

# TOP KNIFE FIGHTER SURGEON COURSE

173 Fighter Wing  
Kingsley Field Oregon

RSV-1E2

THERMAL STRESSES IN  
FIGHTER AVIATION

# Criterion Referenced Objectives

- Explain the effects of heat stress for fighter aircrew
- Identify methods of preventing heat injuries for fighter aircrew
- Recognize the effects of heat injuries on the aviation environment, e.g. G-tolerance & aircrew flight gear
- Identify problems related to cold stress on fighter aircrew

# Overview

- Heat stress impact
- Prevention strategies
- Interaction of heat stress with the flying environment
- Cold stress impact

# Heat Stress

- Clinical sequelae of heat stress:
  - Heat Syncope
  - Heat Cramps
  - Heat Exhaustion
  - Heat Stroke



# Heat Syncope

- Inadequate cardiac return because of peripheral pooling in distended vasculature
  - Fail to cool down appropriately after exercise by walking
  - Locking knees standing in formation
- Temporary, benign, preventable LOC
  - Restored quickly by lying down, raising legs to restore cardiac return
  - Prevention with appropriate activity

# Heat Cramps

- Painful muscle cramps from loss of fluids and sodium
- Muscles of extremities and abdomen
- Normal core temperature
- **Most significant issue: Signals possible worsening of condition**
- RX: PO fluids, sodium replacement, cool environment
- Prevent by adequate hydration and sodium intake before heat/exercise exposure

# Heat Exhaustion

- Excess loss of water and/or salt, unable to continue to exercise
- Profuse perspiration, pallor, low BP
- Mortality is rare
- Rx: Cool environment, rest, fluids, sodium replacement (PO if tolerated, otherwise IV)

# Heat Stroke

- Characteristics
  - **Core temp > 104 F** (core temp is rectal or esophageal)
  - **Altered LOC**
  - Absence of perspiration in classic cases, continued perspiration when exertional; *don't count on it*
- High mortality
- Rx: Lower core body temperature ASAP
  - Inpatient treatment
    - Active cooling/ice water baths
    - IV fluids
    - Watch electrolytes, enzymatic evidence of organ damage



# Prevention

- Hydration – Ongoing, beginning days before exposure
  - Urine should be clear and nearly colorless
  - 4 full bladders per day; if less, drink more!
  - Water is fine unless not able to eat
  - Thirst poor indicator; up to 5% dehydrated by then
- Sodium – Plenty in American diet, do not add
  - Sports drink if laboring in heat over one hour without taking a meal

# Prevention

- Acclimatization – Gradually increase heat exposure over 7-14 days (longer interval is better)
- Limit total exposure when able, regular rest
- BE AWARE – Temperature on the day of injury might not be high; heat injuries often cumulative, so watch trends

# Heat Acclimatization

- Hypothalamus adjusts
- Perspiration changes
  - Earlier
  - More volume
  - Less sodium loss
- Exercise tolerance increases



# Risk Assessment

- Command Considerations
  - Personnel
  - Mission
  - Environment
- Be your commander's advisor



# Weak Link

- THE APPEARANCE OF A HEAT CASUALTY SUGGESTS THAT OTHERS ARE AT RISK
- All members of the unit should be monitored closely
- Command should consider altering/halting operations
- Make your commander aware of the risk!

# Heat Stress & Military Flying

- G-Tolerance
- Flying Environment
- Aircrew Flight Gear



# Heat and Flying

- Flight gear adds heat stress
  - CSU-13/P anti-G suit
  - Combat EDGE
  - Chem ensemble
- Older fighters have poor ECS systems (if you fly the Eagle in the summer you already know this)
- Effects on pilots
  - Increased errors
  - Reduced G-tolerance, probably a function of dehydration
  - Decreased performance

# FITS

- Fighter Index of Thermal Stress
- Antiquated concept
- Still reports as ITS in ATIS (Automated Terminal Information System, broadcast locally at the airfield)
- Hot weather flying procedures as /special interest items (FCIF/SII) now the norm for bases in hot environments



# Hot Weather Recommendations >100°F

- 1st Go, if have to step to spare
  - May take a spare if can get engines running in 20 min
  - If unable, cool down in Ops
- 2<sup>nd</sup> Go
  - If you abort, you're done for the day

# Cold Stress

- Cold Exposures in Fighter Operations
  - Northern latitudes
  - High elevation/high altitude
  - Night
  - Wet weather
  - Over water bailout



# Physiologic Effects of Cold

- Cold-induced vasoconstriction of extremities (preserve core heat)
- Increased muscle tone → shivering
  - Aids thermogenesis until reach 90°F, then decreases
- Cold diuresis (2° to peripheral vasoconstriction)
  - Dehydration decreases G tolerance
- HR/RR, cerebral blood flow ↓
- Multiple changes lead to acidosis
- Myocardium becomes irritable

# Disorders of Cold Stress

- Non-Freezing Injury
  - Trench foot – Prolonged exposure to moisture combined with continuous wear of snug foot gear
  - Si/Sx: Redness, pain, edema
  - Recovery requires hospitalization
  - Susceptible to repeat injury
  - Prevention is key – Good hygiene in the field

# Disorders of Cold Stress

- Freezing Injury - Frostbite
  - Face, hands, feet, ♂ genitalia predominantly
  - Superficial frostbite – Numbness and white patches of skin, often numb
  - Deeper frostbite – Greater thickness frozen tissue, redness and blisters common, risk infection if blisters rupture, si/sx worsen with deeper freezing
  - Thawing can be painful
  - Prevention – Proper clothing and alert for early signs

# Hypothermia

- Mild (32-35° C), moderate (27-32° C), severe (below 27° C)
- Symptoms range from shivering to poor performance (apathy, dysarthria, ataxia) and concentration to paradoxical undressing to coma
- V fib, coagulopathies, acid-base disorders in severe cases

# Treatment of Hypothermia

- Mild – Passive rewarming
  - Remove wet clothing, get into shelter, etc
- Moderate – Active rewarming
- Severe – Requires intensive evaluation and intervention
  - Active core rewarming
  - Address acid base disturbances and coagulopathies
  - Prepared to deal with arrhythmias

# Prevention Strategies

- Risk Assessment
  - Individual airman
  - Environment
  - Mission
- Most important control measure: Provision of adequate time and facilities for rest, rewarming, and inspection
- Appropriate clothing
- Keep the cranium covered



# Risk Factors

- Trauma
- Fatigue
- Undernourished – must have calories to burn
- Overstressed, psychological or physical
- EtOH, drug use
- Underlying debilitating disease (e.g. cancer)

# Cold Weather Injuries

- Usually occur in clusters
- If an injury occurs, inspect **everyone!**



# Summary

- Heat Stress Effects
- Prevention Strategies
- Interaction within the Flying Environment
- Cold Stress Effects
- Next slide for quiz instructions

- [Go to quiz](#)
- Enter your answers on the [answer sheet](#)
- Print only one answer sheet for entire course
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