Clinical Diagnoses Leading to Suspension in Army Aircrew: An Epidemiological Study

Ian P. Curry; Amanda M. Kelley; Steven J. Gaydos

INTRODUCTION: There have been few large-scale epidemiological examinations of military aircrew populations reported in recent literature. This study examined 10 yr of medical records contained in the U.S. Army Aeromedical Electronic Resource Office (AERO) in an effort to identify the most prevalent conditions affecting Army aviator career longevity.

METHODS: This study was a retrospective epidemiological review; data were retrieved on 24,568 rated aircrew patients from the AERO database, of whom 5.2% were women. The dataset was composed of a total of 181,471 cases between June 2005 and June 2015. Age ranged from 17 to 73 yr. The data were examined in terms of raw ICD-9 diagnostic codes, derived systems-based categories, and occupational consequences.

RESULTS: The top 10 diagnoses, causes for waiver, and permanent suspension of aircrew were determined both in terms of the ICD-9 codes and the system groupings. Leading waiver causes included hypertension (11.5%), hearing loss (9.7%), spinal disorder (14.4%), and obstructive sleep apnea (5.2%). Leading permanent suspension causes were psychiatric disorders (28.2%), particularly PTSD, being the leading cause, with spinal pathology (16.1%) second. In almost all diagnostic groupings the Spearman's rho correlation coefficients between age and diagnosis presence were positively related, although often with no association with negative occupational outcome.

DISCUSSION: This study revealed the leading medical causes of waiver and suspension from flying duties, producing evidence to inform leadership understanding of disease prevalence and its subsequent impact on flying status. This is of prime importance to help direct policy and implement strategies for health protection.

KEYWORDS: aircrew, aviator, medical diagnoses, epidemiology.

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Army aeromedical policy is an area of fundamental importance not only to the careers of aviators and aircrew, but more importantly to the operational capability of the Aviation Branch. Keeping aeromedically fit-for-duty aircrew in the air is a fundamental issue of readiness and the Chief of Staff of the Army has maintained that readiness remains the top priority for the Army: "Readiness is #1, and there is no other #1."[6,7] The U.S. Army Aeromedical Activity at Fort Rucker, AL, has for some years operated an effective system of computerized management of medical records, the Aeromedical Electronic Resource Office [AERO; also referred to as the Aeromedical Epidemiological Data Repository (AEDR)]. This system standardizes and summarizes aeromedical decision making and disposition across the force, yet this large database has never been thoroughly exploited to establish clinical areas of organizational concern (Director Army Aeromedical Activity; personal communication; 2016).

The scientific literature in this area is limited and only one review of military pilot suspension and restriction due to medical causes was found in which the records of Canadian Air Force pilots for the years 1978 through 1987 were examined, finding coronary heart disease as the most common cause of permanent suspension.[12] The cohort studied is likely very

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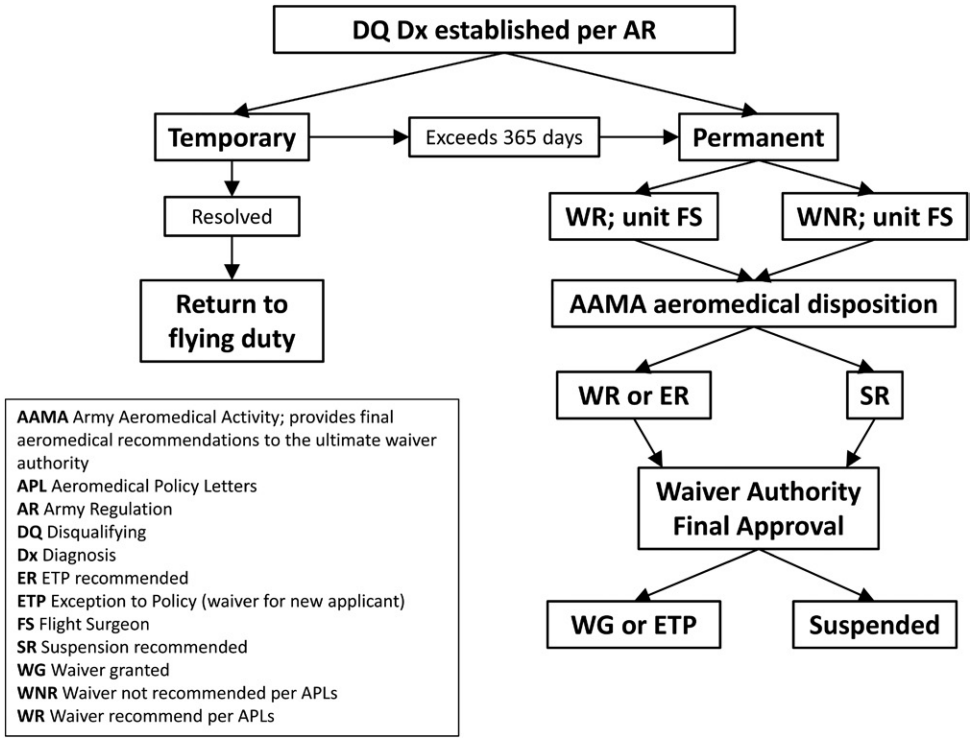

Fig. 1. USAAMA process algorithm.

different to the cohort proposed in this study, the rate of tobacco use has reduced significantly over the 30 yr since their study, and other lifestyle factors and clinical interventions will have changed to potentially alter the medical risk profile of aviators. Other published works refer to either aging pilots in civil aviation[3,11] or the reasons for suspension among civil flight attendants.[9,13] Neither of these types of study have any direct relevance to the military aviator.

The bulk of the research work done over the last 15 yr can be broken down broadly into three categories: reports of interesting but relatively rare causes of suspension;[1] examinations of a particular cause of suspension; and work looking at particular treatments or medications for causes of suspension.[2] These are certainly germane and useful pieces of work, but are too numerous to be cited individually. These studies make valuable contributions to the advancement of aeromedical knowledge, but do very little to address the larger epidemiological questions that are pertinent to the Army Aviation Branch of today: What are the disease processes that are afflicting the modern aviator? Where should scarce resources should be targeted in screening, treatment, and policy making arenas? And where can the greatest effect be realized in terms of increasing aviator career longevity and maintaining or increasing operational output from the aviator population? These questions require a large and well-designed epidemiological review of a contemporary cohort of the aviator population, something this study is designed to fulfill.

The objective of this study was to determine the prevalence and associations of clinical diagnoses leading to suspension of flight status among U.S. Army aircrew (those requiring a class 2 flying duty medical exam; pilots, crew chiefs, and flight surgeons/medics) over a 10-yr period. This study examined associations between prevalent diagnoses, granting of aeromedical waivers, and permanent suspensions of aviators. The data are longitudinal in nature, including large cohorts and over 77 different variables. The AERO data addresses U.S. Army aviators cared for by aeromedical personnel at military treatment facilities around the globe. The Army Aeromedical Activity (AAMA) receives the encrypted data electronically via a computerized system from flight surgeons and aeromedical personnel, ultimately providing medical adjudication recommendations to final authorities concerning matters of flight status, medical waiver, and permanent suspension. The lexicon regarding the "grounding" of aircrew may be confusing and not universally applied across sister-services or nations (e.g., "down-chit," suspended, disqualified, duty not involving flying, etc.). With respect to AAMA specifically, the process is outlined in **Fig. 1**. As the prognosis of grounding conditions may be universal among military aviators, this study is potentially generalizable.

METHODS

Subjects

Prior to execution, the study received U.S. Army Medical Research and Materiel Command Institutional Review Board approval. Data were retrieved on 24,568 rated aircrew patients from the AERO database, of whom 5.2% ($N = 1282$) were women [approximately 5.2% of U.S. Army aviators are women (Human Resources Command; personal communication; 2016)]. The archival dataset was composed of a total of 181,471 cases between June 2005 and June 2015. Age ranged from 17 to 73 yr ($\mu = 37.60$, SD = 8.46, Med = 37, $N = 146{,}156$ cases). All diagnoses were coded using the International Classification of Disease-9 (ICD-9). The AERO database contains medical information relevant to operational readiness of aviation personnel. The de-identified dataset labeled patients by an arbitrary identification number given the longitudinal nature of the database so that individual cases/observations for each patient were discernable in order of occurrence. The dataset consisted of 77 variables, a subset of which was isolated for the purposes of this study: gender, age, rank, ICD-9 code, and aeromedical disposition (6 variables). An additional variable was created by

the authors with Army Flight Surgeon input in order to sort the ICD-9 codes into one of 23 systems-based categories:

- Thyroid disease
- Disorder of blood fats
- Anemia and other blood disorders
- Psychiatric disorder
- Alcohol and drugs
- Neurological disorder including headache and migraine
- Eye disorder
- Ear, nose, and throat disorder
- Cardiovascular, including hypertension
- Lung disorder
- Gastrointestinal tract disorder
- Genito-urinary
- Pregnancy and childbirth
- Dermatological disorder
- Limb disorders
- Disorder of spinal column/back
- Tumor and hematological cancers
- Renal disorders, including calculus
- Breast disorder
- Infection by virus, bacterium, or fungal agent
- Metabolic disorder
- Trauma
- Otherwise not coded

Statistical Analysis

The top 10 most frequently occurring diagnoses and those leading to waiver recommendation or suspension were calculated. For the top diagnoses, Spearman's rho correlation coefficients were conducted to examine the relationships between age and waiver/suspension status as well as age and presence of diagnosis. For this analysis, only the first instance of a particular diagnosis for each individual subject was included. Significance testing criterion was set at $P = 0.05$.

RESULTS

Of the 14,552 waivers recommended by unit aeromedical personnel, 14,184 were granted (97.5%). The most frequent diagnostic code occurring overall was that for lumbago (lower back pain, **Table I**). When the data were limited to cases where a waiver had been granted, the most frequently cited code was that for hypertension (**Fig. 2**, **Table II**). The Spearman's rho correlation coefficient between age and diagnosis presence were positively related such that the likelihood of hypertension increases with age (rho = 0.075, $P = 0.001$). However, age and waiver status for cases with a diagnostic code of "hypertension" was not significant (rho = 0.029, $P = 0.267$). This result suggests that propensity for a hypertension diagnosis increases with age, but age was not found to be associated with the likelihood of waiver vs. suspension. Of the 1443 hypertension cases where a waiver was recommended, a waiver was granted 1442 times (1 case led to a suspension). The most frequently cited diagnostic category for a waiver was spinal-related (Fig. 2, Table II). Of the 1756 cases where a waiver was recommended, it was granted 1755 times (waiver denied for 1 case). A suspension was recommended and granted for 259 cases (**Fig. 3**). The Spearman's rho correlation coefficient between age and diagnosis presence were positively related such that the likelihood of a spinal diagnosis increases with age (rho = 0.019, $P = 0.001$). However, age and waiver status for cases with spinal diagnoses were not significant (rho = −0.007, $P = 0.752$). This result suggests that propensity for a spinal diagnosis increases with age, but age was not found to be associated with the likelihood of waiver vs. suspension.

Table I. Top 10 Diagnoses ($N = 80{,}720$) and Diagnostic Categories ($N = 67{,}947$).

ICD-9 CODE AND DESCRIPTION	UNIQUE PATIENT COUNT	PERCENT
724.2: Lumbago	3765	4.7
401.1: Hypertension	3532	4.4
389.1: Hearing loss	3218	4.0
272.4: Hyperlipidemia	3165	3.9
796.9: Abnormal cardiovascular screening	2776	3.4
277.7: Metabolic syndrome	2734	3.4
272.1: Pure hyperglyceridemia	2331	2.9
530.81: Esophageal reflux	2007	2.5
477.9: Allergic rhinitis	1715	2.1
719.46: Joint pain	1559	1.9
DIAGNOSTIC CATEGORY		
Spinal	10,295	15.2
Orthopedic	8735	12.9
Cardiovascular including hypertension	7845	11.5
Disorder of blood fats	7133	10.5
Gastrointestinal tract disorder	7012	10.3
Ear, Nose, and Throat disorder	6986	10.3
Psychiatric disorder	4669	6.9
Neurological disorder	3635	5.3
Genito-Urinary	1755	2.6
Metabolic disease	1561	2.3

Leading diagnoses for cases of permanent suspension are reflected in **Table III**. The leading code was posttraumatic stress disorder (PTSD) and the leading diagnostic category was psychiatric. In all 100 cases of a PTSD diagnosis whereby a suspension was recommended, it was granted. An additional three cases resulted in a disqualification despite suspension recommendation. Note that all of the 129 PTSD cases where a waiver was recommended resulted in a waiver granted. The correlation analysis shows a positive relationship such that likelihood of PTSD increases with age (rho = 0.007, $P = 0.011$). However, age and waiver/suspension status was unrelated (rho = −0.045, $P = 0.497$). This result suggests that propensity for a PTSD diagnosis increases with age, but age was not found to be associated with the likelihood of waiver vs. suspension. With respect to a psychiatric diagnosis, the relationship is again positive, suggesting that the likelihood of a psychiatric diagnosis increases with age (rho = 0.027, $P = 0.001$). However, the Spearman's rho correlation coefficient between age and waiver/suspension status is negatively related such that the likelihood of a suspension given a psychiatric diagnosis decreases with age (rho = −0.183, $P < 0.001$). This result suggests that propensity for a

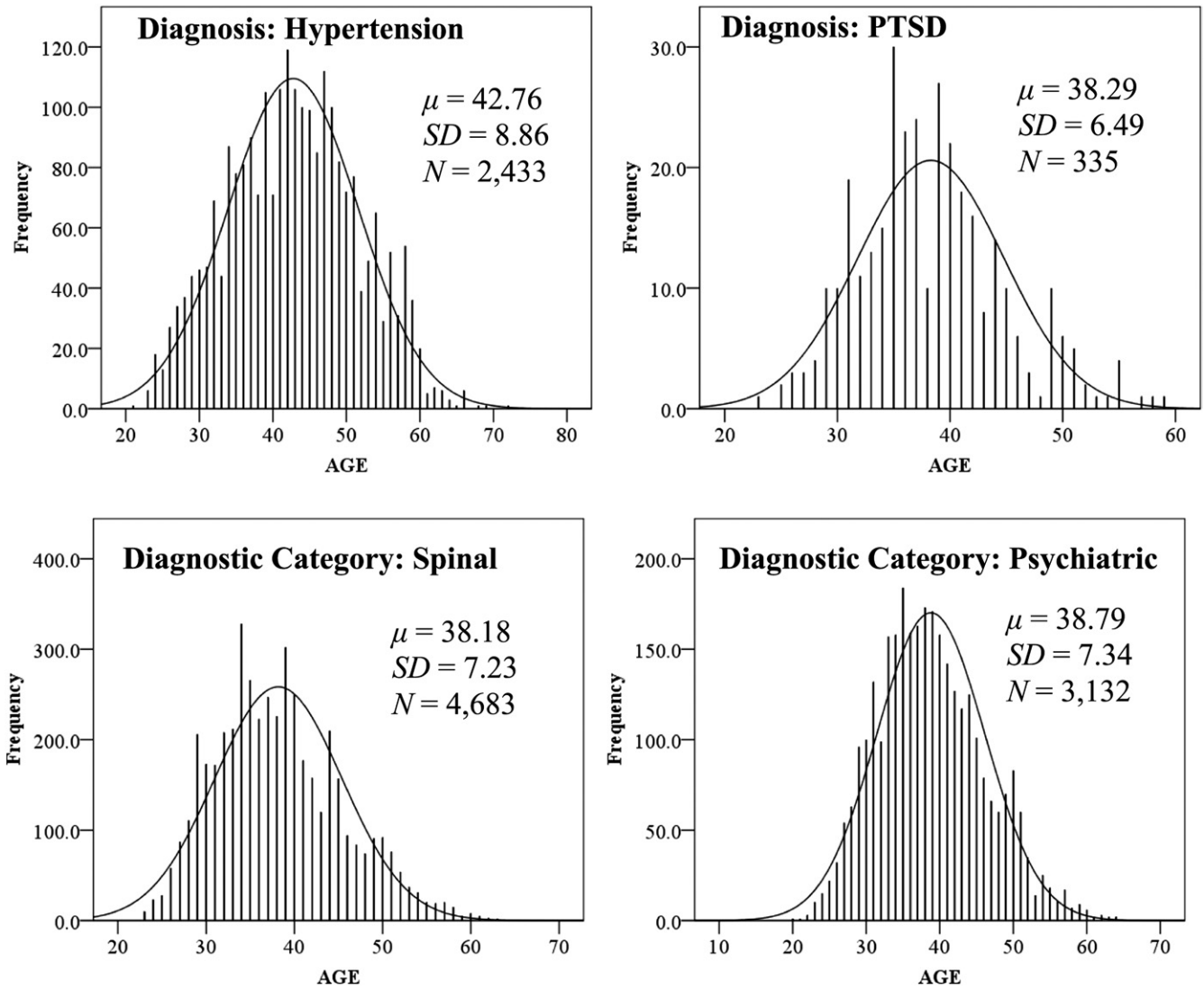

Fig. 2. Age distributions for top diagnoses and diagnostic categories for waiver and grounding status. Overlay is normal line curve.

psychiatric diagnosis increases with age and the likelihood of a waiver vs. suspension also increases with age. Of the 1425 requested waivers for a psychiatric diagnosis, a waiver was granted for 1422 cases, a suspension was granted for 2 cases, and a waiver denied for 1 case (**Fig. 4**). Of the 486 recommended suspensions, all were granted.

One result that was of interest was the absence of cardiovascular disease in the most frequent diagnoses. Hypertension figured as detailed, but only failed level 1 cardiovascular screening, a finding that only requires lifestyle counseling and does not require a waiver, made it into the top 20 diagnoses.

DISCUSSION

The rationale behind the concentration on the 'top 10s' as well as grouping diagnostic codes within systems-based categories in this study was in an effort to tease out important findings without getting lost in the large amount of data to be examined. Large epidemiological reviews are exploratory in nature and are of value for hypothesis generation and further study. Caution should be exercised not to interpret associations as necessarily causal or to overreach conclusions. Nonetheless, leadership oversight and understanding of disease prevalence and its subsequent impact on flying status and readiness are of prime importance to help direct policy, guide research, and implement strategies for health protection and disease prevention.

Clearly any effort relying on retrospective data, however large that dataset may be, is to an extent reliant on the accuracy of the original coding performed by clinicians and subsequently checked by operatives at the U.S. Army Aeromedical Activity. Within this dataset, for example, ICD-9 diagnoses as coded from submissions of flight physicals or aeromedical summaries from unit flight surgeons may be later modified in some cases by aeromedical specialists at AAMA. Fortunately, the sheer weight of data involved allows a confidence in the resulting analysis as individual coding errors are smoothed out as the data is explored.

Table II. Top 10 Diagnoses (N = 12,657) and Diagnostic Categories (N = 12,237) for Waiver Granted.

ICD-9 CODE AND DESCRIPTION	UNIQUE PATIENT COUNT	PERCENT
401.1: Hypertension	1458	11.5
389.1: Hearing loss	1229	9.7
327.23: Obstructive sleep apnea	657	5.2
722.1: Displacement of lumbar intervertebral disc	553	4.4
272.4: Hyperlipidemia	425	3.4
780.57: Unspecified sleep apnea	303	2.4
244.9: Unspecified acquired hypothyroidism	247	2.0
722.52: Degeneration of lumbar or lumbosacral intervertebral disc	238	1.9
722.0: Displacement of cervical intervertebral disc without myelopathy	198	1.6
257.2: Other testicular hypofunction	196	1.5
DIAGNOSTIC CATEGORY		
Spinal	1774	14.5
Cardiovascular including hypertension	1764	14.4
Ear, Nose, and Throat disorder	1753	14.3
Psychiatric disorder	1431	11.7
Neurological disorder	761	6.2
Disorder of blood fats	740	6.0
Gastrointestinal tract disorder	673	5.5
Metabolic disease	459	3.8
Tumor	447	3.7
Orthopedic disorder	424	3.5

In examining the results, an important consideration to be borne in mind is the way that medical regulation is written and policy is applied. For instance, the fact that each encounter for an aviator with a pathology is individually recorded in AERO and thus a single diagnosis can generate five or more data points. This has been dealt with in the analysis of the dataset by only using the first record of a given diagnosis for each aviator.

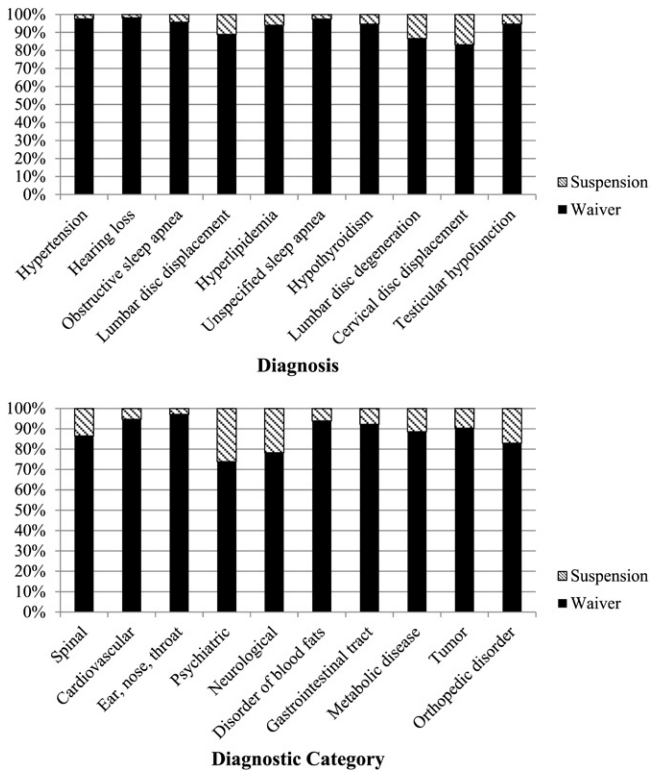

Fig. 3. Outcome/status percentages for top waiver diagnoses and diagnostic categories.

Table III. Top 10 Diagnoses (N = 1882) and Diagnostic Categories (N = 1815) for Permanent Suspension.

ICD-9 CODE AND DESCRIPTION	UNIQUE PATIENT COUNT	PERCENT
309.81: Posttraumatic stress disorder	103	5.5
722.1: Displacement of lumbar intervertebral disc without myelopathy	70	3.7
300.00: Anxiety state unspecified	64	3.4
346.90: Migraine unspecified without mention of intractable migraine without mention of status imgrainosus	42	2.2
722.0: Displacement of cervical intervertebral disc without myelopathy	39	2.1
401.1: Hypertension	38	2.0
722.52: Degeneration of lumbar or lumbosacral intervertebral disc	36	1.9
296.2: Major depressive affective disorder single episode unspecified degree	35	1.9
311: Depressive disorder not elsewhere classified	31	1.6
327.23: Obstructive sleep apnea	30	1.6
DIAGNOSTIC CATEGORY		
Psychiatric disorder	511	28.2
Spinal	292	16.1
Neurological disorder	217	12.0
Cardiovascular including hypertension	115	6.3
Orthopedic disorder	91	5.0
Eye disorder	75	4.1
Ear, Nose, and Throat disorder	67	3.7
Metabolic disease	66	3.6
Gastrointestinal tract disorder	65	3.6
Alcohol and drugs	60	3.3

Regarding the most common ICD-9 code diagnosis, that of lower back pain (lumbago), this is entirely consistent with the literature in terms of rotary-wing pilot morbidity[4,5,8] and does not come as a surprise, nor that spinal morbidity makes up a good proportion of both waivers and suspensions. Of potentially more interest is that pilots are more likely to have a spinal related diagnosis the older they get, but there is no difference in outcomes by age. Young and old pilots are just as likely to be waived or suspended in this diagnostic category.

Another finding of particular interest to the authors are the leading causes of permanent suspension from flying duties, the leading diagnosis being PTSD, and 56.3% of all suspensions being due to psychiatric, spinal, or neurological disorders, with psychiatric at very nearly twice the frequency of the next most common. This finding is in stark contrast with previous studies[12] that have cardiovascular disease as the leading cause of grounding. In this study the finding that failed cardiovascular screening, requiring only lifestyle counseling, was not even in the top 10 in any analysis leads to the conclusion that this may be as a result of differing populations, differing population habits, and possibly a different operational environment; the 10 yr of cohort data are covered entirely by major combat operations and conflicts within the War on Terror. The mental health of military active and veteran military members has remained an important

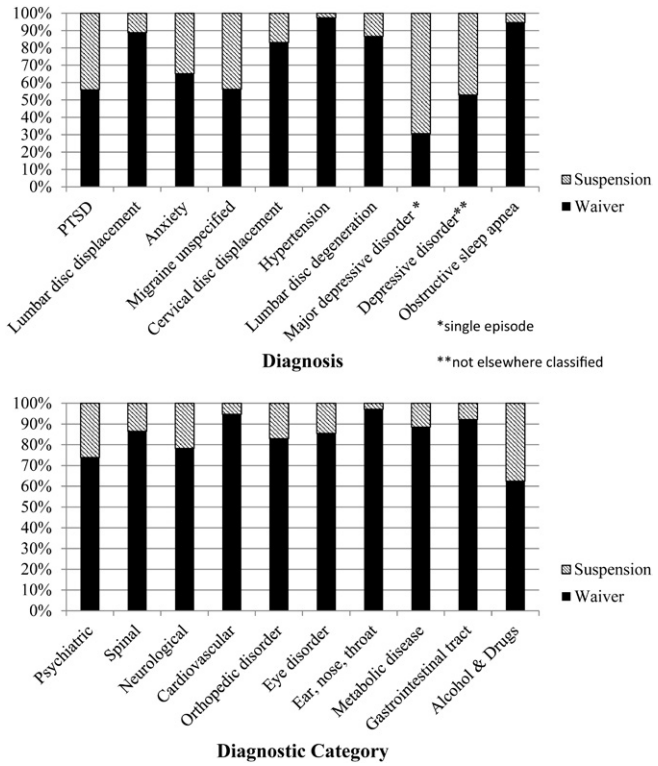

Fig. 4. Outcome/status percentages for top grounding diagnoses and diagnostic categories.

issue during the 10-yr period of this dataset.[10] Looking at the psychiatric issues more specifically within this study, older aviators are more likely to have obtained a diagnosis, but younger aviators are more likely to have been grounded as a result of the diagnosis they have, indicating greater severity in the younger cohort. This is an area that would benefit from greater scrutiny.

The limitations of this retrospective study included issues of potential miscoding, exposure to risk variables, or misclassification. There may also be a concern of temporal relationship between variables of interest, and exposure and outcome assessments could not be controlled. The recordkeeping of the original AERO data is assumed to have been accurate and the large sample size is applicable to rare outcomes and conditions. Aeromedical policy has not remained stagnant over the 10-yr period under study, with changes implemented that could affect aeromedical decision making and ultimate disposition. A huge benefit to further analysis would be access to exposure data for this cohort, individual flight time, aircraft type, and operational experience, which would allow for significantly more probing analysis and robust conclusions. This data exists and it is the aim of the study team to access it if at all possible.

In conclusion, the initial findings of the study reported here provide an interesting overview of the pathology creating morbidity among U.S. Army aviators in the period 2005–2015. The preponderance of psychiatric and spinal causes for a pilot's grounding is interesting and possibly related to the conflicts over the period in the former case and expected in the latter. The fact that cardiovascular disease seems to no longer be an issue for this cohort should be a relief to Army physicians and also helps to validate health improvement measures over the last two decades and more. However, complacency should be avoided and policy changes may need to be made in terms of psychiatric screening and treatment if a significant degradation in operational capacity and capability is to be avoided.

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The opinions, interpretations, conclusions, and recommendations contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

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