the percentage of individuals compared to the closest demographic group (men ages 20–54) under the new 2017 ACC/AHA guidelines needing pharmacological treatment.[7] This product was then multiplied by 30 d for medical grounding as stated in the current ARWG.[11]

RESULTS

We identified 23,500 Naval aviators and aircrew—of whom 23,492 met initial inclusion criteria—to estimate the proportion of those with diagnosed hypertension for FY15. We excluded Warrant Officers from analysis in order to maintain human

subject protection given their small number. An additional 3461 were excluded due to missing a BP measurement. For all other objectives and further analysis, 20,031 (85%) active duty Naval aviators and aircrew met inclusion criteria. Population demographic characteristics for this population are presented in **Table II**. For those individuals diagnosed with hypertension ($N = 490$), the mean age is 38.7 yr (compared to 31.1 yr for the entire population), 79.4% were ages 30–59 yr, 94.9% were men, and the majority had a rank of Senior Enlisted (29.6%), Senior Officers (29.3%), or Junior Officers (37.1%).

Using the JNC 7 guidelines, we calculated prevalence of hypertension in 20,031 included subjects. The overall number and proportion categorized with a hypertension IDC 9 code was 490 (2.09%). The prevalence of hypertension using BP readings and categorized by subcategories demonstrate the majority have prehypertension (12,485), followed by normotension (6242), Stage 1 hypertension (1170), and Stage 2 hypertension (134). When 2017 ACC/AHA guidelines were applied to the same BP reading subcategories, the majority of this study population fall under Stage 1 hypertension (7807), followed by normotension (6242), Elevated BP (4678), Stage 2 hypertension (1296), and Crisis hypertension (8) (**Table III**).

Total hypertension was calculated by adding BP subcategories (≥ Stage 1). By applying JNC 7 guidelines, there are 1304 individuals who have hypertension (Stage 1 or 2) according to BP readings; however, only 485 (excluding 5 individuals without BP readings out of the original 490 individuals diagnosed with hypertension) were formally diagnosed with hypertension using ICD-9 codes. Under 2017 ACC/AHA guidelines there will be an estimated 9111 who have hypertension (Stage 1, 2, or crisis) according to BP readings. The adjustment factor was calculated to be 0.37 and, after application, it was determined an estimated 3389 of the 9111 individuals would be diagnosed with hypertension under the new guidelines (Table III).

Prevalence data was used to calculate absolute and percent change. According to BP readings, the absolute increase in hypertension is 7807 individuals. The new guidelines led to a decrease in elevated/prehypertension by 63%, an increase in Stage 1 and 2 hypertension by 567% and 867%, respectively, and an increase in total hypertension (≥ Stage 1) by 599%. According to ICD 9 hypertension diagnosis, the new guidelines also increased hypertension diagnosis by 599% (as expected due to the same adjustment factor) with an absolute increase of 2904 individuals (Table III, **Fig. 1**).

Impact to readiness is dependent on the disposition of hypertension within the ARWG. If the ARWG disposition remains the same, immediate impact to readiness will result in 510 lost work days. This calculation is derived from 30-d mandatory grounding for the estimated additional 0.6% of men who are expected to require pharmacological treatment as stated by the ACC/AHA.[7] In this population that would equate to 17 aviators. This disposition is consistent with the current ACC/AHA recommendations. ACC/AHA advises the assessment of Stage 1 hypertension in an otherwise healthy adult include a 10-yr heart disease and stroke risk assessment. If the risk is less than 10%, the recommendation includes lifestyle changes and the member is to be reassessed in 3–6 mo. If the risk assessment is greater than 10%, treatment includes lifestyle changes and medication with monthly follow-ups until BP is controlled. The threshold for pharmacological treatment in an otherwise healthy adult is 140/90 mmHg (systolic BP/diastolic BP).[14]

DISCUSSION

With an overall percent increase of 599%, changing the hypertension guidelines impacts a population of Naval aviators and aircrew to a greater extent than the U.S. general population (44%) or closest demographic group: male population ages 20–54 (172%).[7] This highlights that there are many members in the naval aviation community who were once defined as

Table II. Population Demographics, FY 2015.

	ACTIVE DUTY NAVAL AVIATORS & AIRCREW	ACTIVE DUTY NAVAL AVIATORS & AIRCREW W/BP READINGS	ACTIVE DUTY NAVAL AVIATORS & AIRCREW W/HTN DIAGNOSIS
	***N* = 23,492**	***N* = 20,031**	***N* = 490**
	***N* (%)**	***N* (%)**	***N* (%)**
Mean Age (years)	31.0	31.1	38.7
Age Group			
≤29	11,026 (46.94)	9335 (46.60)	62 (12.65)
30–39	8931 (38.02)	7606 (37.97)	195 (39.80)
40–49	3313 (14.10)	2897 (14.46)	194 (39.59)
50–59	222 (0.94)	193 (0.97)	39 (7.96)
Gender			
M	21,510 (91.56)	18,252 (91.12)	465 (94.90)
F	1982 (8.44)	1779 (8.88)	25 (5.10)
Rank			
Enlisted, Junior	4306 (18.33)	3531 (17.63)	19 (3.88)
Enlisted, Senior	4779 (20.34)	4042 (20.18)	145 (29.59)
Officer, Junior	11,811 (50.28)	10,204 (50.94)	182 (37.14)
Officer, Senior	2596 (11.05)	2254 (11.25)	144 (29.39)

Frequency (*N*) and percent (%) of identified study populations by demographic variables (mean age, age group, gender, and military rank).

Table III. Comparison of Proportions of HTN Applying JNC 7 and 2017 ACC/AHA Guidelines.

	JNC 7 GUIDELINES (*N*)	2017 ACC/AHA GUIDELINES (*N*)	ABSOLUTE CHANGE	% CHANGE
HTN BP Categories				
Normotensive	6242	6242	0	0
Elevated/Prehypertensive	12,485	4678	−7807	−63
Stage 1	1170	7807	6637	567
Stage 2	134	1296	1162	867
Crisis		8	8	
Total (≥ Stage 1)	1304	9111	7807	599
HTN Diagnosis (ICD-9)	485	3389	2904	599

Frequency (*N*), absolute change, and percent (%) change comparisons of U.S. Naval aviators and aircrew with hypertension (HTN) identified by blood pressure (BP) readings (Stage 1 and above) or ICD-9 diagnosis.

prehypertensive and now fit the definition for Stage 1 hypertension. Depending on the ARWG's disposition on hypertension, the impact to readiness could be as minor as 510 lost work days if only those requiring medication are medically grounded.

This analysis is the first to provide an estimate of the absolute change and percent change for hypertension when comparing JNC 7 vs. 2017 ACC/AHA hypertension guidelines in a population of Naval aviators and aircrew or any uniformed service. Earlier studies differed from this investigation in that most were designed to detect only recognized cases and all were conducted prior to the inception of the 2017 ACC/AHA hypertension guidelines. One group of researchers at a Department of Defense medical treatment center used pharmacy records to estimate the prevalence of treated hypertension to be 1.5% of the entire population.[6] Another investigation of hypertension in a population of active duty service members reported similar findings, with an overall prevalence of treated hypertension to be 2%.[10] These findings are similar to the prevalence of diagnosed Naval aviators and aircrew in this study (2.09% overall).

Smoley et al.[10] also investigated single BP measurements to suggest that the prevalence of hypertension in U.S. military populations is higher than what is reflected in pharmacological and medical records. They revealed 21% of male service members have hypertension and 62% of male service members have prehypertension based on BP readings according to JNC 7 guidelines.[10] These findings are similar to the prevalence of prehypertension according to BP readings in this study (62.3%), but are dissimilar to the prevalence of hypertension (6.5%). This is most likely because Naval aviators and aircrew have higher physical qualifying standards compared to the general U.S. military population.

The strengths of this study include: it is composed of the entire population of Naval aviators, navigators, and aircrew in the single claims data set for the U.S. military; due to the large population size ($N = 23{,}492$), there is little random variation. The majority of this large population size met inclusion criteria (20,031 of 23,492).

A limitation and a source of error is the likely discrepancy between the number of individuals who are categorized with hypertension and those with actual high BP. Using a single BP reading at the first medical appointment of the calendar year standardizes the data for analysis, but could lead to false negatives or (more likely) false positives. The U.S. Preventive Services Task Force (USPSTF) recommends hypertension be diagnosed only after two or more elevated readings are obtained on at least two visits over a period of one to several weeks.[12] Furthermore, many experts believe ambulatory BP readings are more accurate than ones determined in a clinical setting due to factors such as White Coat Syndrome.[9] This study was aware of this limitation and aimed to mitigate it by applying the 0.37 adjustment factor described in the analysis plan.

Another limitation is coding of hypertension diagnosis. In most cases Flight Surgeons are the Naval aviators' Primary Care Managers (PCM) and military providers do not have professional coders.[3] As in all secondary data analysis, there is the possibility of coding error. The fact that 485 out of 1304 individuals with high BP are coded suggest that an unknown number of those with high BP could be coded for hypertension. To further illustrate the complexity of coding, there is another code for high BP, ICD-9 code 796.2 (high blood pressure without diagnosis). There were 331 Naval aviators and aircrew with this code, comprising 1.4% of the population. The adjustment factor of 0.37 was meant to account for the proportion of those diagnosed with hypertension and those with high BP signifying possible hypertension despite the potential errors in coding. Coding complexities and inconsistencies among providers pose a challenge for this study and the accuracy of all health databases.

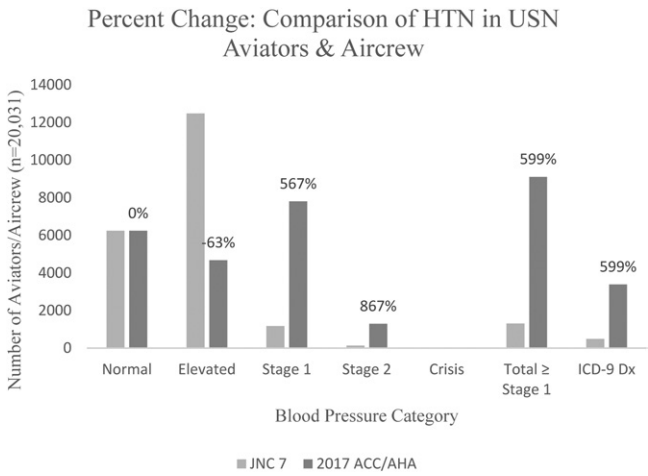

Fig. 1. Percent change and comparison of blood pressure readings under JNC 7 vs. 2017 ACC/AHA guidelines (Normal, Elevated, Stage 1, Stage 2, and Crisis), and those with hypertension by BP measurement (Stage 1 and above) or ICD-9 diagnosis.

The large composition and inclusion of the population allow us the ability to generalize for this population. On the other hand, we are unable to generalize beyond the naval aviation community. The aviation community is unique in that it has rigorous physical standards to be qualified to fly. This is illustrated in the inconsistencies in hypertension rate according to the BP readings of this study (6.5%) compared to the Smoley et al.[10] study on hypertension in a general U.S. military population (21%).

Currently the ARWG states hypertension is disqualifying and requires a waiver.[11] If left unchanged, and without deviation, this would require every individual with a hypertension diagnosis—regardless of pharmacological treatment—to be temporarily grounded while awaiting waiver approval. By applying the new guidelines, the absolute change estimate for hypertension diagnosis is an additional 2904 individuals. If the Navy disqualified the additional 2904 aviators and aircrew from duties involving flying while awaiting a waiver, impact to readiness would be staggering. If each individual is grounded for 30 d, there would be a total of 87,120 lost work days. This scenario is unlikely due to the ability for local flight surgeon boards to approve individuals to fly while awaiting waivers.[11] This would apply to the majority of these individuals that do not meet the BP threshold required for pharmacological treatment. To minimize lost work days but maximize treatment opportunity, it is recommended that NAMI apply the recommended ACC/AHA guidelines. For individuals with Stage 1 hypertension and 10-yr heart disease risk of less than 10%, allow them to keep flying while lifestyle modifications are implemented. This would constitute the majority of new hypertension diagnoses with the estimate of 0.6% of these individuals requiring medication and, therefore, a 30-d grounding period.

Stage 1 hypertension is an important category for awareness and, though the new guidelines result in a relatively small amount of lost work days, the impact to readiness should not be ignored, especially for long-term readiness investment. As previously discussed, prehypertension/elevated BP and hypertension have a profound effect on the development of cardiovascular disease. BP values in the Stage 1 category are associated with a more than threefold greater likelihood of developing hypertension and a twofold increase in relative risk of cardiovascular disease as compared to those below 120/80 mmHg.[5] Of those with elevated or Stage 1 hypertension, 40% are expected to be Stage 2 hypertensive in 4 yr.[2] Similarly, a previous longitudinal study of prehypertensive aviators, based on guidelines for prehypertension of systolic BP of 120–139 mmHg and diastolic of 80–89 mmHg, had 3.7 times (95% CI; 2.3–6.2) the odds of developing hypertension than those who did not have prehypertension.[4] It is therefore appropriate to address lifestyle changes at this point, rather than waiting until later when a lifetime of damaging habits added to age leads to hypertension complications such as cardiovascular disease.

In conclusion, there will be an estimated 599% increase in hypertension diagnosis with the new 2017 ACC/AHA guidelines in a population of active duty Naval aviators and aircrew. This percent increase in hypertension is greater than what is expected out of the general population (44%) and men ages 20–54 (172%).[7] This points to the conclusion that there are many members in this population who were once defined as prehypertensive and now fit the definition for Stage 1 hypertension, which in turn would increase the number requiring medical waivers. The most likely course of action presents a total loss of 510 work days; however, not embracing the new guidelines has the potential for greater long-term negative impact on the individual's health and the military healthcare system. The Navy must also be prepared to meet the added demand for access to nutrition and fitness counseling services that will accompany this sixfold increase in patients requiring lifestyle modification. By meeting the demand now, the number of aviators who suffer lost work days and, ultimately, the consequences of long-term hypertension will be curtailed in the future. Success lies in minimizing the immediate negative impact to readiness and fostering the potential for long-term health gains for Naval aviators and aircrew.

ACKNOWLEDGMENTS

The content of this publication is the sole responsibility of the author(s) and does not necessarily reflect the views or policies of the Uniformed Services University of the Health Sciences (USUHS), the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc. (HJF), the Department of Defense (DoD), or the Departments of the Army, Navy, or Air Force. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government.

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