Glucose metabolism changes in patients with sepsis on FDG PET

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Background

• Main features of sepsis are uncontrollable activation of pro and anti-inflammatory responses resulting in metabolic changes in vital organs

• Abnormal glucose metabolism is a known stress-related response

• Sepsis induced encephalopathy: decreased cerebral blood flow and cerebral glucose uptake (described in rat experiments)
Background

• FDG PET CT in infection:
  - Catheter or prosthesis related infection
  - Osteomyelitis
  - Early localization of site of infection in patients with sepsis or fever of unknown origin
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• FDG PET CT in infection:
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Hypothesis

- Patients with sepsis have decreased FDG uptake within major organs and relatively increased uptake within muscles and soft tissues compared to patients with infection without sepsis.

- FDG distribution in patients with sepsis can correlate with severity and may predict prognosis.
Materials and Methods

Retrospective review

Population

• Adult patients who underwent whole body PET CT for evaluation of infection/sepsis

Study period

• Jan 2016 – Jan 2017
Materials and Methods

Data

• Demographics
• PET CT (Date, indication, SUV)
• Clinical data (VS, GCS, labs)
Materials and Methods

- PET CT review
  - All PET CT were reviewed by 2 radiology residents
  - Reviewers were blinded to clinical status
Materials and Methods

• PET CT review
  ◆ SUV of the following major organs
    ➢ Brain
    ➢ Liver
    ➢ Spleen
    ➢ Adrenal gland
    ➢ Bone Marrow
    ➢ Subcutaneous fat
    ➢ Muscles
Materials and Methods

- PET CT review
  - Special considerations
    - Brain: Bilateral frontal/parietal/temporal/occipital lobes, brain stem
    - Standardized SUV area (40 cm² for liver) for R and L hepatic lobes
    - Organs involved with focal infectious process were excluded
Materials and Methods

Sepsis groups

• Clinical data was reviewed by 2 ID physicians to determine sepsis diagnoses based on VS, GCS and lab values from the same day of PET CT

• Clinicians were blinded to PET CT results
Materials and Methods

- Statistical analysis
  - Difference in major organ SUV values for the 2 groups was calculated with a simple t-test
Results

61 patients with infection

- 7 with no images or with partial images
- 3 pediatrics
- 5 with inconclusive sepsis status

46 patients included in final study
Sepsis

No sepsis

17 (37%)

29 (63%)
<table>
<thead>
<tr>
<th>Organ</th>
<th>Sepsis</th>
<th>No sepsis</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal lobe</td>
<td>4.3 (1.9)</td>
<td>7.5 (4.0)</td>
<td>0.0008</td>
</tr>
<tr>
<td>Parietal lobe</td>
<td>4.5 (1.9)</td>
<td>8.3 (4.1)</td>
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<td>Temporal lobe</td>
<td>3.9 (1.6)</td>
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<tr>
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<td>4.5 (2.2)</td>
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<tr>
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<td>4.3 (1.8)</td>
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</tr>
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<td>Liver</td>
<td>3.1 (1.1)</td>
<td>3.1 (1.4)</td>
<td>0.97</td>
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<tr>
<td>Spleen</td>
<td>3.1 (1)</td>
<td>3 (1)</td>
<td>0.77</td>
</tr>
<tr>
<td>Adrenal</td>
<td>2.3 (1.4)</td>
<td>1.9 (0.5)</td>
<td>0.2</td>
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<tr>
<td>BM T12</td>
<td>4 (1.7)</td>
<td>2.9 (0.8)</td>
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<td>BM iliac crest</td>
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<td>Subcut fat</td>
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<td>Muscle</td>
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BM: bone marrow, Subcut: subcutaneous
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Results

- Sepsis: 4.5
- Non-sepsis: 8.3

Parietal lobe
Discussion

• Patients with sepsis have significantly decreased SUV values in the brain and increased SUV values in bone marrow compared to patients with no sepsis

• Patient with sepsis may have qualitatively increased uptake in muscles and subcutaneous tissue – no statistically significant SUV value

• Sepsis encephalopathy can be quantified with FDG PET CT

• Increased bone marrow activity related to systemic inflammatory response
Discussion

• Further analysis:
  
  ▪ Account for concomitant conditions, medications.
  
  ▪ FDG distribution correlation with early sepsis versus severe sepsis
  
  ▪ PET CT distribution pattern and outcome/prognosis of septic patients
Conclusion

• There is altered glucose metabolism in sepsis

• FDG uptake as a useful tool to locate infection, assess severity and predict prognosis
References

- **Hiroyuki et al** Blood glucose control in patients with severe sepsis and septic shock *World J Gastroenterol* 2009; 15(33)
- **Semmler et al** Sepsis causes neuroinflammation and concomitant decrease of cerebral metabolism *Journal of Neuroinflammation* 2008; 5(38)
- **Lheureux and Preiser** Year in review 2013: Critical Care – metabolism *Critical Care* 2014; 18(571)
- **Singer et al** The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) *JAMA* 2016; 315(8)
- **Charito et al** FDG PET of infection and inflammation *Radiographics* 2005; 25(5)
Thank you

Chee Lee Hwee, MD