The Power of Digital Pathology for Improvement of Intraoperative Patient Management

Pilot program for intraoperative teleconsultation in Ile de France

Telepathology Working Group AP-HP
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Catherine GUETTIER
Head of Pathology – Bicêtre University Hospital (Paris)
Healthcare organization in Ile de France

Ile de France: **12 000 000 inh**

420 health structures - Assistance Publique-Hôpitaux de Paris

388 pathologists – 3.3/100,000 inh
Context: Situation of Pathology in France

- Shortage and aging of pathologists
- Reorganization of Pathology structures with shared technical facilities
- Increased number and complexity of cases
- Molecular pathology
- Systematic reviewing of lymphomas and « rare cancers » required by the National Institute of Cancer (INCa)
Telepathology is the area of telemedicine involving the transmission of pathological specimen images for remote study and diagnosis of disease.

Two fields of application:
- Intraoperative consultation
- Second opinion diagnosis

Two technologies
- Real-time systems - through a robotically controlled motorized microscope.
- Digital slide systems - pathology specimen slides are numerized and high-resolution digital images created for transmission.
Digital slides

- **Digital slides or « Whole Slide Images »**
  Numerization of the whole tissue section from a glass slide

- **500 Mo – 3 Go.**

- **Virtual microscope.**

- **No change in time.**

- **Available for consultation through an intranet or the Internet.**
Digital slide: viewer
Telepathology network in Ile de France 1/3
18 month pilot program (June 2014 - December 2015)

18 structures of Pathology

Regional Health Agency of Ile de France
Call for Telemedecine projects 2012
Telepathology 550 000€

Paris

CHU Bichat
CHU Cochin
CHU HEGP
CHU Pitié Salp.
CHU Saint Antoine
CHU St Louis
CHU Trousseau

Outside Paris

- CHU A. Paré
- CHU A. Béclère
- CHU K. Bicêtre
- CHU P. Brousse
- CHU H. Mondor
- CHG Pontoise
- CHG Eaubonne
- CHG Villeneuve St George
- CHG Marnes La Vallée/Meaux
- CHG Versailles
- La Croix St Simon
- ACP Bièvres
<table>
<thead>
<tr>
<th>Telediagnosis for frozen sections</th>
<th>Second opinion Teleconsultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ CHU P. Brousse ↔ CHU Bicêtre</td>
<td>Already equipped with a scanner</td>
</tr>
<tr>
<td>▪ CHG Meaux</td>
<td>▪ CHU Bichat</td>
</tr>
<tr>
<td>Scanner provided through the project</td>
<td>▪ CHU Cochin</td>
</tr>
<tr>
<td>▪ La Croix St Simon ↔ CHU Saint Antoine</td>
<td>▪ CHU HEGP</td>
</tr>
<tr>
<td>Scanner provided through the project</td>
<td>▪ CHU Pitié Salp.</td>
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<td></td>
<td>▪ CHU Saint Antoine</td>
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<td>▪ CHU St Louis</td>
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<tr>
<td></td>
<td>▪ CHU Trousseau</td>
</tr>
<tr>
<td></td>
<td>▪ CHU A. Paré</td>
</tr>
<tr>
<td></td>
<td>▪ CHU A. Béclère</td>
</tr>
<tr>
<td></td>
<td>▪ CHU K. Bicêtre</td>
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<td>▪ ACP Bièvres</td>
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</tbody>
</table>
Telepathology network in Ile de France 3/3

Industrial Partners

- TRIBVN HEALTHCARE
- TELESIDE

Centralized Telepathology Platform

- Specific agreement for Health data storage

Players

Universitary Hospitals - APHP
- DOMU- APHP – Telemedecine
- IT departments
- URC Eco

General Hospitals
- IT departments
- Private lab

Pathologist working group

ARS Ile de France/ GCS-SESAN
Regional Telepathology platform
### Reglementary issues for telemedecine in France

<table>
<thead>
<tr>
<th>Main rules</th>
<th>Digital slides</th>
<th>Law</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Patient’s consent</td>
<td>- CE marking for <em>in vitro</em> diagnosis of scanners and software</td>
<td>- Law n°2009-879 July 21, 2009 « Hospital, Patients, Healthcare and territory »</td>
</tr>
<tr>
<td>- Telepathology record in the LIS</td>
<td>- Digital slide storage?</td>
<td>- Telemedecine decree October 19, 2010</td>
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<tr>
<td></td>
<td>- Digital slide archiving?</td>
<td></td>
</tr>
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</table>

**Responsability of intraoperative frozen section by Telepathology?**

Pathologist only
Historical background of introperative frozen sections

• Initial will of the surgeons

• **First reports:**
  Thomas S. Cullen en 1895 (Baltimore, USA),
  Louis B. Wilson en 1905 (Rochester, USA).

• Implemented between 1920-1930.

• **Cryomicrotome** in 1959.

• **First telediagnosis on frozen sections in** Tromsø — Norway 1989 with a robotized microscope.

• **First telediagnosis on digital frozen sections** in the first 2010.

Antony A. Gal, Frozen Section Technique at the Mayo Clinic, *Arch Pathol Lab Med*—Vol 129, December 2005
Intraoperative consultation

• Pathological examination which takes place during a surgical operation and the result of which influences the continuation of the intervention

• Indications
  - Preliminary diagnosis,
  - Assessment of tumor spread
  - Quality of surgical resection
  - Tumoral character of a tissue sample.

• Time constraint < 30mn

• Frozen section and quick staining: poor slide quality

• Pathologist assisted by a technician

• Result: preliminary indication but not a definite diagnosis

• % of diagnostic errors in the literature: <5%
Telediagnosis for frozen sections

Technologist
- CHU P. Brousse
  July 2013
- CHG Meaux
- La Croix St Simon

Different workflows
- INTRANET/VNC
  Local Server

Pathologist
- CHU Bicêtre
- CHG Marnes La Vallée
- CHU St Antoine
Intraoperative teleconsultations

Internet

**Hospital 1**
- Operating room: Request for intra-operative consultation

  - Technologist
    - File’s registration
    - Videomacroscopy
    - Sampling
    - Cutting/Staining
    - Slide numerization x20

**Hospital 2**
- Pathology laboratory

  - Pathologist
    - Assistance for sampling
    - Microscopic diagnosis

**Telepathology Platform**
- Telepathology file
- Webex launch

**Turnaround time < 30 min**
Intraoperative teleconsultations

Intranet

Hospital 1
Operating room: Request for intra-operative consultation

- File’s registration
- Videomacroscopy
- Sampling
- Cutting/Staining
- Slide numerization x20

Hospital 2
Pathology laboratory

- Assistance for sampling
- Microscopic diagnosis

2.7 km

VNC (Intranet)
100 Mb/s (10 MB/s)

Turnaround time < 30 min

Local server LIS/IMS
Workstations for intraoperative teleconsultation
Activity of the pilot program for IOC
637 completed intraoperative consultations/42 technical failures

<table>
<thead>
<tr>
<th>Sites</th>
<th>Technicians</th>
<th>Pathologists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croix St Simon / St Antoine</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Meaux / Marne-la-Vallée</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Paul Brousse / Bicêtre</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sites</th>
<th>IOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Brousse / Bicêtre</td>
<td>334</td>
</tr>
<tr>
<td>Meaux / Marne-la-Vallée</td>
<td>292</td>
</tr>
<tr>
<td>Croix St Simon / St Antoine</td>
<td>53</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>679</strong></td>
</tr>
</tbody>
</table>

45 users of the platform
- 18 technologists
- 27 pathologists
Intraoperative consultations 1/4

Paul Brousse - Bicêtre

Paul Brousse

Technologist X 1 Pathologist X 1

- Intraoperative teleconsultations
- Specimen registration

Bicêtre

Technologists X 14 Pathologists X 8

- 2008 - 2013
- Biobanking
- Fresh specimen grossing
- Fixed specimen grossing
- Immunohistochemistry

2.7 km

From 2013 July 1st

Technologist X 1

- Frozen sections
- Fresh specimen macroscopy
- Biobanking

Pathologist X 9

- Slide producing
- Biobanking

Only 1 pathologist on duty for frozen sections of both sites
## Results: Paul Brousse – Bicêtre

<table>
<thead>
<tr>
<th>Intraoperative consultations</th>
<th>Before telepathology</th>
<th>After telepathology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>December 2012-May 2013</td>
<td>July 2013-December 2015</td>
</tr>
<tr>
<td>Number</td>
<td>76</td>
<td>498</td>
</tr>
<tr>
<td>Single</td>
<td>45</td>
<td>259</td>
</tr>
<tr>
<td>Multiple</td>
<td>31</td>
<td>239</td>
</tr>
<tr>
<td>Technical incidents</td>
<td>0</td>
<td>59</td>
</tr>
</tbody>
</table>

*astrid laurent-bellue*
### Intraoperative teleconsultations 3/4

#### Results: Paul Brousse - Bicêtre

<table>
<thead>
<tr>
<th>Turnaround Time before and after use of telepathology</th>
<th>Before telepathology</th>
<th>After telepathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnaround Time (min)</td>
<td>n = 76</td>
<td>n = 498</td>
</tr>
<tr>
<td>Mean</td>
<td>0:26:12</td>
<td>0:38:00 (p&lt;0.001)</td>
</tr>
<tr>
<td>Mean single/multiple</td>
<td>0:22:36/00:31:24</td>
<td>0:32:30/0:43:54</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0:09:36</td>
<td>0:17:06</td>
</tr>
<tr>
<td>Min</td>
<td>0:05:00</td>
<td>0:13:00</td>
</tr>
<tr>
<td>Max</td>
<td>0:50:00</td>
<td>2:20:00</td>
</tr>
<tr>
<td>% turnaround times ≤ 30 min</td>
<td>71.1%</td>
<td>38.6% (p&lt;0.001)</td>
</tr>
<tr>
<td>Number of turnaround times ≥ 1h</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

* Astrid Laurent-Bellue
Intraoperative teleconsultations 4/4

Results: Paul Brousse - Bicêtre

<table>
<thead>
<tr>
<th>Concordance between intraoperative consultation and final diagnosis</th>
<th>Before telepathology</th>
<th>After telepathology</th>
<th>Fischer’s test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Complete concordance</td>
<td>71</td>
<td>93.4%</td>
<td>460</td>
</tr>
<tr>
<td>Partial concordance</td>
<td>1</td>
<td>1.3%</td>
<td>8</td>
</tr>
<tr>
<td>Discordance</td>
<td>4</td>
<td>5.3%</td>
<td>30</td>
</tr>
<tr>
<td>Missing data</td>
<td>1</td>
<td>0.9%</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>100.00%</td>
<td>498</td>
</tr>
</tbody>
</table>

* Astrid Laurent-Bellue
## Issues in intraoperative teleconsultations

<table>
<thead>
<tr>
<th>Technical issues</th>
<th>Organizational issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Scanner breakdown</td>
<td>▪ Time schedule of surgical operations/technologist hours</td>
</tr>
<tr>
<td>▪ Multiple connexions PF/Webex</td>
<td>▪ Result transmission to the surgeon</td>
</tr>
<tr>
<td>▪ Automatic upgrading of dedicated computers</td>
<td>▪ Simultaneous intraoperative consultations for the same or different patients</td>
</tr>
<tr>
<td>▪ Degradation of dedicated computers</td>
<td></td>
</tr>
<tr>
<td>▪ Network limitations</td>
<td></td>
</tr>
<tr>
<td>➢ Maintenance</td>
<td>➢ Internal organization</td>
</tr>
<tr>
<td>➢ Integration</td>
<td>➢ Special devices</td>
</tr>
<tr>
<td>➢ Lock</td>
<td>➢ Multiple slide scanners</td>
</tr>
<tr>
<td>➢ Controlled access</td>
<td>➢ Faster scanners</td>
</tr>
<tr>
<td>➢ Regional Network</td>
<td></td>
</tr>
</tbody>
</table>
### Changes in professional practices

<table>
<thead>
<tr>
<th>Technologists</th>
<th>Pathologists</th>
<th>Surgeons</th>
</tr>
</thead>
<tbody>
<tr>
<td>- New skills in macroscopy</td>
<td>- Diagnosis without palpation</td>
<td>- Longer turnaround time</td>
</tr>
<tr>
<td>- Digital imaging</td>
<td>- Use of digital slides for diagnosis</td>
<td>- New intraoperative organization</td>
</tr>
<tr>
<td>- Increased responsibilities</td>
<td>- Increased relationship of trust with technologists</td>
<td></td>
</tr>
<tr>
<td>- Stress</td>
<td>- Help in frozen section diagnosis</td>
<td></td>
</tr>
<tr>
<td>- Professional pride</td>
<td>- Optimized medical organization</td>
<td></td>
</tr>
</tbody>
</table>
Economic aspects

- Intraoperative teleconsultation/Conventional intraoperative consultation/: no specific valorisation (HAS 2014)

<table>
<thead>
<tr>
<th>Costs</th>
<th>Annual cost amortized over 5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment costs</td>
<td></td>
</tr>
<tr>
<td>Scanner</td>
<td>10450€</td>
</tr>
<tr>
<td>Analysis station</td>
<td>310€</td>
</tr>
<tr>
<td>Logiciel</td>
<td>1650€</td>
</tr>
<tr>
<td>Running costs</td>
<td></td>
</tr>
<tr>
<td>Scanner maintenance</td>
<td>4140€</td>
</tr>
<tr>
<td>Software maintenance</td>
<td>718€</td>
</tr>
<tr>
<td>Production cost</td>
<td>25,3€/act</td>
</tr>
</tbody>
</table>

Intraoperative telediagnostic act (200/an) : **112€**

Current valorisation (CCAM) : **84€**

Medical time saving to be valued
Conclusion

- Feasability
- A real challenge for technologists and pathologists
- Increased network speed and performance.
- Faster scan/Multislide scanner
- Point to point intra- or inter-health structure via Intranet/VPN
- Keep the link with the surgical team
## Telepathology Working Group in Ile de France

<table>
<thead>
<tr>
<th>NAME</th>
<th>SITE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippe Bertheau</td>
<td>St-Louis</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Frédéric Beuvon</td>
<td>Cochin</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Frédérique Capron</td>
<td>La Pitié</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Agnès Chabouis</td>
<td>DOMU</td>
<td>Telemedecine</td>
</tr>
<tr>
<td>Joël Cucherousset</td>
<td>Montfermeil</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Bettina Fabiani</td>
<td>St-Antoine</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Isabelle Goubin-Versini</td>
<td>Pontoise</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Philippe Gros</td>
<td>ACP Bièvres</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Catherine Guettier</td>
<td>Bicètre</td>
<td>Pathologist</td>
</tr>
<tr>
<td>Gilles Le Naour</td>
<td>La Pitié</td>
<td>IT</td>
</tr>
<tr>
<td>Eric Poullier</td>
<td>CSS SI Patient</td>
<td>IT</td>
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</table>