Permanent Medical Grounding in Royal Canadian Air Force Pilots (2008–2017)

Damian Haworth; Gary Gray; Richard Zoltenko; Alireza J. Bashirzadeh

BACKGROUND: The aim of this retrospective registry study was to review the medical causes of RCAF pilot permanent grounding during the period 2008–2017 and to compare our findings to the previous study of 1978–1987 to determine if disease patterns had changed.

METHODS: Material was obtained from the RCAF 1 Canadian Air Division Surgeon's medical registry of military pilots. Anonymized data for permanently grounded pilots were classified by medical diagnosis, age, and training status.

RESULTS: During the period 2008–2017, there were a total of 162 pilots permanently grounded, of which 110 were trained and 52 untrained.

DISCUSSION: In comparison to the 1991 study, there has been a decrease in permanent groundings due cardiovascular disease, but an increase due to mental health conditions, musculoskeletal issues, and motion sickness.

KEYWORDS: aviation, medical certification, diagnostic categories.

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It is now nearly 30 yr since the publishing of "Permanent Grounding and Flying Restrictions in Canadian Forces Pilots: A 10-Year Review."[11] The current study was initiated to determine if the most common medical causes of Royal Canadian Air Force (RCAF) pilot groundings have changed, with the goal of improving current aeromedical selection standards and providing improved countermeasures for problems leading to medical grounding.

Currently the aeromedical disposition of Canadian military pilots is reviewed at two locations. Prior to commencing training, aeromedical authority rests with the Canadian Forces Institute of Environmental Medicine. Once training begins, pilots are under the jurisdiction of the Aeromedical and Clinical Services Office at the RCAF 1 Canadian Air Division Surgeon.

Complex cases are reviewed by the Aerospace Undersea Medical Board, which is a national advisory panel of military medicine specialists that meets quarterly under the chairmanship of the RCAF Surgeon, who is the final aviation medical authority for the Canadian Air Force. When a Canadian military pilot is found medically unfit, they are assigned an A7 air factor. This may be temporary or permanent.

METHODS

The Office of the 1 Canadian Air Division Surgeon has a standalone registry that records all the medical decisions made by that office (including those discussed by Aerospace Undersea Medical Board). This database was examined for all those pilots who received a permanent A7 air factor between 1 January 2008 and 31 December 2017. The data were anonymized prior to review. The primary diagnosis causing the permanent grounding was noted and whether the pilot was trained (wings graduate) or in-training (designated as untrained in this paper). Data on those in the pilot classification prior to commencing training were not included in this study. The medical diagnoses were grouped (in order of frequency of groundings) as shown in **Table I**.

From the Royal Canadian Air Force, Winnipeg, Manitoba, Canada.

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Address correspondence to: Damian Haworth, M.D., Flight Surgeon, Royal Canadian Air Force, 38 Coriano St., Edmonton, Alberta T0A2H0, Canada; englishflydoc@hotmail.com.

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Table I. Distribution of Medical Conditions Resulting in Permanent Grounding.

CATEGORY	TOTAL	PERCENTAGE
Mental health*	38	23.46%
Musculoskeletal	34	20.99%
Motion sickness	16	9.88%
Neurological	15	9.26%
Eye conditions	10	6.17%
Ear, nose, and throat	8	4.94%
Cardiovascular conditions	7	4.32%
Diabetes/endocrine	6	3.7%
Other	28	17.28%

*This category included nine cases of substance use disorder involving drugs or alcohol.

Table II. Mental Health Diagnoses.

DIAGNOSIS	FREQUENCY
Depression	11
Anxiety	9
Substance Use Disorder	9
Suicide attempt	3
Insomnia	2
Bipolar	1
Adjustment Disorder	1
Eating Disorder	1
Personality Disorder	1
Total*	38

*21 trained, 17 untrained.

Statistical Analysis

There were four variables examined: year of permanent grounding, pilot age, medical diagnosis, and training status (trained vs. untrained). The statistical significance of the proportions of the medical causes in relation to the other variables were examined as follows:

1. Chi-squared test of training variable vs. diagnosis;
2. Chi-squared test of diagnosis (diagnosis type);
3. Chi-squared test of diagnosis (mental health vs. motion sickness); and
4. analysis of variance (ANOVA) age vs. diagnosis.

RESULTS

The database yielded 162 results of permanent pilot grounding due to medical reasons over the 10-yr period. Duplicate and incomplete records were removed. The distribution of medical conditions is provided in Table I and illustrated in **Fig. 1**.

Mental health issues were the leading cause of permanent grounding followed by musculoskeletal problems. **Table II** identifies the mental health diagnoses. Musculoskeletal disorder diagnoses are shown in **Table III**. **Table IV** indicates the neurological diagnoses resulting in grounding.

Regarding ENT problems, there were two each of Eustachian tube dysfunction, hearing loss, and barotrauma (two trained—hearing loss; six untrained—Eustachian tube, barotrauma). With respect to ophthalmological groundings, there were three cases of progressive myopia to beyond standards in untrained pilots, three cases of visual floaters, two problems with stereopsis/depth perception, and two cases of keratoconus in trained pilots.

For cardiovascular, there were three cases of coronary disease and two myocardial infarctions in trained pilots. Of note, there were no cases of valvular or structural heart disease that resulted in grounding over the 10 yr period. Under metabolic, there were four cases of Type 2 diabetes mellitus in trained pilots, and one Type 1 in an untrained pilot.

There was a statistically significant relationship of age to the pattern of medical diagnoses (ANOVA showed nine degrees of freedom, *P*-value 2.64e-11), with younger pilots showing a higher incidence of motion sickness and Eustachian tube dysfunction problems, and older trained pilots manifesting musculoskeletal problems. Mental health issues were prevalent in both age groups, with the trained pilots showing a high incidence of mental health

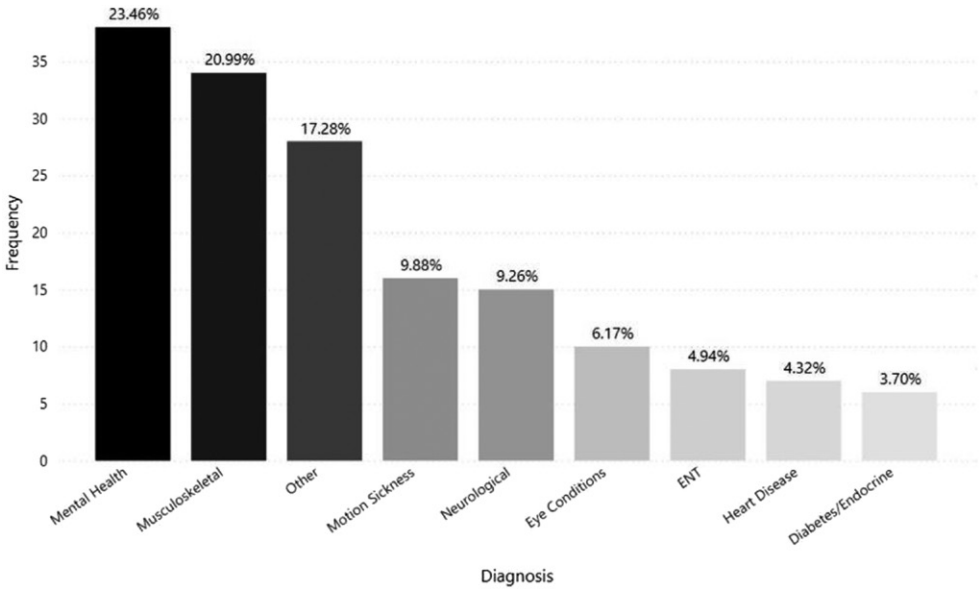

Fig. 1. Medical diagnosis in order of frequency.

Table III. Musculoskeletal Disorders.

DIAGNOSIS	FREQUENCY
Back pain	8
Chronic pain (general)	5
Shoulder disorders	4
Knee and ankle disorders	4
Generalized osteoarthritis	3
Inflammatory arthritis	3
Neck pain	2
Hip disorders	2
Other	3
Total*	34

*30 trained, 4 untrained.

issues in their fourth decade. **Fig. 2** depicts the relationship of pilot age to medical diagnostic categories, and **Fig. 3** shows the average age at time of diagnosis.

There were 110 trained pilots and 52 untrained pilots in this study. There was a statistically significant relationship between training status (trained vs. untrained) and certain medical diagnoses resulting in grounding (x-squared = 485.23, degrees of freedom = 272, and *P*-value = 3.277e-14). In untrained pilots, motion sickness was more common, while in trained pilots, musculoskeletal issues predominated. Mental health issues affected both trained and untrained pilots. **Fig. 4** depicts the relationship between training status and reasons for grounding.

Table IV. Neurological Diagnoses.

DIAGNOSIS	FREQUENCY
Migraine	5
Multiple sclerosis	3
Head injury	3
Narcolepsy	2
Altered consciousness	1
Seizure	1
Total*	15

*10 trained; 5 untrained.

DISCUSSION

If we compare our results to the 1991 study,[11] there are substantial differences. The previous study showed only 60 groundings over a 10-yr period compared to the 162 in ours. The prior study showed an annual permanent grounding rate of 2.2 per 1000 pilots.[11] Our study showed an annual grounding rate of 7.36 per 1000 pilots. The reason for this difference is not readily apparent. The previous study included both permanent groundings and permanent operational flying restrictions, which, when combined, totaled 7.7 per 1000 pilots. The current study does not include permanent operational flying restrictions. The difference in grounding rates could reflect a change in policy with respect to disposition for medical conditions, with more pilots in the earlier study allowed to continue flying with a flying restriction. Additionally, in the interval between the two studies the RCAF introduced specific aeromedical standards for aircrew, whereas previously aircrew had been considered under the broader medical standards for all Canadian Armed Forces personnel.[2]

van Leusden et al. found the most common causes of permanent grounding were cardiac disease and neurological conditions.[11] Cardiac disease (including coronary artery disease as well as valvular and structural heart problems) accounted for 42% of the permanent groundings between 1978–1987.[11] This

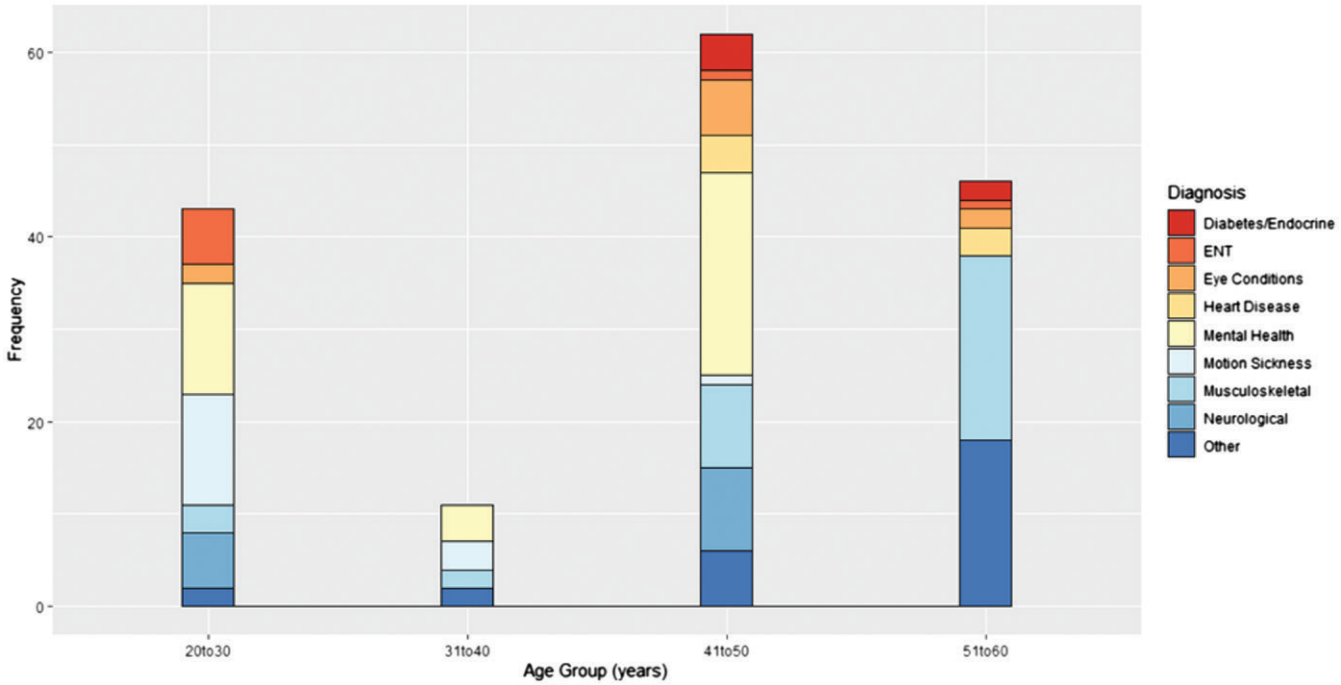

Fig. 2. Medical diagnosis frequency compared to age.

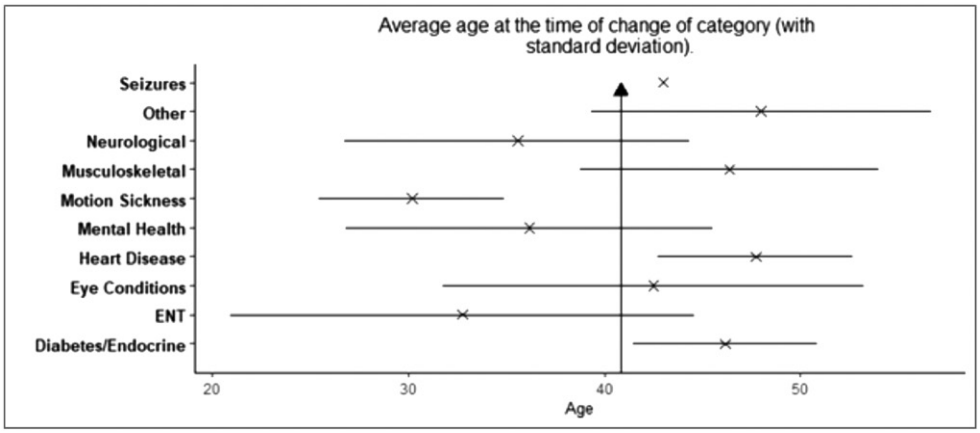

Fig. 3. Average age at time of grounding.

compares to 4.3% in the current study. This is nearly a tenfold reduction. Since the earlier study, the RCAF introduced an echocardiographic screening program for all pilot applicants.[5] Of note, there were no groundings in the present study for valvular or structural heart disease, suggesting the echocardiographic screening program has been successful. The RCAF has also initiated a screening program for coronary heart disease, with early intervention for all aircrew at increased risk and secondary investigation of those at high risk.[8] This suggests that the program, with emphasis on primary prevention and regular assessment of cardiovascular risk factors, has had the desired effect, with a substantial reduction in cardiac disease in Canadian military pilots. There has also been a major reduction in cardiovascular events in the population as a whole over the intervening 30 yr.[4]

The 1991 study also showed a high preponderance of neurological problems, causing 22% of permanent groundings (half of those cases were individuals with migraine).[11] This compares with 8.6% in our study. Again, the reasons for this are open to conjecture. However, the Canadian Forces Environmental Medicine Establishment has had an emphasis on screening for migraines during the pilot application process and it is possible more individuals are now being screened out during selection. Additionally, more pilots with migraine are now being allowed to return to flying with an operational flying restriction, generally "with or as copilot", with fewer permanent groundings.

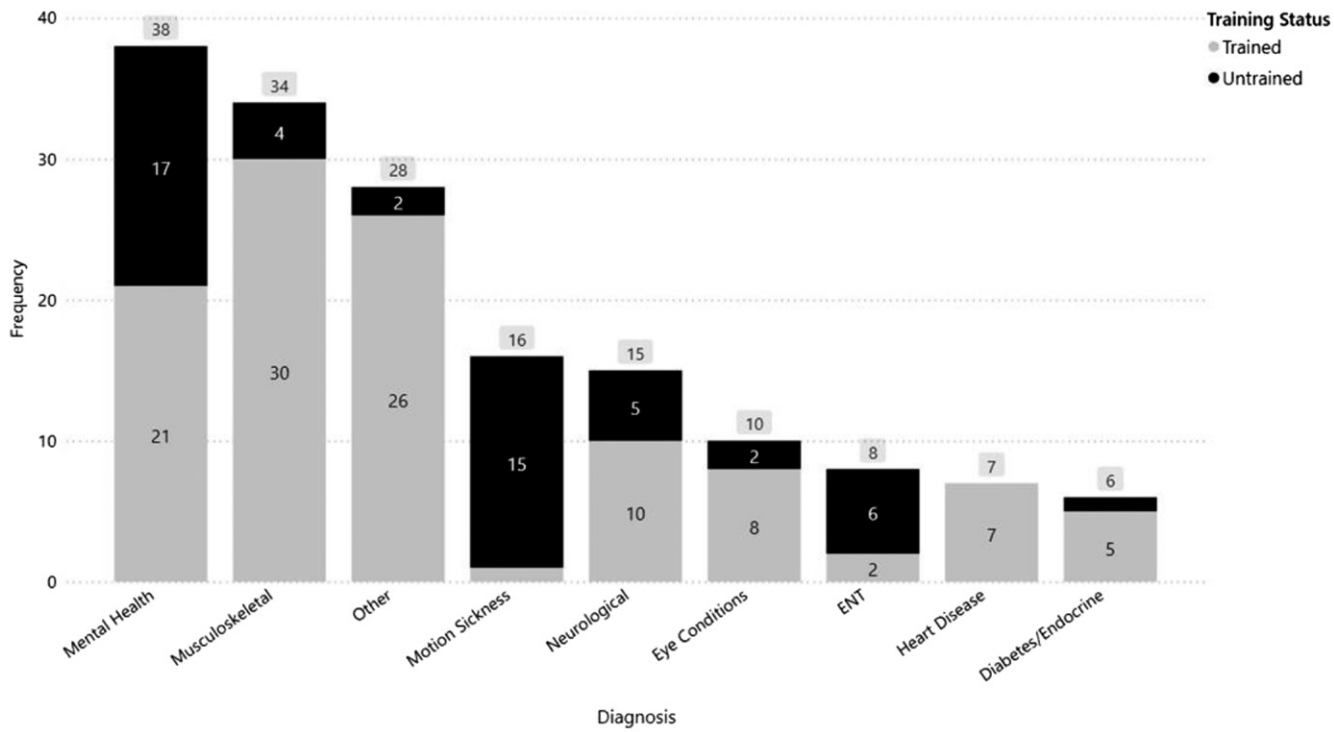

Fig. 4. Training status by diagnosis groups.

Psychiatric/mental health diagnoses contributed a large portion of the increase in groundings in the current study, perhaps reflecting the increased societal awareness and acceptance of mental health conditions as worthy of medical attention, including among aircrew.[3] Over the past three decades, pilot mental health has been an area of increasing attention and concern.[1,10] Pilots rarely sought attention for mental health issues unless desperate 30 yr ago. As a result of societal recognition and acceptance, more aircrew are seeking advice and support for mental health issues, including addiction. Since the last study, the RCAF has introduced protocols for assessing and treating depression with a return to duties while taking an SSRI,[9] as well as for substance abuse.

Age was a significant factor in causes of grounding. From the results of our study two distinct groups have emerged with differing disease profiles. There are the younger, untrained pilots and the older, experienced trained pilots. The data are not surprising, with younger pilots mainly having issues with motion sickness, while older pilots are more frequently grounded for musculoskeletal (MSK) problems, reflecting the MSK stressors of military flight operations, including rotary wing vibration and G stressors in fighter operations, both compounded by night vision goggles. Both groups included a significant proportion with mental health problems.

Most interestingly, the 1991 study showed that it was younger pilots who were most likely to have a medical restriction due to musculoskeletal problems.[11] This is a total reverse of our current study, in which MSK issues mainly affected pilots in the 40 to 50 yr age group. This would be consistent with cumulative damage, with degenerative changes manifesting with back and neck pain in middle age.

Both studies showed only one seizure causing a permanent grounding. Seizure is much feared as a cause of complete pilot incapacitation, but it is a rare event. EEG was used as a screening tool for RCAF pilots in the 1990s, but has subsequently been dropped from initial pilot examinations. It would be fair to say that its usefulness was limited since there was no increase in seizure disorders in the current study.

Looking at other studies, the U.S. Air Force permanent disqualification study of 1995–1999 showed similar results to the 1991 RCAF study.[7,11] Using U.S. Air Force medical waiver files, there were 157 permanent disqualifications during a 5-yr period, but this included both pilots and navigators.[7] The disqualification rate was 0.18% per year of the total U.S. Air Force pilot/navigator population.[7] This is roughly similar to the RCAF data. The most common causes for medical disqualification were coronary artery disease, neurological problems, MSK issues, and psychiatric conditions.[7] It should be noted that the two studies mentioned both date from the 1990s and that there have been substantial improvements in treatment options for cardiovascular risk factors as well as improvements in imaging for accurate diagnosis of coronary artery disease.

For a more recent disqualification study, Høva et al.[6] looked at Norwegian commercial pilot groundings between 2006 and 2010. Previously, cardiovascular disease had been the main medical reason for Norwegian pilot groundings. However, they hypothesized that increased work pressures in the airline industries may cause increased groundings due to mental illness. This did not prove to be true. They had 85 pilots disqualified between 2006–2010 with a pilot disqualification rate of 6.8 per 1000 pilot years.[6] The most common causes were neurological problems (25.9% of total), then cardiovascular disease (17.6%), and then psychiatry and ENT (both 15.3%).[6] While their study results are different, they do show a concurrent decrease in cardiovascular disease groundings.

Our study has shown two distinct pilot groups as regards permanent pilot groundings in the RCAF. There are the younger untrained pilots who are mainly affected by mental health issues and motion sickness. The other group is the older, trained pilots who also suffer from mental health issues, but have a much higher incidence of MSK conditions.

When looking at possible future interventions, we should consider these groups in turn. Looking at the trained pilots first, the key emphasis should be on retention of a trained asset. The high frequency of mental health issues would suggest a greater need for mental health support, including treatment options with a view to rehabilitation and return to flying duties (this would be particularly true with substance use disorders). For MSK problems, primary prevention with back and neck strengthening programs are being explored. This, coupled with engineering mitigations and open access to physiotherapy, may reduce the number of pilots over 40 being grounded for these issues.

With regard to untrained pilots, the decision process is twofold. Firstly, whether unsuitable pilot candidates can be detected in the initial medical selection process. Secondly, whether student pilots can be more effectively retained when they have completed a substantial part of their training. For mental health issues, this study raises the question of whether pilot applicants can be effectively screened for mental health disorders and also if student pilots can be better supported during their training. Motion sickness is a common problem among student pilots. However, this study has shown an alarming number of permanent student groundings due to this condition (there is a substantial dollar value for each student who is released from pilot training). The RCAF motion sickness desensitization program is currently being modified to be more in line with the U.S. Air Force approach. It is hoped this will improve efficacy in supporting student pilots through pilot training.

On a final note, our colleagues of 30 yr ago have been successful in reducing the frequency of permanent groundings due to cardiovascular disease. Let us hope we can emulate their success with pilot mental health, MSK issues, and motion sickness treatment.

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Authors and Affiliations: Damian Haworth, M.B.Ch.B., M.P.H., Flight Surgeon, Royal Canadian Air Force, Winnipeg, Manitoba, Canada; Gary Gray, M.D., Ph.D., Canadian Forces Environmental Medical Establishment, Toronto,

Ontario, Canada; Richard Zoltenko, B.A., Division Surgeon's Office, 1 Canadian Air Division, Royal Canadian Air Force, Winnipeg, Manitoba, Canada; and Alireza J. Bashirzadeh, M.Sc., M.Sc., Alberta Health Services, Alberta, Canada.

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