Apheresis: What’s that?

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Amsterdam, the Netherlands
Apheresis (ἀφαίρεσις)

- Aphairesis
  - To take away
**Apheresis**

Method of obtaining one or more blood components by machine processing of whole blood in which the residual components of the blood are returned to the donor / patient during or at the end of the process.

Reference
Guide to the preparation, use and quality assurance of blood components
European committee on Blood Transfusion
2010-16th Ed.
Apheresis in ancient medicine

Disease reflects presence of disease-causing factors in the blood; selective blood letting (apheresis) should initiate cure.

Hippocrates (460-377 BC)
Apheresis

- Manual
- Automated
History

• 1877 de Laval
History

• 1877  de Laval
• 1950s  Cohn and Latham
History

• 1877 de Laval
• 1950s Cohn and Latham
• 1960s Freireich and Judson (IBM)
Apheresis equipment

- Fenwal
- Fresenius
- Terumo BCT
- Haemonetics
- ........

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Apheresis techniques

• Plasmapheresis

• Cytapheresis
  - Platelet apheresis
  - Stem cell (HPC) apheresis
  - Lymphocyte apheresis
  - Monocyte apheresis
  - Granulocyte apheresis
  - Erythrocyte apheresis

• Multicomponent apheresis
Principle apheresis

• Filtration techniques

• Centrifugal techniques
Principle apheresis

- Filtration techniques
- Centrifugal techniques
- Combinations
Separation of blood components

- Separation based on the presence of cells
- Separation based on specific gradients
## Blood

<table>
<thead>
<tr>
<th></th>
<th>Specific weight</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma</td>
<td>1,026</td>
<td></td>
</tr>
<tr>
<td>Platelets</td>
<td>1,040</td>
<td>1-4 μm</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>1,050-1,061</td>
<td>6-10 μm</td>
</tr>
<tr>
<td>Monocytes</td>
<td>1,077</td>
<td>10-30 μm</td>
</tr>
<tr>
<td>Basophils</td>
<td>1,080</td>
<td>10-15 μm</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>1,082</td>
<td>9-15 μm</td>
</tr>
<tr>
<td>Neutrophils</td>
<td>1,088</td>
<td>12-15 μm</td>
</tr>
<tr>
<td>Erythrocytes</td>
<td>1,100</td>
<td>6-8 μm</td>
</tr>
</tbody>
</table>
Separation
Separation in ‘bowl’
## Blood

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<tr>
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Separation in system

Plasma
Platelets
Lymphocytes
Monocytes
Granulocytes

Erytrocytes
Cytapheresis
Separation in centrifuge belt
Separation in Amicus system
Separation
Cell selection
WBC collection
Separation in centrifuge belt
# Blood

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Count</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets</td>
<td></td>
<td>4 μm</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td></td>
<td>10 μm</td>
</tr>
<tr>
<td>Monocytes</td>
<td></td>
<td>30 μm</td>
</tr>
<tr>
<td>Basophils</td>
<td></td>
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## Hydroxy Ethyl Starch

- **PlasmaSteril 6%** 450,000 D
- **Haes-Steril 6%** 200,000 D
- **EloHaes 6%** 200,000 D
- **Voluven** 120,000 D
Apheresis

• Donors
  • To collect blood components

• Patients
  • To collect blood components
  • To reduce blood components
  • To exchange blood components
Donor apheresis

- Plasmapheresis
  - FFP
  - Source plasma
- Plateletapheresis
  - In Plasma
  - In PAS
- Leukocytapheresis
  - Stem cells
  - T-cells
  - Monocytes
  - Granulocytes
- Erytrocytapheresis
- Combinations
Patient apheresis: Collection of components

- Stem cells (hematopoietic / mesenchymal)
- Cells for cellular therapy
  - T-cells (DLI)
  - Fototherapy
  - Monocytes (dendritic vaccination therapy)
- RBCs
TA: Removal / exchange procedures

• Something to remove from the blood stream
  • IgG vs IgM
  • Cell distribution
Reduction of components

- Platelets
- Leukocytes
- Red blood cells
Exchange of components

- Plasma
- Red Blood Cells
Indications for TA


Guidelines on the Use of Therapeutic Apheresis in Clinical Practice—Evidence-Based Approach from the Apheresis Applications Committee of the American Society for Apheresis

Zbigniew M. Szczepiorkowski,1† Jeffrey L. Winters,2* Nicholas Bandarenko,3* Haewon C. Kim,4* Michael L. Linenberger,5* Marisa B. Marques,6* Ravindra Sarode,7* Joseph Schwartz,8* Robert Weinstein,9* and Beth H. Shaz10*
### TABLE I. Indications for Therapeutic Apheresis—ASFA 2010 Categories\(^a\)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
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</table>
| I        | Disorders for which apheresis is accepted as first-line therapy, either as a primary standalone treatment or in conjunction with other modes of treatment.  
[Example: plasma exchange in Guillain-Barré syndrome as first-line standalone therapy; plasma exchange in myasthenia gravis as first-line in conjunction with immunosuppression and cholinesterase inhibition]. |
| II       | Disorders for which apheresis is accepted as second-line therapy, either as a standalone treatment or in conjunction with other modes of treatment.  
[Example: plasma exchange as standalone secondary treatment for acute disseminated encephalomyelitis after high-dose IV corticosteroid failure; extracorporeal photopheresis added to corticosteroids for unresponsive chronic graft-versus-host disease] |
| III      | Optimum role of apheresis therapy is not established. Decision making should be individualized. [Example: extracorporeal photopheresis for nephrogenic systemic fibrosis; plasma exchange in patients with sepsis and multiorgan failure]. |
| IV       | Disorders in which published evidence demonstrates or suggests apheresis to be ineffective or harmful. IRB approval is desirable if apheresis treatment is undertaken in these circumstances.  
[Example: plasma exchange for active rheumatoid arthritis]. |
### TABLE II. Level of Evidence Used in the ASFA Special Issue 2010

<table>
<thead>
<tr>
<th>Evidence level</th>
<th>Evidence quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Obtained from at least one properly designed randomized controlled trial</td>
</tr>
<tr>
<td>Type II-1</td>
<td>Obtained from a well-designed controlled trials without randomization</td>
</tr>
<tr>
<td>Type II-2</td>
<td>Obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group</td>
</tr>
<tr>
<td>Type II-3</td>
<td>Obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments could also be regarded as this type of evidence</td>
</tr>
<tr>
<td>Type III</td>
<td>Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees</td>
</tr>
</tbody>
</table>
### TABLE III. Grading Recommendations Adopted from Guyatt et al. [13]

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Description</th>
<th>Methodological quality of supporting evidence</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1A</td>
<td>Strong recommendation, high-quality evidence</td>
<td>RCTs without important limitations or overwhelming evidence from observational studies</td>
<td>Strong recommendation, can apply to most patients in most circumstances without reservation</td>
</tr>
<tr>
<td>Grade 1B</td>
<td>Strong recommendation, moderate quality evidence</td>
<td>RCTs with important limitations (inconsistent results, methodological flaws, indirect, or imprecise) or exceptionally strong evidence from observational studies</td>
<td>Strong recommendation, can apply to most patients in most circumstances without reservation</td>
</tr>
<tr>
<td>Grade 1C</td>
<td>Strong recommendation, low-quality or very low-quality evidence</td>
<td>Observational studies or case series</td>
<td>Strong recommendation but may change when higher quality evidence becomes available</td>
</tr>
<tr>
<td>Grade 2A</td>
<td>Weak recommendation, high quality evidence</td>
<td>RCTs without important limitations or overwhelming evidence from observational studies</td>
<td>Weak recommendation, best action may differ depending on circumstances or patients’ or societal values</td>
</tr>
<tr>
<td>Grade 2B</td>
<td>Weak recommendation, moderate-quality evidence</td>
<td>RCTs with important limitations (inconsistent results, methodological flaws, indirect, or imprecise) or exceptionally strong evidence from observational studies</td>
<td>Weak recommendation, best action may differ depending on circumstances or patients’ or societal values</td>
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<tr>
<td>Grade 2C</td>
<td>Weak recommendation, low-quality or very low-quality evidence</td>
<td>Observational studies or case series</td>
<td>Very weak recommendations; other alternatives may be equally reasonable</td>
</tr>
</tbody>
</table>
Indications TA
In summary

• Apheresis: what's that?
• Donor apheresis to collect components.
• Patient apheresis to collect components.
• Therapeutic apheresis in patients.