The Aeromedical Management of Allergic Rhinitis

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INTRODUCTION: Allergic rhinitis is a prevalent condition warranting special aeromedical consideration due to its potential for acute and painful manifestations involving the middle ear or paranasal sinuses during rapid barometric pressure changes. Although second generation antihistamines and intranasal steroids are safe and effective treatments for this common condition, aeromedical management varies.

METHODS: An aeromedical policy review of 14 public access civil and military data repositories was undertaken. Policy within a convenience sample of nine countries (Australia, Canada, Croatia, France, New Zealand, Norway, Sweden, United Kingdom, and United States) was further ascertained through subject matter expert consultation. A convenience sample of recent primary care review articles and ENT guidelines were reviewed in order to substantiate the evidence basis for aeromedical practices.

RESULTS: Policies range from disqualification of flight applicants with any history of allergic rhinitis to the authorization of short-term, select undeclared medication use for the management of mild symptoms, with military authorities applying a more conservative approach. A range of intranasal and oral therapies are approved and requirements for waiver vary across most authorities.

DISCUSSION: Variation in practices must be considered when managing flight crews as part of military coalition peacetime and combat operations, as well as for international civil aviation missions conducted in support of natural disaster relief, rescue, and other stability efforts. Standardization of approved therapies for allergic rhinitis could be a useful starting point for the harmonization of aeromedical global policies in the future. Beneficial national specific policy updates may be undertaken on the basis of international experience.

KEYWORDS: aeromedical, allergic, rhinitis, hay fever.

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Allergic rhinitis is recognized by aeromedical specialists as an important and prevalent condition, affecting up to 30% of adults worldwide.[2] Allergic rhinitis is an immunoglobulin E-mediated disease that occurs after exposure to indoor or outdoor allergens, such as dust mites, animal dander, molds, and pollen. Symptoms include rhinorrhea, sneezing, and nasal congestion, obstruction, and pruritus.[35] Management options include allergen avoidance, nasal saline irrigation, pharmacotherapy, and immunotherapy. This condition requires special aeromedical consideration due to the potential for distraction during key stages of flight. Mucosal edema affecting the paranasal sinus drainage pathways in the nose or the mucosa of the Eustachian tube and middle ear in an individual suffering from allergic rhinitis significantly increases the potential for sinus or middle ear barotrauma. The potential for barotrauma is greatest during descent, such as prior to landing in all aircraft or during high energy periods of aeronautical maneuvering in tactical military aircraft. The sinus and middle ear pain that occur secondary to barotrauma can be considerable; visual changes, conductive hearing loss, and sneezing associated with allergic rhinitis can compound the issue of distraction from flight duties. Appropriate aeromedical disposition and treatment of pilots with allergic rhinitis is therefore critical.

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Comprehensive symptoms and proposed treatment of allergic rhinitis have been described since the 10th century, in which Persian physician Abū Bakr Muhammad ibn Zakariyyā al-Rāzī, known as Rhazes in the Western world, advocated covering the head in cold weather, abstaining from drinking cold water, as well as smelling musk and myrrh as preventative measures. His proposed remedies included dipping a fabric in the nose, fumigation, shaving the head and rubbing mustard and allium on it, and ear or forehead bloodletting.[1] In 1873, Blackley described a series of experiments linking pollen exposure to allergic rhinitis, and determined that high altitude and seaside environments could be conducive to alleviation of symptoms. He advocated self-quarantine within select rooms of the house with extensive fabric barriers placed into room entrances during high pollen seasons, as well as physical relocation to coastal areas, and avoidance of fumes and cold air. He conducted an extensive series of experiments in treatment, determining intranasal metal filters and most formulations of distilled chemicals were unsatisfactory, with the unfavorable side effects of arsenic particularly offsetting any benefit.[7] In the early 1900s, von Pirquet determined that the interaction between endogenous and exogenous factors was key in the development of allergic symptoms, laying the foundations for antihistamine and steroid therapies.[20]

From the time of Theodore Lyster, it has been recognized that physical conditions greatly impact safety of flight and that medical assessments are a vital part of aviation safety. An understanding of normal anatomy and aeromedical consequences of its abnormalities is critical in ascertaining specific safety implications. As outlined in Davis et al.'s "Fundamentals of Aerospace Medicine":[27]

> *"The nose and paranasal sinus may be considered as a single unit because normal sinuses are aerated in direct communication with the air in the nasal cavity. Both structures are lined with ciliated mucosa that normally produce a thin mucus blanket that is slowly transported by ciliary action to the nasopharynx, where it is eventually swallowed. The nares perform critical functions of humidification, warming, cleansing of inspired air, in addition to olfaction. The nose and sinus lend a characteristic resonance to speech that can change …during the course of a sinonasal infection. Within the nasal cavity there are three pairs of tubinates. The inferior turbinates are highly vascular and can readily engorge with blood in response to inflammatory or autonomic stimuli. The middle turbinates…are capable of some swelling and can develop polypoid dengeration in response to assorted irritants such as nasal allergens or chronic purulent sinus drainage. Normal rhythmic back and forth nasal air flow also creates a small amount of airflow into and out of the sinuses, thereby maintaining normal oxygen pressure within. Interruption of this airflow coupled with compromise of ciliary action can lead to mucus stagnation and an increased likelihood of infection. Conditions that cause infection or blockage of the ostia and nasal cavity favor the development of bacterial sinusitis. These include viral upper respiratory infections, significant allergic rhinitis (particularly when accompanied by nasal polyps), overuse of decongestant sprays, and even inhalation of excessively dry air.*[27]

> *"The Eustachian tube is the only route for air to leave the middle ear when the tympanic membrane is intact. The Eustachian tube also provides a drainage route for mucus secreted by the middle ear mucosa and is the primary route for pressure equalization. The Eustachian tube is closed most of the time; opening usually happens without our awareness, chiefly by contraction of the tensor veli palantini muscle during swallowing and yawning."*[27]

Allergic symptoms can cause swelling of the mucosal lining of the Eustachian tube that can be sufficient to cause dysfunction and/or failure of Eustachian tube opening, leading to trapped gas at altitude and/or conductive hearing loss when the middle ear's ambient pressure is changed from the external ambient pressure. Barotitis media, caused by the rapid decrease in middle ear pressure that can occur within the middle ear during descent in an individual with allergic rhinitis who is unable to "open" the Eustachian tube due to mucosal swelling, may result in an effusion (serous or hemorrhagic) and is typically associated with significant pain. Employing the Valsalva, Toynbee, and/or Frenzel maneuvers, yawning, deviating the chin and tilting the head away from the side of the ear block, and application of intranasal decongestant may help alleviate this pain when occurring emergently in flight, but often ascent to a higher altitude is required to resolve an ear block. Breathing high concentrations of oxygen for extended periods of time allows the middle ear "air" to reach a higher percentage of oxygen. In the presence of Eustachian tube dysfunction (or when an individual goes to sleep shortly after an extended flight in which they were breathing oxygen), a larger volume of this oxygen enriched middle ear atmosphere is absorbed by the middle ear mucosa and this can also create significant negative middle ear pressures, leading to ear block, especially in predisposed individuals. This is referred to as oxygen barotitis or delayed barotitis media.[27]

Allergic rhinitis is an example of an aeromedical problem with variable timing and severity of symptoms, treatment but no cure, risk of catastrophic failure during critical phases of flight, and treatment that has significant negative side effects. Public safety is at significant risk when flight is undertaken with uncontrolled allergic rhinitis or with the use of sedating medication. Yet pilots, fearing stigma and disqualification due to treatment, may be unwilling to disclose the extent of symptoms, electing to self-manage with potentially dangerous medications or forgoing any treatment at all. Risk management must consider baseline risk of temporary disqualifications due to common colds in otherwise healthy adults compared to potentially chronically recurrent disqualifications and associated risks for in-flight emergency in a pilot with chronic allergic rhinitis who is certified for flight. Economic, military, and political factors may contribute toward loosening or tightening existing aeromedical policies. A review of international policies and, where data is available, how such policies have been established will be discussed.

Guidelines for the diagnosis and management of allergic rhinitis, a condition significantly contributing to ear and paranasal sinus barotrauma, have evolved over time and are increasingly standardized throughout professional organizations. The International Primary Care Respiratory Group (IPCRG),[29] British Society for Allergy and Clinical Immunology (BSACI),[32] American Academy of Allergy, Asthma and Immunology

(AAAAI),[26,41] American College of Allergy, Asthma and Immunology (ACAAI),[26,41] the proponents of the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines,[8,22] and a number of other authorities[33,35,42] recommend intranasal corticosteroids for the initial treatment of persistent symptoms affecting quality of life and second-generation nonsedating antihistamines for mild intermittent disease.

Clinical severity is determined by impact on quality of life, with most treatment algorithms indicating allergy testing and immunotherapy referral for refractory symptoms.[35] A variety of approaches have been taken with regards to the evaluation of flight candidates who have a history of allergic rhinitis symptoms, with history and basic physical exam universally required across military and civil aeromedical authorities. The U.S. Navy advocates sinus plain film testing as part of the initial evaluation for aviation duties in an individual with symptoms suggestive of allergic rhinitis[39] and the U.S. Air Force requires CT imaging for personnel with chronic sinusitis.[37]

Medications for the control of allergic rhinitis in flight crews should be considered in the context of efficacy as well as side effect profile. Intranasal corticosteroids act by decreasing the influx of inflammatory cells and inhibiting the release of cytokines, thereby reducing inflammation of the nasal mucosa.[35] Their onset of action can be less than 30 min, although peak effect may take days, with maximum effectiveness usually noted by 4 wk of use.[15] Intranasal corticosteroids are more effective than oral, as are intranasal antihistamines, in the treatment of persistent or more severe allergic rhinitis.[35] There is no evidence that one intranasal steroid is superior.[15] The most common adverse effects are throat irritation, epistaxis, stinging, burning, and nasal dryness.[35] The correct application of spray can limit septal irritation.

First-generation antihistamines are unquestionably associated with adverse cognitive effects[4] and have been found in 11% of pilot autopsy reports involving U.S. civil air accidents.[34] Compared with first-generation antihistamines, second-generation drugs apart from cetirizine cause less sedation and other adverse side effects.[4] Second-generation nonsedating oral antihistamines include desloratadine, fexofenadine, loratadine, and levocetirizine, with bilastine being the newest in its class.[40] Bilastine has been reported to be more effective than fexofenadine and comparable to placebo with respect to sedation profile on cognitive tests at altitude.[40] Second-generation antihistamines other than cetirizine do not significantly cross the blood-brain barrier. The use of medications can indicate more than mild, intermittent disease and often requires further medical evaluation or opinion for use during flight.

Intranasal antihistamine use was historically limited by adverse effects, twice daily dosing, cost, and decreased effectiveness compared with intranasal corticosteroids.[5,35] More recent studies suggest an emerging role of the intranasal antihistamine azelastine. Indicated for the treatment of both allergic and nonallergic rhinitis in both adults and children, azelastine offers a rapid onset of action (15 min) and flexibility of both doses (i.e., one or two sprays/nostril twice daily), as well as length of utilization (i.e., fixed or as needed). Compared with other agents used to treat allergic rhinitis, azelastine nasal spray exhibits superior efficacy to oral antihistamines (e.g., desloratadine and cetirizine), other intranasal antihistamines (e.g., levocabastine), and the intranasal corticosteroid mometasone furoate, and comparable efficacy to the potent intranasal corticosteroid fluticasone propionate (FP).[5,6,14,19] Combination therapy with intranasal FP has the potential to enhance clinical benefit, as the combination of azelastine and FP nasal sprays reduce symptoms in allergic rhinitis patients more than either agent alone. Azelastine nasal spray has an excellent safety profile.[19]

Oral decongestants may cause headache, elevated blood pressure and intraocular pressure, tremor, urinary retention, dizziness, tachycardia, and insomnia. Both intranasal cromolyn and ipratropium are less effective than first-line therapies and require multiple daily doses.[35] The leukotriene D4 receptor antagonist montelukast is comparable to oral antihistamines and treats concomitant asthma, but is less effective than intranasal corticosteroids.[35] Immunotherapy is undertaken for refractory symptoms, but can be waived for use by some aeromedical regulatory organizations in conjunction with short-term flight restriction. The effectiveness of acupuncture, probiotics, and herb and plant extract compounds have not been established.[35] The efficacy of measures to eliminate dust mites has most recently been debunked.[35]

MP-AzeFlu is a novel intranasal formulation of azelastine hydrochloride (AZE) and FP delivered in a single spray. This medication is emerging as a first-line treatment for moderate to severe symptoms as it has surpassed intranasal steroids in terms of symptom control and treatment response.[23,24] Initial short- and long-term studies support the safety of this medication.[24] Other new treatments for persistent allergic rhinitis include H3 antihistamines, toll-like receptor (TLR) agonists, cellulose powders and microemulsions, novel biomolecular formulations, and omalizumab.[25] These newer medications warrant further investigation regarding safety in the flight environment.

The authors reviewed a convenience sample of civil and military aeromedical policies from countries within the North American, Balkan, Pacific, Scandinavian, and Western European regions, with exclusion of space-related aeromedical policies. Internationally, military aviation policies regarding allergic rhinitis are more conservative than civil aviation policies. The use of first generation antihistamines is universally restricted across military and civil aeromedical regulatory organizations within the reviewed nations due to an unacceptable risk for sedation. Civil and military aeromedical policies for reviewed organizations are summarized in **Table I** and **Table II**, respectively.

International Civil Aviation Organization (ICAO). ICAO provides aeromedical guidance to both NATO and non-NATO nation members. While not all diseases are specifically addressed by ICAO, this organization warns aeromedical examiners to be alert for the diagnosis of 'hay fever' and advises them to caution pilots on the dangers of medication use.[21] Commission Regulation European Union (EU) No. 1178/2011 of 3 November 2011 stipulates technical requirements and administrative procedures related to civil aviation aircrew

Table I. International Civil Aeromedical Policies for Management of Allergic Rhinitis.

COUNTRY	AEROMEDICAL AUTHORITY (POLICY DATE)	CONDITION APPROVED FOR ENTRY	DIAGNOSTIC TESTING REQUIREMENTS	APPROVED CLASSES OF MEDICATION	SPECIFICALLY UNAPPROVED MEDICATIONS	WAIVER SPECIFICALLY REQUIRED
Multiple	ICAO[22] (2012)	Yes	None	Not specified	Not specified	Not specified
Multiple; Croatia, France, Norway, and others	EASA[18] (2011)	Yes; Conditional: Normal nose/sinus function.	None	'Medication compatible with flying'	Not specified	Further medical evaluation is required for class 1 applicants with significant nasal passage restriction and/or sinus dysfunction.
Australia	CASA[3] (Unavailable)	Yes; Conditional: Normal inner ear and sinus function.	None	inS (intermittent use), NSAH (select), inD (intermittent use)	inD (if required for equilibration)	N/A; Reporting is required if symptoms are severe and/or last 7 d or longer.
Canada	Civil Aviation Medicine Branch, Transport Canada[11,13] (2007)	Yes; Conditional: Pressure equalization must be normal. Free nasal and sinus airflow. No permanent Eustachian tube obstruction.	None	Clinical judgment	Not specified	Waiver with central review required for unfit conditions.
New Zealand	CAA[12] (2016)	Yes; Conditional: Very mild symptoms. If medications used must be approved and control symptoms.	None	inS, NSAH* (select) if nasal steroids alone do not control	SAH (including cetirizine) when used within 48 h of flight.	Waiver required for use of IM steroids.
United Kingdom	CAA[37] (2012)	Yes; Conditional: Normal sinus function.	None	Clinical judgement	Not specified	Not specified
United States	FAA[19] (2015)	Yes; Conditional: Must not be severe in nature.	None	NSAH*	SAH when used within five dosing intervals of most recent dose.	Waiver with FAA review required for severe allergy.

* Only after ground trial.

CAA: Civil Aviation Authority; CASA: Civil Aviation Safety Authority, Australia; EASA: European Aviation Safety Agency; ICAO: International Civil Aviation Organization; inD: intranasal Decongestants; inS: intranasal Steroids; NSAH: Non-Sedating Antihistamines; SAH: Sedating Anti-Histamines.

pursuant to Regulation (EC) No. 216/2008 of the European Parliament,[16] with further aeromedical guidance provided by a separate document, the Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No. 1178/2011.[17]

The European Aviation Safety Agency (EASA), the Commission Regulation (EU), and Acceptable Means of Compliance policies address the general rather than specific medical conditions of pilots. However, several national civil aeromedical policies in our review specifically address allergic rhinitis as a medical condition with special considerations. The civil aeromedical policies regarding allergic rhinitis are outlined below and in Table I.

Australian Civil Aviation Safety Authority (CASA). Initial certification, conducted in accordance with the Clinical Practice Guidelines for Designated Aeromedical Examiners, requires normal middle ear and sinus function. Diagnostic requirements for candidates with a history of allergic rhinitis are not specified beyond the physical exam. For pilots with symptoms of allergic rhinitis, the use of nonsedating antihistamines, intermittent use of intranasal decongestant, and/or regular use of intranasal steroids are acceptable if the condition does not cause pain or distraction. Desloratadine, fexofenadine, and loratadine are approved without reporting if symptoms are mild and last less than 7 d. Intranasal decongestants, when required to enable equalization, are not considered compatible with flight. Formal reporting and medical evaluation are required when symptoms persist 7 d or more.[3]

Canadian Civil Aviation Medicine Branch. The Civil Aviation Medicine Branch of Transport Canada mandates self-declaration of an allergic condition on the aeromedical examination of initial and subsequent certifications, but does not provide specific guidance about the management of allergies.[11,12] Pressure equalization must be normal, nasal and sinus airflow must be free, and permanent Eustachian tube obstruction must be absent in pilots and pilot candidates.[11,12]

Croatian Civil Aviation Agency (CAA). The Croatian Civil Aviation Authority applies EASA standard Commission Regulation (EU) No. 1178/2011, Annex IV, Part Med, Subpart B.[13] This regulation does not explicitly address allergic rhinitis, but stipulates that "applicants shall not possess any abnormality of the function of the ears, nose, sinuses or throat, including oral cavity and larynx, or any active pathological condition, congenital or acquired, acute or chronic, or any sequelae or surgery or trauma which is likely to interfere with the safe exercise of the privileges of the applicable license." Applicants for a Class 1 medical certificate with significant restriction of the nasal passages and sinus dysfunction shall undergo further medical examination and assessment to establish that this condition does not interfere with the safe exercise of the

Table II. International Military Aeromedical Policies for Management of Allergic Rhinitis.

AUTHORITY (POLICY DATE)	APPROVED FOR ENTRY	REQUIRED TESTS	APPROVED MEDICATION	UNAPPROVED MEDICATIONS	WAIVER CONDITIONS
Australian Defense Force[3] (no date)	Yes; must not be severe or uncontrolled; no history of surgery.	None	inS* (select); NSAH* (select); inCA*	SAH	Considered following desensitization & minimal symptoms
Royal Canadian Air Force (2016)	Yes; not chronic; normal ventilation of paranasal sinuses and normal middle ear function.	None	inS; NSAH* (select); inAH; inD**; inCA; intranasal Saline Rinse	SAH; oD; oS	Considered on a case-by-case basis
Croatian Air Force[24] (2014)	Yes; ENT endorsement required.	None	inS; NSAH	SAH	Annual ENT evaluation
Danish Armed Forces Health Service	No; any history is disqualifying.	Not specified	inS; NSAH* (select/ loratadine only) if inS do not control	SAH; oS	Considered following effective trial of immunotherapy
French Military Aviation Authority (2008)	Yes; no Eustachian tube dysfunction, nasal obstruction or polyps.	Tympanometry	inS; NSAH; inD**	SAH; oS	Waiver required for nasal polyps, pulmonary manifestation, oral steroid or following surgery
Royal New Zealand Air Force (draft policy)	Yes; mild & intermittent symptoms only.	None	inS; NSAH* (select)	SAH	Considered for immunotherapy All medication use requires review
Royal Norwegian Air Force (2011)[27]	Yes; mild & seasonal only.	ENT review and hypobaric assessment	inS	SAH	Considered for immunotherapy
Swedish Armed Forces	Yes; must be well controlled using approved medications.	None	inS; NSAH (select)	SAH	Not specified
UK Royal Air Force[28] (2016)	Yes; only if no symptoms for 4+ yr (recently liberalized).	None	inS; NSAH (select)	SAH	Not specified
U.S. Navy[36] (2016)	Yes; minimum 12 mo since last dose of immunotherapy.	Waters view (Sinus X-ray)	inS; NSAH (select)*; montelukast*, inCA; inAH* (azelastine only)	SAH; inAH containing decongestant	Considered for immunotherapy
U.S. Army[35] (2014)	Yes; assessment required if known ENT treatment, immunotherapy within 5 yr, or use of oral steroids.	None	inS; NSAH (select); inCA; inAH; short acting decongestants	SAH	Required if known ENT treatment, immuno-therapy within 5 yr or use of oral steroids
U.S. Air Force[34] (2013)	Yes; if mild***	CT required if chronic sinusitis	inS; inAH (olopatadine only); NSAH* (select); inCA; oD	SAH; NSAH containing-decongestant	Considered for montelukast therapy and immunotherapy

inAC: intranasal Anti-Cholinergics; inAH: intranasal Anti-Histamines; inCA: intranasal Cromoglicic Acid; inD: intranasal Decongestants; inS: intranasal Steroids; NSAH: Non-Sedating Antihistamines; oD: oral decongestants; oS: oral Steroids; SAH: Sedating Anti-Histamines.

* Only after ground trial; Australia (7 d), Canada (minimum 3 d), Denmark (7–14 d), New Zealand (not specified), United States Navy (7 d), United States Air Force (minimum 3 d for NSAH, ground only for duration of active symptoms for all other medications).

** Emergency use only.

*** For FC 1/1A pilots, USAF authorizes monotherapy with a single approved agent only.

privileges of the license held (Lt. Col. Ljiljana Belošević, Head of Occupational Medicine Department, Croatian Military Medical Centre, Head of Aeromedical Centre, and Medical Assessor in Croatian Civil Aviation Agency. Personal communication; 17 January 2017).

French Civil Aviation Authority (CAA). The certification of French professional civil aviation pilots is governed by Regulation (EC) of the European Parliament,[13] and its acceptable means of compliance,[17] which lack specific reference to allergic rhinitis. For French civil aviation, the main consideration is tubal air flow (Col. Sébastien Coste, Chief of the Aviation Medicine Training Centre of the French Military Health Service Academy. Personal communication; 30 January 2017).

New Zealand Civil Aviation Authority (CAA). New Zealand permits the initial and subsequent medical certification of civil aviation pilots with allergic rhinitis provided that the condition is mild and successfully treated with approved medications. The use of loratadine, desloratadine, or fexofenadine is approved when intranasal steroids do not control symptoms, following a ground trial. Other antihistamines must not be used within 48 h of flight.[10]

Norwegian Civil Aviation Authority (CAA). Norwegian civil aviation policy follows the Regulation for Aircrew, European Aviation Safety Agency (EASA).[17]

UK Civil Aviation Authority (CAA). The UK civil aeromedical policy is guided by EASA and additional material issued by the UK CAA Medical Department. Aeromedical policy

does not explicitly address allergic rhinitis, but stipulates that applicants shall not possess any abnormality of the function of the ears, nose, sinuses, or throat which is likely to interfere with the safe exercise of the privileges of the applicable license(s). Any sinus dysfunction is considered unfit until resolved.[36]

U.S. Federal Aviation Administration (FAA). U.S. civil aviation pilot applicants and certified pilots may fly with seasonal allergies and use nonsedating antihistamines after an unspecified 'adequate initial trial.' The use of sedating antihistamines is restricted for at least five dosing intervals from the time of the last dose taken.[18] In 2010, the FAA recorded 10,834 waivers for allergic rhinitis.[2]

NATO does not promulgate guidelines regarding military aeromedical disposition. A summary of select individual policies follow, with some national military aeromedical policies unavailable through public access websites. These policies are also delineated in Table II. While most countries have a unified military aeromedical policy, the armed service branches of the United States differ from one another with regards to certification standards, diagnostic requirements, and approved medications.

Royal Australian Air Force (RAAF). Initial applicants who require medications for allergic rhinitis can be considered for pilot training if the symptoms are not severe. Applicants who have completed an immunotherapy program are also considered.[4] Specific medications may be used after a successful 7-d ground trial. Approved medications are select nonsedating antihistamines (fexofenadine, loratadine), select intranasal steroids (beclomethasone, budesonide, fluticasone), and intranasal sodium cromoglycate (Wg. Cdr. Joleen Darby, Commanding Officer, Institute of Aviation Medicine, RAAF Edinburgh. Personal communication; 7 February 2017). A waiver is required for active pilots or pilots in training who develop a medication requirement for control of allergic rhinitis symptoms.

Royal Canadian Air Force (RCAF). Chronic sinusitis (defined as a sinus infection for more than 3 mo) and chronic rhinitis of any cause that may interfere with the performance of flying duties are both disqualifying conditions for medical certification of initial aircrew applicants. Any chronic disorder or defect which interferes with normal ventilation of the paranasal sinuses or middle ear is also considered to be disqualifying for applicants. Trained aircrew with upper respiratory infections or allergy-related congestion are grounded until normal Eustachian tube function has returned, confirmed by examination by an RCAF aviation medicine provider. The use of loratidine, desloratidine, or fexofenadine to manage symptoms of allergic rhinitis is permitted in RCAF aircrew, but only after a nonflying trial period of at least 3 d has been completed. Once the minimal dosage required to effectively control symptoms has been established and absence of side-effects has been determined, aircrew may be returned to flying duties. Once successfully trialed in aircrew, grounding is not required for recurrent, intermittent use of these three second-generation antihistamines. First-generation antihistamines, newer antihistamines which produce drowsiness and CNS side-effects, such as clemastine and cetirizine, and systemic decongestants are not recommended for use in RCAF aircrew. Intranasal decongestants may be considered on a case-by-case basis. Intranasal antihistamines, intranasal corticosteroids, sodium cromoglycate, and saline rinses may be used in aircrew for allergic rhinitis and do not require a flying restriction (Major Erin Smith, Head of Military Medicine Section, Canadian Forces Environmental Medicine Establishment, Canadian Armed Forces. Personal communication; 1 March 2017).

Croatian Air Force. Croatian pilot candidates and license holders with history of allergic/vasomotor rhinitis may be assessed fit to fly. A specialist ENT exam is required for initial and recertification medical examinations, with fitness to fly determined on a case-by-case basis. Aeromedical decision making takes medical history, clinical expression of disease, clinical findings, medications, and aircraft flown into account. Second-generation antihistamine and intranasal steroid use is permitted[28] (Lt. Col. Ljiljana Belošević, Head of Occupational Medicine Department, Croatian Military Medical Centre, Head of Aeromedical Centre and Medical Assessor in Croatian Civil Aviation Agency. Personal communication; 17 January 2017).

Royal Danish Air Force. For Royal Danish Air Force initial pilot applicants, a disclosed history of allergies is disqualifying. In trained pilots who develop allergic rhinitis, the use of nasal steroids such as budesonide, fluticasone, and mometasone are acceptable if pulmonary manifestations and/or systemic steroid use is absent. Second-generation oral antihistamines are considered if symptom resolution is not achieved through intranasal steroids; however, only loratadine is accepted and must be ground tested for 1 to 2 wk prior to use in flight. If allergic rhinitis worsens, pilots are eligible for a 1- to 2-yr desensitization program, but require a waiver and are restricted from flight for 12 h after each injection (Lars Rosenkvist, M.D., D.Av.Med., AOPO, Associate Medical Chief, Danish Armed Forces Health Service and Aeromedical ENT Consultant, Danish Civil Aviation Administration, Denmark. Personal communication; 19 December 2016).

French Air Force. For French military pilot applicants with allergic rhinitis, qualification is determined on a case by case basis. Nasal polyps are specifically disqualifying. Pilots with a new diagnosis of allergic rhinitis can be certified if there is no tubal disturbance or surgical requirement. For seasonal and perennial allergic rhinitis, the use of intranasal steroids or nonsedating second-generation antihistamines is acceptable. The use of vasoconstrictive intranasal decongestant is tolerated for emergency use to limit the risk of barotrauma. Pulmonary manifestations and a need for systemic steroids are disqualifying.[9] Aeromedical policy is established from expert consensus (Col. Sébastien Coste, Chief of the Aviation Medicine Training Centre of the French Military Health Service Academy. Personal communication; 30 January 2017).

Royal Air Force of New Zealand. Given a high incidence of allergic rhinitis in the country, the Royal Air Force of New Zealand cannot afford to reject all candidates suffering from this condition. Entry with allergic rhinitis is, therefore, acceptable if it is mild with a short season and can be easily controlled by intranasal treatment. Intermittent use of nonsedating oral antihistamines is permitted. Candidates who require regular oral

treatment for long periods, any steroid requirement, and/or have other atopic conditions, such as asthma or severe eczema, are rejected. Candidates who have completed successful desensitization therapy can be considered for entry. All aircrew undergo hypobaric training, at which time fitness for flying training is further assessed. Serving aircrew who have, or develop, allergic rhinitis should first be treated by intranasal medication. If this is unsuccessful, oral, nonsedating antihistamines can be used. Medications compatible with flying are loratadine (first choice) and desloratadine or fexofenadine (second choices). A ground trial is required prior to resuming flying duties. In addition, if the condition is moderate to severe, the pilot is designated as unfit for solo flight (Wg. Cdr. A. D. K. Campbell, Royal New Zealand Air Force, Officer Commanding Aviation Medicine Unit. Personal communication; 24 February 2017).

Royal Norwegian Air Force. All Royal Norwegian Air Force aircrew applicants are examined by an ear, nose, and throat (ENT) specialist. The ability to equalize pressure in the middle ear and sinuses must be demonstrated in an altitude chamber test to 8000 ft (ascent rate 20,000 ft/min, descent rate 4000 ft/min). The ENT specialist will normally observe or be inside the chamber during this test. Tympanic membranes are evaluated before and after the test. Applicants shall not possess any abnormality of the function of the ears, nose, sinuses, or throat which can increase the risk of flying. Any sinus dysfunction is considered unfit until resolved and the Royal Norwegian Air Force follows the U.S. Air Force's policies[37] in this regard. For certified pilots, the transient and occasional use of approved drugs for a mild degree of rhinoconjunctivitis during the pollen season may be approved by the Aviation Medical Board; however, year-round use is disqualifying. Pollen desensitization may be approved as treatment if satisfactory results are documented by a physician with expertise in allergies.[30]

Swedish Armed Forces. The Swedish military will accept initial flight candidates who have well controlled allergic rhinitis. If medications are used, they must be approved. Intranasal steroids are accepted for treatment. Desloratadine and loratadine are the first and second choice, respectively, for systemic therapy (Lt. Col. Robert Wetterholm, Chief Flight Surgeon, Swedish Air Force. Personal communication; 10 January 2017 and 22 February 2017).

UK's Royal Navy, Army Air Corps, and Royal Air Force. Historically, UK aircrew candidates must have been free of treatment and symptoms of allergic rhinitis for a minimum of 4 yr. Candidates who did not meet these criteria were rejected. However, since 2017, candidates with mild symptoms, fully controlled by approved medication, are now considered for helicopter and air transport roles. New generation oral antihistamines are considered safe and effective, but should only be used in aircrew if intranasal preparations have proved ineffective or intolerable. In this case, desloratadine, fexofenadine, and loratadine are approved.[31]

U.S. Army, Navy, and Air Force. Uncomplicated, mild allergic rhinitis is not considered disqualifying for any of the U.S. armed aviation services.[2,37–39] The U.S. Navy requires plain film sinus X-ray imaging in all candidates who endorse a history of allergic rhinitis[39] and the U.S. Air Force requires a sinus CT for any candidate with a history of chronic sinusitis.[37] No imaging is required for the initial certification of U.S. Army pilots with uncomplicated allergic rhinitis.[38] Approximately 2% of all disqualified U.S. Air Force and Army candidates were disqualified as a result of uncontrolled allergic rhinitis.[2] A U.S. Air Force review revealed 4686 submitted cases with 321 disqualifications, with the vast majority of disqualifications for causes other than the diagnosis of allergic rhinitis (Col. Daniel Van Syoc, Deputy Chief, USAF Aeromedical Consultation Service USAF (Ret.). Personal communication; 17 January 2017). The U.S. Army reviewed 531 allergic rhinitis waivers for a population of 160,000 individual crewmen, denying 69 entry to flight service.[2]

For the management of symptoms, all U.S. armed services will consider the use of additional medications beyond intranasal steroids and second-generation antihistamines, with service-specific differences in whether decongestant medications are acceptable and which types of nasal antihistamines are approved. The U.S. Navy requires a 7-d ground trial of all oral medications and the intranasal antihistamine azelastine prior to use in flight, as well as for any medication switches[39] (CAPT Chuck Reese, USN (Ret.), USN Aeromedical ENT Consultant. Personal communication; 3 January 2017). Of all the commercially available nasal antihistamine sprays such as azelastine and olopatadine, only olopatadine is approved for use in the U.S. Air Force.[37] All three U.S. military services will consider a waiver for immunotherapy.[37–39]

DISCUSSION

Barotrauma associated with uncontrolled allergic rhinitis is an important safety of flight consideration. Rejection of candidates with a history of allergic rhinitis symptoms in the last 4 yr (United Kingdom) or any personal history of allergic rhinitis (Demark) are examples of a conservative approach, although the UK military has liberalized aeromedical policy following this review in order to enable otherwise best qualified candidates to enter the aviation service. At the other end of the spectrum, Australian civil aviation pilots do not need to disclose the use of nonsedating antihistamines if symptoms are mild or last fewer than 7 d and U.S. Army pilot candidates can enter the service using specific medications for mild allergic rhinitis without a waiver. Functional evaluation in the hypobaric environment is undertaken within some military organizations, which seems an especially useful assessment tool; the initial disqualification rate in this hypobaric tested population is not clear. Diagnostic imaging resources vary among nations and no body of evidence yet suggests the utility of such testing. CT imaging where available may further delineate chronic ENT disease. Further evaluation of such diagnostic requirements is warranted, as hypobaric testing and focused CT evaluations may have utility in preventing medical attrition within the trained aviation population. Hypobaric testing is already

informally undertaken as part of many flight training programs, given that undisclosed moderate to severe disease could be expected to manifest at this time. Formalization of a hypobaric diagnostic requirement could be cost effective if it prevents the attrition of candidates who are not be able to progress through fast jet training programs.

Nonsedating antihistamines and nasal steroids are the most frequently authorized medications, with some authorities endorsing one or the other and many accepting the use of both classes of medications. Given the idiosyncratic nature of some medications, the use of a ground trial appears to be a rational and prudent practice. No civil or military aeromedical authorities endorse the use of sedating antihistamines and several restrict the use of intranasal decongestants, which may give a falsely reassuring impression of long-term ear clearing ability when administered on the ground. Montelukast, oral steroids, and immunotherapy are considered for waiver in some countries, but are subject to additional scrutiny and immunotherapy requires temporary grounding in the hours following administration. Pulmonary manifestations and a requirement for systemic steroids are specifically cited as red flags for disqualification and/or further medical evaluation by some aeromedical authorities. Where variation among aeromedical policy exists, such as for the approval of a specific mediation, diagnostic requirement, or duration of post immunotherapy injection ground time, individual organizations may consider the experience of other nations in updating internal policy. Because of this international review, a relaxing of entry standards for aviation candidates with a history of allergic rhinitis is being approved in the United Kingdom.

The absence of unified guidelines, even within the same country, can be attributed to differences in: 1) terminology/aviator classification, 2) mission definitions and requirements, 3) the processes of aeromedical policy development, and 4) the review and application of aeromedical policies. Benefits of unified policies such as the European Commission Regulation[13] and Acceptable Means Guidance[17] include increased efficiency, increased interoperability, and the facilitation of aeromedical epidemiological research.[43] While full harmonization of military and civil international policies is complicated by many factors, an awareness of such differences enables appropriate aeromedical consultation and treatment during civil and military coalition operations. International aeromedical policy reviews foster academic collaboration between diverse aeromedical professionals and enable best practices to be considered by local national aeromedical authorities.

The question of how various policies are developed and how good policy is formulated are challenging areas of discussion. Many countries have evolving and/or draft policies in place as new evidence emerges, with some countries adopting those of the U.S. Air Force, which has developed a substantial evidence base for its aeromedical practices given the large numbers of pilots in its service. Some countries do not have written policies for specific medications, but instead give latitude for professional judgement in most matters, especially in the realm of civil, noncommercial carrier aviation. This provides great flexibility to the aeromedical examiner, but puts safety at significant risk if the examiner is impaired and/or unfamiliar with contemporary pharmaceutical and/or aeromedical knowledge.

The quality of an aeromedical policy must be judged on its ability to safely balance the economic, militarily, or individually driven need for flight with the risk to public safety, loss of aircraft, and subsequent loss of military power if mishaps occur due to a particular medical condition governed by that policy. This translates into the selection of flight candidates who can successfully complete training and maintain an adequately productive career in aviation using the most relevant and cost effective diagnostic approaches and selecting the most efficacious medications with the highest of safety profiles. The importance of the ability of policies to be rapidly updated to reflect new medications and/or medication safety data cannot be overstated.

The authors are unaware of any trials to date which have directly compared accident rates in countries with differing aeromedical standards for any specific condition. Such an analysis would be greatly complicated by important confounders such as baseline aviation safety technology and practices within the country, the acceptable level of risk for the flight mission, and divergent qualification policies for secondary medical conditions that could also contribute to a mishap.

Furthermore, the authors are unaware of any studies which compare the successful completion of training, subsequent retention, and/or accident rates among pilots who have been subject to divergent screening techniques such as history and physical alone vs. an altitude chamber assessment and/or coronal CT assessment. In the absence of such data, it is impossible to formulate truly evidence-based guidelines. Best specific practices can be broadly adopted across ICAO and NATO, but enforcement of such policies may not be within the remit of these organizations. Given fluctuating and variable degrees of need for pilots based on military, agricultural, and transportation requirements within each nation at any specific time, it is also problematic to prescribe enduring international guidelines regarding initial certification standards.

Based on this aerospace medicine and human performance review and the limitations of international guidelines, the authors posit the following as interim 'best practices' (summarized in **Table III**). Occasions for deviation from a best practice should be predicated on the individual needs of each nation, following a cost-benefit analysis. Furthermore, best practices must be updated routinely to reflect updated diagnostic modalities, medications, and unique considerations of novel aircraft as they develop.

Further refinement of aerospace medicine and human performance best practices should occur as part of an international panel effort, which involves specialty area board-certified physicians who are dual qualified as specialists in aerospace medicine. Medication selection, length of aeromedical grounding following introduction of new medication(s), and length of temporary grounding for immunotherapy injection should be evidence based. In time, genetically and/or environmentally established metabolic markers may facilitate selection of best

Table III. Proposed Best Practice.

CATEGORY	TRAINING STATUS	REVIEW REQUIREMENTS	ACCEPTABLE TREATMENTS	UNACCEPTABLE TREATMENTS
Civilian	Entry	Mild allergic rhinitis. AME review, evidence of TM mobility,[1]	N/A	N/A
		Moderate allergic rhinitis or history of immunotherapy, oral steroid use, surgery, or chronic sinusitis. ENT review, evidence of TM mobility, CT scan of paranasal sinuses (chronic sinusitis only).		
		Severe or uncontrolled allergic rhinitis. Disqualification.		
	Trained	Mild allergic rhinitis. AME review, evidence of TM mobility, temporary suspension pending control with acceptable treatments.	inS, inAH, NSAH, LTRA, saline irrigation, immunotherapy	SAH, oral steroids, oral decongestants*
		Moderate allergic rhinitis or chronic medication use. AME review, evidence of TM mobility, temporary suspension pending control with acceptable treatments. Consider requirement for ENT review.		
		Severe or uncontrolled hay fever. Disqualification.		
Military	Entry	Mild allergic rhinitis. AME review, evidence of TM mobility. Altitude chamber run for fast jet applicants.	N/A	N/A
		Moderate allergic rhinitis or history of chronic medication use, immunotherapy, oral steroid use, surgery, or chronic sinusitis. ENT review, evidence of TM mobility, ± nasal endoscopy, CT scan of paranasal sinuses (chronic sinusitis only). Altitude chamber run for fast jet applicants.		
		Severe or uncontrolled allergic rhinitis, pulmonary manifestations or polyps. Disqualification.		
	Trained	Mild allergic rhinitis. AME review, evidence of TM mobility, temporary suspension pending control with acceptable treatments. Altitude chamber run for fast jet aircrew at initial diagnosis.	inS, inAH, NSAH, saline irrigation, immunotherapy	LTRA, SAH, oral steroids, oral decongestants*
		Moderate allergic rhinitis or chronic medication use. AME review, evidence of TM mobility, temporary suspension pending control with acceptable treatments. Consider ENT review including evidence of TM mobility, ± nasal endoscopy, CT scan of paranasal sinuses (chronic sinusitis only). Altitude chamber run for fast jet aircrew at initial diagnosis.		
		Severe or uncontrolled allergic rhinitis, pulmonary manifestations or polyps. Disqualification.		

inS intranasal steroid; inAH intranasal antihistamine; NSAH nonsedating antihistamine; LTRA leukotriene receptor antagonist; TM Tympanic Membrane.

* Continuous use.

Mild: symptoms for less than 2-4 wk/yr, easily controlled with one medication or ignored, no history of sinus infections associated with allergic symptoms. No more than one episode of barotrauma in their history (which may be how they figured out they needed something for their allergies).

Moderate: requires two or more medications to control symptoms, symptoms occur more than 4 wk out of the year, an occasional episode of bacterial sinusitis associated with allergy symptoms. Has received immunotherapy to control symptoms (but the symptoms are controlled with immunotherapy).

Severe: Has breakthrough symptoms in spite of maximal management medications or immunotherapy.

Visualization may include direct visualization with valsalva, pneumotoscopy, or tympanometry.

medication(s) and appropriate grounding durations for each individual aircrew member. Our proposed interim 'best practices' are limited by their development without the input of African, Asian, Middle Eastern, Russian, or South American aeromedical experts, who must be included in a truly international consensus. As the international population expands exponentially, ultimately requiring our collective reach beyond the planet, medical technology may likewise expand to include development of individually tailored therapies based on specific genetic and environmental susceptibilities. We must strive to enable every performance advantage in the highly challenging spaceflight environment. The process of international collaboration on aeromedical standards should begin now, with further research to develop truly evidence-based diagnostic, selection, and retention practices. The development of easy to access and routinely updated international best practices is an important bridge to cross on a long-term journey toward optimized human performance in the flight environment.

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