ASO Aeromedical Topics

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Grading:

Homework Exercise (NATOPS Ch.8)	Completion
Take-home Quiz	100%

Homework Exercise (NATOPS, Ch.8). The NATOPS guidance in Chapter 8 – the Aeromedical and Survival chapter – was developed from knowledge of causal factors in mishaps and items in Hazard Reports, and is continually evolving with new hazard and mishap experience. The chapter is literally "written in blood." It is also meant to be "all things to all communities," and is generic to a wide variety of aircraft, crews, and missions. It will be part of your job as an ASO to remind flight crew of the requirements in Chapter 8, and encourage compliance. Your familiarity with this chapter, and understanding of factors which lead to these recommendations will enhance your credibility with aircrews.

You will be asked to choose two "bullets" from the NATOPS 3710.7 Instruction, Chapter 8 and comment on what you do or don't like about them, why, and how you would recommend changing them if you don't feel they're adequate. No more than one page is necessary. The exercise will be discussed in class and you will be given credit for completion, but no subjective score is assigned. The purpose of this exercise is to increase your familiarity with this chapter, and to serve as a discussion base for improvement of this guidance.

Reading Assignment: OPNAVINST 3710.7S, Chapter 8. (pp. 8-1 thru 8-26).

Take-home Quiz (100%): The take-home quiz is to be completed alone. You may use any source except another person, work done by that person, or copies of previous exams. The exam will be distributed after the fourth Aeromedical class, and will be due several days later – the exact date will be given in class. Your exam is to be turned in at the Aeromedical Office at room E-205, on the second deck of the East Wing of Herrmann hall (one deck below the Aviation Safety Offices). The exam will cover key aeromedical concepts presented in class during the first four lectures.

Course Organization:

The aeromedical section will cover topics included in the following outline, and covers aeromedical topics in four broad areas: Mishap Prevention, Mishap Investigation, Mishap Reporting, and Flight Surgeon Support of the ASO. Time does not permit discussion in all areas listed – the student is encouraged to discuss special topics of interest with the instructor, and to pursue supplemental reading.

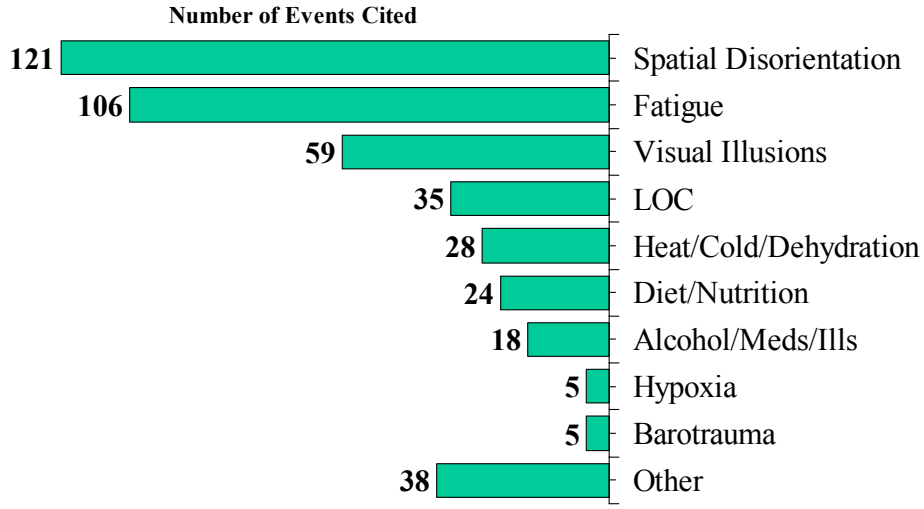
ASO Aeromedical Topics

- Prevention/Safety
  - Aeromedical Mishap Causal Factors
    - Hypoxia/Hyperventilation
    - G-LOC
    - Spatial Disorientation
    - Fatigue, circadian rhythms
    - Dysbarysm/DCS
    - Human Factors
      - Stress
    - Medical Conditions
      - Drugs, OTCs, Nutritional Supplements
  - OPNAVINST 3710.7S, Chap 8
- Mishap Investigation
  - FS Role in AMB
    - Survivor care
    - Field Investigation
    - Care of AMB
  - Crash Survivability
  - Blood-borne Pathogens
- Reporting
  - The Aeromedical Analysis
- FS Support of ASO
  - Training, Squadron teaching, etc.
  - OPNAVINST 6410.1
    - Utilization of Naval FS

Aeromedical Mishap Causal Factors:

Ever since the first balloonists took to the air in the late 1700's, human physiology has been challenged with the special environment of flight. Medical factors have continued to play a part in aviation safety, necessitating physicians who are specially trained in flight and aviation medicine. Human factors contribute to roughly 80% of current day mishaps. Recent data at the Naval Safety Center from the past 5 years show that aeromedical factors are cited in half the mishaps and hazards in Naval Aviation, as represented in the following bar chart.

Aeromedical Factors
Cited in Mishaps & Hazards



NAVSAFCEN Data 1997 - 2002

The first periods of instruction will examine some of these factors in depth, and will relate them to specific mishaps.

Aeromedical Topic: Hypoxia & Hyperventilation

Learning Objectives:

1. Define Hypoxia
2. List the 4 types of hypoxia; give an example of each
3. Discuss the oxyhemoglobin dissociation curve
4. Name the signs and symptoms of hypoxia
5. List the factors that influence hypoxia and state their effects
6. Discuss the treatment of hypoxia

Key Points

- Hypoxia results when the body tissues do not receive adequate amounts of oxygen for aerobic metabolism to continue.
- Central nervous system tissues (i.e. the brain and eye) are most sensitive to hypoxia.
- Inadequate supply of oxygen to the tissues can be categorized from four causes:
    - 1. Inadequate amount of oxygen in the atmosphere is known as “hypoxic hypoxia.”
    - 2. Reduced oxygen-carrying capability of the blood is known as “hypemic hypoxia.”
    - 3. Slow or stagnant circulation of the blood is known as “stagnant hypoxia.”
    - 4. Inability of the cell to use oxygen from poisoning is known as “histotoxic hypoxia.”

- Hemoglobin in red cells has unique features which enable it to bind to oxygen molecules and carry them in solution in the blood to the body's cells.
- The body's respiratory drive responds primarily to carbon dioxide, and only weakly to oxygen levels, which makes the onset of hypoxia insidious.
- The partial pressure of oxygen in the atmosphere decreases as altitude increases.
- Onset of hypoxia is more rapid as the altitude of exposure gets higher.
- Time of useful consciousness (TUC) is the time that a subject has after being exposed to hypoxic conditions before he/she becomes incapable of effective problem-solving and performance.
- Hyperventilation is an increased respiratory drive beyond what the body needs physiologically, and is caused by a number of factors.
- The symptoms of hypoxia and hyperventilation are very similar, and usually cannot be distinguished by the individual.
- The treatment for both hyperventilation and hypoxia is the same: give oxygen.

Reading Assignment: Green, et. al. Human Factors for Aircrew; pp 3-11.
Hawkins. Human Factors in Flight, 2nd Ed.; pp 92-94; 117; 305-306.

Aeromedical Topic: G-LOC

Learning Objectives:

1. Identify the type of hypoxia represented by G-LOC
2. Describe the physical principles responsible for G-LOC
3. Discuss the physiologic response to the high G environment
4. List factors which may impair G-tolerance
5. Identify active and passive measures to improve G-tolerance
6. Discuss the mechanism of the "Push-Pull" effect

Key Points

- In high G fields, the heart must pump harder to maintain sufficient blood pressure at the level of the head, due to the increased weight of the blood column.
- Pressure sensors in the carotid and aortic arteries help regulate blood pressure.
- Stagnant or stopped blood flow to the head will cause hypoxia and loss of consciousness (G-LOC).
- A small residual amount of oxygen in the tissues of the brain will permit metabolism (and consciousness) for 6-15 seconds after complete cessation of blood flow to the head.
- Active straining maneuvers, G-suits, G-warm-up maneuvers, and the body's physiologic reactions can temporarily increase G-tolerance by one to several G's.
- A variety of effects (illness, dehydration, fatigue, stress, etc.) can reduce the body's G-tolerance.
- Blood flow to the eye is first affected due to the higher pressures needed to pump blood against the intraocular pressure (12-20 mmHg).
- High blood pressure in the carotid arteries ("negative G") can make the body even more susceptible to G-LOC when positive G is applied. (Push-pull effect).

Reading Assignment: Green, et. al. Human Factors for Aircrew; pp 14-15.

Aeromedical Topic: Spatial Disorientation

Learning Objectives:

1. Discuss Spatial Disorientation, its primary cause, and its three basic types.
2. Describe the sensory inputs involved in determining and maintaining orientation.
3. Briefly cover the structure and function of the vestibular system and its role in flight.
4. Review various forms of spatial disorientation and the conditions that lead to them.
5. Discuss the involvement of the vestibular system and spatial disorientation in Class A Flight Mishaps.

Key Points

- Spatial Disorientation..."used to describe a variety of incidents occurring in flight where the pilot fails to sense correctly the position, motion or attitude of the aircraft or of himself within the fixed co-ordinate system provided by the surface of the earth and the gravitational vertical. In addition, errors in perception by the pilot of his position, motion or attitude with respect to his aircraft, or of his own aircraft relative to other aircraft". (*From ASCC AIR STD 61/117/07: The Contribution of Spatial Disorientation to Accidents and Incidents)*
- Spatial orientation is maintained primarily with the sense of vision.
- Each inner ear is equipped with motion sensors (the vestibular system) which assist the body in balance and tracking tasks.
- Motion sensors independently sense angular acceleration (the semicircular canals) and linear acceleration/gravity (the otolith organs).
- The vestibular system helps drive the eyes in maintaining stable vision with head and body movement (the vestibulo-ocular reflex).
- False sense of rotation or attitude can arise from sustained movements, particularly in flight, since the vestibular system cannot sense sustained rotations.
- If the pilot's perception of motion and attitude differs from the actual, he is "spatially disoriented."
- Spatial disorientation can be unrecognized (Type 1), recognized (Type 2), or incapacitating (Type 3). Unrecognized spatial disorientation is a frequent cause of CFIT mishaps.
- Somatogravic/oculogravic ("body-gravity"; "eye-gravity") illusions of climbing or diving can result from sustained linear accelerations.
- Somatogyral/oculogyral ("body-rotating"; "eye-rotating") illusions can result from sustained turns which are not sensed or sensed inappropriately.
- G-excess illusions can result when head movements are made while in an abnormal G-field (as during a turn) due to abnormal gain from the otoliths.
- Coriolis illusions (tumbling or spinning sensations) can result from head movements being made while in a rotating environment, as fluid motion is stimulated in different semi-circular canals.

Video: "The Nashville Mishap" (shown in class).

Reading Assignment: Green, et. al. Human Factors for Aircrew; pp 12, 16-17; 49-52.
Av. Psych. Lecture Summaries, pp 99-104.

Aeromedical Topic: Stress & Performance

Learning Objectives:

1. Understand Hans Selye's development of the concept of stress.
2. Describe the features of the General Adaptation Syndrome
3. Identify sources of stress.
4. Review basic human stress reactions and stress coping failures.
5. Describe "typical" aviator coping patterns

Key Points

- Stress is the non-specific response of the body to any demands made upon it.
- Stress is the body's physiological and psychological reaction to stressful events or stressors.
- Individuals under stress have a higher incidence of health problems and higher rates of accidents.
- Most of us understand the effects of physical stressors (cold, heat, noise), and the stressful effects of some social threats (competition, test taking, public speaking, etc), but we may ignore the insidious effects of relationship and work stressors.
- A stress-coping pattern sometimes exhibited by aviators includes acting out behaviors observed as "hostility", anger, and excess risk taking.
- Naval aviation culture is one that values people that can tolerate stress, and those that can perform their jobs in spite of the occurrence of social and job stressors.

Reading Assignment: Green, et. al. Human Factors for Aircrew; pp 67-79.
Hawkins. Human Factors in Flight, 2nd Ed.; pp 99-104.
Av. Psych. Lecture Summaries, pp 147-152.

Aeromedical Topic: Fatigue & Circadian Rhythms

Learning Objectives:

1. Recognize mishaps where fatigue may be a factor.
2. Discuss the prime causes of fatigue.
3. Describe the symptoms and signs indicative of fatigue.
4. Describe the physiology of sleep, and the effects of sleep deprivation.
5. Describe the effects of circadian cycles and how they contribute to fatigue states.
6. Identify key countermeasures to cope with fatigue.
7. Understand key benefits and risks of performance-maintenance drugs.

Key Points

- Fatigue is a leading cause of mishaps, but it is often missed, since there is no objective way to measure fatigue levels.
- Fatigue is a physiologic state, not dependent on motivation or attitude.
- Fatigue produces a decline in a variety of measures of performance.
- High level mental activities such as complex decision making and planning suffer most, whereas simple well-practiced skills are less sensitive to fatigue.
- Fatigue can be conceptualized as the brain running out of energy and becoming less efficient with continued wakefulness.
- Sleep is the body's mechanism of restoring the fatigued brain to peak energy and performance.
- Sleep architecture is complex, and consists of different stages of activity (REM and non-REM sleep.)
- Sleep needs are genetically determined; most people require 8 to 8 ¼ hours sleep/night.

- Circadian ("about-a-day") rhythms govern all activities of the body, and are synchronized with daytime light exposure.
- Sleep induction, maintenance, and termination are tied to circadian rhythms. The effect of the alerting circadian rhythm is to boost the brain's alertness during the day while fatigue accumulates, and induce and maintain sleep at night while the brain recovers.
- Shifts in time zones will disrupt circadian rhythms, and require a varying time to resynchronize. During this disruption, fatigue levels will be unpredictable, sleep efficiency will be reduced, and performance will degrade unpredictably.
- Understanding how fatigue and circadian rhythms affect performance allows countermeasures to be developed, including the use of drugs.

Reading Assignment: Green, et. al. Human Factors for Aircrew; pp 81-92.
Hawkins. Human Factors in Flight, 2nd Ed.; pp 56-83.
Av. Psych. Lecture Summaries, pp 153-165.

The last two lectures deal with the Flight Surgeon's role in mishap investigation, and how the Flight Surgeon supports the ASO in squadron programs, training, and pre-mishap planning.

Aeromedical Topic: Flight Surgeon Field Investigation

Learning Objectives:

1. Describe key roles for flight surgeons in mishap response situations.
2. Identify aeromedical factors of interest at mishap site investigations.
3. Describe the difference between presumptive and positive identification of remains, and give examples of each.
4. Describe the association between G-forces and injury mechanisms in the F/A-18 El Toro Airshow mishap.

Key Points

- Flight surgeons have unique responsibilities at the mishap site, including survivor care, and analysis of injury patterns and cause of death in fatalities.
- Identifying the aeromedical causes of mishaps helps educate aircrews about mishap prevention.
- Certain injury patterns help identify which individual is in control of the aircraft at the time of the crash.
- Certain injury patterns result from predictable crash dynamics, and can be used to infer the forces involved in the crash.
- Analyzing crash survivability helps identify factors which cause additional injury and death, and to make design recommendations to make aircraft safer during crash sequences.
- Victim identification is important for a variety of reasons, including identifying mishap causal factors, mishap responsibility, validating benefit claims, and returning deceased remains to families. Differing standards of identification exist from presumptive to positive.

Reading Assignment: NAVSAFCEN. Naval Flight Surgeon's Pocket Reference to Aircraft Mishap Investigation; pp 53-84.

Aeromedical Topic: Crash Survivability

Learning Objectives:

1. Derive the equations that relate G-forces to changing velocity and stopping distances.
2. Describe the concept of "crash force pulse", and list several types and the circumstances they might be encountered.
3. List the factors of the "CREEP" acronym, and how each factor affects crash survivability.
4. Describe key sources of knowledge regarding human impact tolerances.
5. Identify elements of crash survivability in mishap investigations, and make recommendations for design change.

Key Points

- Peak "G" decelerations can be calculated using the velocity changes and stopping distances involved in a mishap.
- Peak "G" decelerations in crashes are proportional to mishap forces, and predict what injuries may be expected on the body.
- Analyzing crash survivability helps identify factors which cause additional injury and death, and to make design recommendations to make aircraft safer during crash sequences.
- CREEP is an acronym describing the conditions that affect survivability in a mishap:
    - C: Container – the aircraft must maintain a structural space of protection around the individual.
    - R: Restraints – proper restraint of the body is essential to avoid secondary collisions of the body within the cockpit and airframe.
    - E: Energy – energy absorption is crucial to dissipating the forces experienced in a crash before they reach the occupants.
    - E: Environment, or surrounding structures in the cockpit, must not intrude or cause further injury.
    - P: Post-crash factors, such as fire and water can cause additional injuries and/or fatalities.
- Human tolerances to acceleration/deceleration and injury patterns have been determined from a variety of sources such as accident reports, study subjects, cadaver and crash-test dummies, and computer modeling.

Reading Assignment: NAVSAFCEN. Naval Flight Surgeon's Pocket Reference to Aircraft Mishap Investigation; pp 85-106.

Aeromedical Topic: Flight Surgeon Support of the ASO

Learning Objectives:

1. Describe the importance of OPNAVINST 6410.1 – "Utilization of Naval Flight Surgeons."
2. Discuss the Flight Surgeon's role in pre-mishap planning.
3. Identify three responsibilities Flight Surgeons' have in mishap prevention.
4. Describe the contents of the Aeromedical Analysis, and how it relates to the Safety Investigation Report (SIR).
5. Identify the steps necessary to control exposure to biohazards at the mishap site.

Key Points

- The Flight Surgeon is a key ally in helping the ASO implement safety programs and in educating squadron members.
- The Flight Surgeon is responsible for developing, maintaining and exercising medical pre-mishap plans.

- The Flight Surgeon must regularly educate aircrew members to the aeromedical hazards of flight, and must ensure all aircrew are medically fit for flight.
- The Flight Surgeon is an active member of the Aircraft Mishap Board, but he/she also puts out an independent report, the Aeromedical Analysis, which is enclosure 14 to the SIR package.
- All recommendations made by the Flight Surgeon in the AA, must be incorporated into the SIR.
- The Flight Surgeon and the ASO are required to assess the biohazard risk at a mishap site, and recommend to the Senior Member sufficient controls to protect investigating members.

Video: FAA. "Aircraft Accidents and Bloodborne Pathogens: A Hazardous Combination" (shown in class).

Reading Assignment: NAVSAFCEN. Naval Flight Surgeon's Pocket Reference to Aircraft Mishap Investigation; pp 22-25; 26-44.

OPNAVINST 3750.6R Aeromedical Reading

207 a	Premishap Planning
Appendix 2B	Premishap Plan Checklist
307-311	Injury Classification
313	Naval Aircraft Mishap Severity Classes
419	Physiologic Episode Hazard Report
607c(3) (a-f)	Medical Evidence
608	Tech and Med Assistance to AMBs
716d(3)	Aeromedical Analysis
Appendix O	HFACS