Occupational Hazards in the High-Performance Flight Environment

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Disclaimer

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Overview

• Hazards/exposures
• Specialized physiology
• Musculoskeletal impacts
• Case presentation
Fighter Pilot Population

- Highly screened
- Predominantly young
- Highly motivated
  - Less likely to present with mild/mod symptoms
  - Expedited recovery from acute illness/injury
  - High RTW rates
  - Supervisors/commanders highly involved in RTW
  - Subtle airframe community differences

*Practice of medicine with patients of normal physiology in an abnormal environment*
Hazards of the Flight Environment

- Low gravity
- Vibration
- Noise - F-35: 145 dB “mil power”, 149 dB “afterburner”
- Air sickness
- Psychological - stress, anxiety, fear, combat impacts
- Radiation / Cancer
  - Electromagnetic field and cosmic ionizing radiation
  - “Radiation-related cancers”: esophagus, stomach, large intestine, female breast, bladder/urinary tract, thyroid gland and leukemia - UNSCEAR
- Aircraft mishap / ejection injuries
- Circadian Rhythm Disruption
Hazards of the Flight Environment

- Positive pressure breathing effects
- Hypoxia
- Smoke / Fumes / Toxic chemicals
- Hyperventilation
- G-forces
- Hypoxia-like events / Physiologic episodes
- Depressurization / Decompression sickness
- Dehydration / Diet / Thermal stress
Specialized Physiology

- G-forces Mitigation
  - Resting G tolerance: ~3.5 Gz of protection
  - G-suit: ~1.5 Gz protection /~3 Gz ATAGS
  - Positive pressure breathing
  - Anti-G Straining Maneuver (AGSM)
- Positive pressure breathing / Supplemental O₂
  - Unassisted and assisted (pressure vests)
  - Acceleration atelectasis
Specialized Physiology

- Hypoxia recognition and mitigation

- Continuous high-level mental and physical functioning
  - Single seat aircraft
  - High stress environment
  - Rapid processing/ID and decision-making
  - Physical / mental / executive synthesis and functioning demands
  - Small decrement = big impact

<table>
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<tr>
<th>Altitude</th>
<th>Time of useful consciousness</th>
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<tr>
<td>18,000</td>
<td>20-30 min</td>
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<tr>
<td>22,000</td>
<td>10 min</td>
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<td>25,000</td>
<td>3-5 min</td>
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<td>9-12 s</td>
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<tr>
<td>50,000</td>
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Table 1. Time of useful consciousness. "TUC" is the amount of time crew members have to institute life saving measures before they are incapacitated after acute exposure to the hypobaric conditions of high altitude.

Fighter Pilot Equipment

- Flight helmet/visor
- Joint Helmet Mounted Cueing System (JHMCS)
- Night vision goggles
- Oxygen mask
- Flight suit
- Pressure/survival vest
- Life preserver unit
- “Poopy Suit” – survival/dry suit
- G-suit
- Gloves
- Boots

Cockpit Fit and Helmets
Musculoskeletal Impacts

• Thoracic/Lumbar pain
  • Higher rates of work-related pain in pilots
  • Effects thought to be due to G-forces
  • Centrifuge trainings

• Cervical pain
  • Wide prevalence range reported in literature: 19-97%
  • Meta-analysis:
    • no difference in prevalence of cervical pain (OR=1.07, CI: 0.87-1.33) and cervical disc degeneration (OR=1.26, CI: 0.81-1.96) between fighter pilots and helo/cargo pilot
    • no difference in disc degeneration (OR=1.14, CI: 0.61-2.16) between fighter pilots and non-flying personnel
  • Study of USAF pilots:
    • relative risk of fighter pilot cervical spine disease (CSD) diagnosis was 10% less than non-fighter pilot (RRR: 0.9, CI: 0.85-0.95, p<0.0001)
    • fighter pilot risk to undergo CSD surgical intervention was 46% higher than that of a non-fighter pilot (RRR: 1.46, CI: 1.07-1.99, p<0.016)
Musculoskeletal Impacts

• Risk Factors
  • High G sorties
  • Use of JHMCS and night vision goggles
  • Flight hours
  • Physical exercise regimen / neck muscle training
  • Cockpit seat-back angle

• High Risk Neck Movements
  • Rotation Beyond 35° (scanning, wingmanship)
  • Lateral Bending (optokinetic cervical reflex)
  • Extension Beyond 30° (scanning, refueling)
  • Flexion Beyond 15° (cockpit instruments)
  • “Check Six” ("dogfighting")

Basic Fighter Maneuvers

- [https://www.youtube.com/watch?v=E2gFtuJMq8c](https://www.youtube.com/watch?v=E2gFtuJMq8c)
Prevention Measures

- Pilot screening programs
- Aircraft engineering/design
- Lumbar support use
- Duty modification: only low/moderate G exposure missions
- Avoidance of high-risk maneuvers under high G forces
- In-flight neck bracing
- Neck-strengthening exercises
- General physical conditioning
- Home neck traction
Case

• 34 year old male F-16 pilot with no significant past medical history presents with right elbow pain that has been worsening over last 3 months. Denies history of trauma and reports pain started insidiously.

• 8 years experience in F-16; 2000 flight hours

• Reports work schedule consists of flying twice a day for approximately 1 hour each sortie. Flight profiles consist of constant requirement for aft/back pressure to the control stick with interval multi-directional stick pressure spikes for maneuvering.
Work Environment
Right Arm Ergonomics
Lateral Epicondylitis Treatment / Management

• Classic Work-Related MSD Risk Factors
  • Force
  • Repetition
  • Awkward Posture

• Rest
• OT / Dry Needling / Massage / Ice / NSAIDs
• Custom bracing
• Training on ergonomic posture and flight performance techniques
• Adjustment of flight schedules and profiles
Conclusion

• Hazard exposures in the fighter aircraft environment are often multifactorial.
• Giving a pilot a diagnosis may have significant short and long-term implications to their career – presentation timelines and reported symptoms may be altered from a standard patient.
• It is vital to understand the flight environment, the specific airframe flown and the mission training performed to properly evaluate the patient.
• Injury risk factors are often similar to other military and civilian occupational fields but interventions are usually specialized.
• Treatment and recommendation protocols may be altered based on training versus contingency operations.
Sources


QUESTIONS?

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