Contribution of telemedicine to External Quality Assessment Scheme for blood smear and bone marrow interpretation: the Belgian experience

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Belgian EQAS for Blood smear interpretation

- 1991: Operational (n = 616)
- Mandatory
- 3 surveys/year

- 2004: MGG virtual microscopy (CD ROM)  
  + unstained blood smear (n = 232)  
  
  SZU-HEE LEE, Virtual Microscopy: Applications to Hematology, Laboratory Hematology. 2005;11:38-45

- 2006: Didactic cases

- 2008: Bone marrow Pilot study #1 (n = 106)

- 2009: Bone marrow Pilot study #2 (n = 98)
<table>
<thead>
<tr>
<th>Date</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004 November</td>
<td>ALL</td>
</tr>
<tr>
<td>2005 March</td>
<td>Normal, B Prolymphocytic Leukaemia</td>
</tr>
<tr>
<td>2005 June</td>
<td>Normal, Hereditary Spherocytosis</td>
</tr>
<tr>
<td>2005 November</td>
<td>Normal, Secondary leukaemia</td>
</tr>
<tr>
<td>2006 March</td>
<td>Normal, B12 deficiency</td>
</tr>
<tr>
<td>2006 June</td>
<td>Normal, Drepanocytosis, <em>May Hegglin</em> (didactic)</td>
</tr>
<tr>
<td>2006 November</td>
<td>Myeloma, <em>Chediak-Higashi</em> (didactic)</td>
</tr>
<tr>
<td>2007 March</td>
<td>Normal, CML</td>
</tr>
<tr>
<td>2007 June</td>
<td>Normal, Reactive Lymphocytosis</td>
</tr>
<tr>
<td>2007 November</td>
<td>Normal, Hairy Cell Leukemia</td>
</tr>
<tr>
<td>2008 March</td>
<td>Normal, TTP</td>
</tr>
<tr>
<td>2008 May</td>
<td>B12 deficiency, <em>Secondary leukaemia</em> (didactic) (bone marrow aspirate)</td>
</tr>
<tr>
<td>2008 June</td>
<td>Secondary ALL, <em>BiN Polyclonal Hyperlymphocytosis</em> (didactic)</td>
</tr>
<tr>
<td>2008 November</td>
<td>T Prolymphocytic leukaemia, <em>MDS Ider20Q</em> (didactic)</td>
</tr>
<tr>
<td>2009 March</td>
<td>Hairy Cell Leukaemia, <em>t(8;21) AML</em> (didactic)</td>
</tr>
<tr>
<td>2009 June</td>
<td>Normal, T cell large Granular Lymphocytic leukaemia</td>
</tr>
<tr>
<td>2009 November</td>
<td>Normal, Leukemoid reaction</td>
</tr>
<tr>
<td>2009 November</td>
<td>Myeloma (bone marrow aspirate)</td>
</tr>
<tr>
<td>2010 March</td>
<td>CLL, <em>Mucopolysaccharidosis Maroteaux-Lamy syndrome</em> (didactic)</td>
</tr>
<tr>
<td>Date</td>
<td>Diagnosis</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>2010 June</td>
<td>Normal, Plasmodium Falciparum, TTP</td>
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<tr>
<td>2010 November</td>
<td>Normal, Sezary Lymphoma</td>
</tr>
<tr>
<td>2010 November</td>
<td><strong>Mantle Cell Lymphoma</strong></td>
</tr>
<tr>
<td>2011 March</td>
<td>Normal, Acute Lymphoblastic Leukemia</td>
</tr>
<tr>
<td>2011 June</td>
<td>Normal, Acute Myeloblastic Leukemia</td>
</tr>
</tbody>
</table>
Galerie des globules blancs "Contrôle"
Morphologie des globules rouges et des plaquettes

"Contrôle"
From wide fields to whole slide...

- **Picture resolution** (100x): 1360*1024 (24 bits images)
  $\rightarrow \sim 4,177$ MB per picture

- **QUANTITY (whole slide)**
  - 20x, 12% overlapping: 40*60 = 2400 pictures
  - 40x, 12% overlapping: 80*120 = 9600 pictures
  - 100x, 12% overlapping: 300*200 = 60,000 pictures
  - (+ current research on multi level recombination)

- **SIZE**
  - **WHOLE SLIDE**
    $\rightarrow 100x : 250$ GB
  - **AREA OF INTEREST (1/5 of the Slide)**
    $\rightarrow 100x : 50$ GB (JPEG2000: $\sim$7GB)
Stitching

- 100x : 1pixel = ~0.2µ
  → highly sensitive
  → shifts

- **Rigid** registration (translation, rotation)
  - Capture path as input
  - Post optimisation

- **Algorithm**
  - Reference vector
    - Filtering: gray scale, normalisation
  - Best match vector
  - Computes the shift
  - Stitching
**MAIN WORKFLOW**

**CAPTURE**
- MICROSCOPE
- CAMERA

**VISUALISATION**
- HOMEMADE VIEWER
- ANY JPEG2000 COMPATIBLE VIEWER

**COREGISTRATION**
- CLIENT₁
- …
- SERVER
- CLIENTₙ

**Storage**
- (Shared repository)

**Mega-image**
Technical improvements: Size

90 Pictures

450 Pictures
Technical improvements: Z axis combination

900 Pictures
Technical improvements: Z axis combination

900 Pictures
96% of participants rated the software as good or excellent.
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Participation (%)</th>
<th>Diagnosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May-Hegglin anomaly</td>
<td>93</td>
<td>61</td>
</tr>
<tr>
<td>Chediak-Higashi syndrome</td>
<td>95</td>
<td>82</td>
</tr>
<tr>
<td>BiN Polyclonal Hyperlymphocytosis</td>
<td>97</td>
<td>67</td>
</tr>
<tr>
<td>MDS with isolated del(20q)</td>
<td>89</td>
<td>81</td>
</tr>
<tr>
<td>AML with t(8;21)(q22;q22)</td>
<td>92</td>
<td>86</td>
</tr>
<tr>
<td>Mucopolysaccharacidosis</td>
<td>92</td>
<td>95</td>
</tr>
</tbody>
</table>
Belgian EQA Participant opinion

Blood

- Assessment: 88% participants → Good/Very good
- Selected cells: relevant for diagnosis
- MGG virtual slide vs. Glass slide: no significant difference

Bone marrow

- Easy to use: 61% participants
- Picture quality: > 90% satisfaction
- Too small wide fields → number and quality of megakaryocytes difficult to evaluate.
Conclusions

Implementation of Virtual Slides to EQAS in Belgium is well appreciated by the users by allowing control and improvement of the skills.

The quality was technically improved
higher size of the wide-field automated capture
thanks to the comments of the users.

Standardization of the observed cells by the experts allowed to improve the quality of the selected cases.

Virtual Microscopy allowed implementing a control on bone marrow smears which was impossible with manual smears for ethical and practical reasons.
Thanks to:

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EQA Advisory Board

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