



***Virtual Microscopy  
Online Pilot Survey 2009***

prepared by

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## Virtual Microscopy Online Pilot Survey

### Introduction:

Virtual Microscopy is the creation of digital images of material on glass microscope slides which can be viewed on a computer in a manner that resembles using a microscope.

The advantages for a morphology external quality assurance program are that all participants will receive identical material for analysis and because only a small amount of material is required for this purpose, a much greater range of rare cases and sample types can be provided.

In 2007, a pilot survey in which participants were asked to assess digital images on DVD revealed a positive outcome for image quality, ease of use and other potential applications.

In 2009 a survey using digital images of three blood films was placed online. Participants were asked to provide an online submission of red cell, white cell and platelet findings, and the most likely diagnosis. The purpose was to gather information about participants' experience with the online digital system as a whole and to compare the descriptive and diagnostic responses with those received in previous surveys with glass slides of the same cases.

### Method:

Digital slides from three cases used in previous glass slide morphology surveys were produced using an Aperio ScanScope® digital slide scanner.

Prior to their use in the glass slide survey, these three cases had been assessed as suitable for that by a selection committee of three haematologists and a scientist.

Participants were asked to register, login, follow the links to the image and submit their findings online in relation to red cell, white cell and platelet abnormalities, the most likely diagnosis and coexisting condition (where relevant).

Each participant was also provided with a hard copy survey to ensure we capture their experience of the online images even if they had difficulties with using the online system.

Participants' online findings were compared with results those from the glass slide surveys.

### Results:

**PART A:** The online virtual microscope survey results were compared with the results from the same slides in the previous surveys. As only 101 laboratories participated in case study 1, 95 in case study 2 and 91 in case study 3, compared to over 500 laboratories in the glass slide surveys, the numbers have been converted to percentages.

**PART B:** Shows the overall assessment of the online method by the participants in relation to image quality, ease of viewing the digital slide online and access to the online images.



**PART A**

**CASE STUDY 1**

<b>VM0901a</b>	WCC=11.4x10 <sup>9</sup> /L Hb=102g/L MCV=78fL PLT=422x10 <sup>9</sup> /L 6 year old female with visual problems & recurrent abscesses
Morphology Survey Number: <b>MP07-02c</b>	Target diagnosis: <b>Chediak Higashi syndrome</b>

**DIGITAL SLIDE VM0901a**

DIAGNOSIS	PERCENT OF PARTICIPANTS (%)	ASSESSMENT
Chediak-Higashi anomaly	92.1	Acceptable
Other congenital neutrophil abnormality	2.0	Partially Acceptable
Acute leukaemia	1.0	Not Acceptable
May-Hegglin anomaly + Viral infection	1.0	Not Acceptable
Alder-Reilly anomaly	1.0	Not Acceptable
Hereditary spherocytosis	1.0	Not Acceptable
Refractory cytopenia with unilineage dysplasia (includes refractory anaemia)	1.0	Not Acceptable
Kawasaki syndrome	1.0	Not Acceptable
Total	100	

**GLASS SLIDE Survey MP7-02c**

DIAGNOSIS	PERCENT OF PARTICIPANTS (%)	ASSESSMENT
Chediak-Higashi anomaly	95.3	Acceptable
Good description - Scientist only	1.9	Acceptable
Congenital Neutrophil abnormality	0.2	Partially Acceptable
Alder Reilly Anomaly	0.8	Not Acceptable
Chronic Lymphocytic Leukaemia	0.2	Not Acceptable
Hypereosinophilic syndrome	0.2	Not Acceptable
Infectious Mononucleosis	0.2	Not Acceptable
Lymphoplasmacytoid lymphoma	0.2	Not Acceptable
Myeloproliferative disorder	0.2	Not Acceptable
Sepsis/Septicaemia	0.2	Not Acceptable
Other	0.2	Not Acceptable
No diagnosis or acceptable descriptions	0.2	Not Acceptable
Acute Leukaemia with no FAB or WHO Classification	0.2	Not Acceptable
Total	100	



**CASE STUDY 2**

<b>VM0901b</b>	WCC=13.0x10 <sup>9</sup> /L Hb=85g/L MCV=96fL PLT=299x10 <sup>9</sup> /L 70 year old male. Unwell
Morphology Survey Number: <b>MP6-02a</b>	Target diagnosis: <b>G6PD deficiency</b>

<b>DIGITAL SLIDE VM0901b</b>		
<b>DIAGNOSIS</b>	<b>PERCENT OF PARTICIPANTS (%)</b>	<b>ASSESSMENT</b>
Oxidative haemolytic anaemia	43.2	Acceptable
Oxidative haemolytic anaemia + Drug effects	9.5	Acceptable
Oxidative haemolytic anaemia + Bacterial infection / sepsis	8.4	Acceptable
Oxidative haemolytic anaemia + Haemolysis	5.3	Acceptable
G6PD deficiency	4.2	Acceptable
G6PD deficiency + Bacterial infection / sepsis	3.2	Acceptable
G6PD deficiency + Drug effects	1.1	Acceptable
MAHA	2.1	Partially Acceptable
Oxidative haemolytic anaemia + Hyposplenism	1.1	Partially Acceptable
Microangiopathic haemolytic anaemia + Bacterial infection / sepsis	1.1	Partially Acceptable
G6PD deficiency + Hyposplenism	1.1	Partially Acceptable
AIHA warm	3.2	Not Acceptable
AIHA warm + Bacterial infection / sepsis	3.2	Not Acceptable
AIHA warm + Haemolysis	2.1	Not Acceptable
Clostridial sepsis	1.1	Not Acceptable
Refractory anaemia with ringed sideroblasts	1.1	Not Acceptable
Splenic marginal zone lymphoma	1.1	Not Acceptable
Heavy metal poisoning	1.1	Not Acceptable
Haemoglobin variant - other + Bacterial infection / sepsis	1.1	Not Acceptable
MDS associated with isolated del(5q) abnormality + Bacterial infection / sepsis	1.1	Not Acceptable
Liver disease + Hyposplenism	1.1	Not Acceptable
Liver disease + Haemolysis	1.1	Not Acceptable
MDS associated with isolated del(5q) abnormality	1.1	Not Acceptable
Bacterial contamination of sample	1.1	Not Acceptable
Bartonellosis	1.1	Not Acceptable
Total	100	



**CASE STUDY 2**

<b>GLASS SLIDE Survey MP6-02a</b>		
<b>DIAGNOSIS</b>	<b>PERCENT OF PARTICIPANTS (%)</b>	<b>ASSESSMENT</b>
Oxidative haemolytic anaemia	43.8	Acceptable
G6PD deficiency	17.9	Acceptable
Drug induced haemolytic anaemia	10.7	Acceptable
Good description - scientist only	7.7	Acceptable
Lead poisoning	3.2	Not Acceptable
Bacterial infection	1.8	Not Acceptable
No diagnosis or acceptable description	1.2	Not Acceptable
Microangiopathic haemolytic anaemia	1.2	Not Acceptable
Myelodysplastic syndrome - MDS	1.2	Not Acceptable
Anaemia due to Blood loss	1.0	Not Acceptable
Autoimmune haemolytic anaemia (AIHA)	0.8	Not Acceptable
Fe deficiency +/- treatment	0.4	Not Acceptable
Haemoglobinopathy	0.4	Not Acceptable
MDS/MPD	0.4	Not Acceptable
Megaloblastic anaemia	0.4	Not Acceptable
Acquired Sideroblastic Anaemia	0.2	Not Acceptable
Enzyme deficiency	0.2	Not Acceptable
Hereditary stomatocytosis	0.2	Not Acceptable
Liver disease	0.2	Not Acceptable
Mechanical / valve haemolysis	0.2	Not Acceptable
No abnormality detected	0.2	Not Acceptable
Sideroblastic anaemia	0.2	Not Acceptable
Splenic lymphoma with villous lymphocytes (SLVL)	0.2	Not Acceptable
Unknown	6.3	Not Acceptable
Total	100.0	



**CASE STUDY 3**

<b>VM0901c</b>	WCC=13.2x10 <sup>9</sup> /L Hb=119g/L MCV=103.6fL PLT=204x10 <sup>9</sup> /L  54 year old male. No clinical notes available
Morphology Survey Number: <b>MP7-07a</b>	Target diagnosis: <b>Myelofibrosis + Splenectomy</b>

DIGITAL SLIDE VM0901c		
DIAGNOSIS	PERCENT OF PARTICIPANTS (%)	ASSESSMENT
Myelofibrosis - primary + Hyposplenism	4.4	Acceptable
MPD + Hyposplenism	1.1	Acceptable
Myelodysplastic / myeloproliferative disease unclassified + Hyposplenism	1.1	Acceptable
MPD with acute leukaemic transformation + Hyposplenism	1.1	Acceptable
MAHA + Hyposplenism	4.4	Partially Acceptable
No abnormality detected + Hyposplenism	3.3	Partially Acceptable
MDS associated with isolated del(5q) abnormality+splenectomy / hyposplenism	1.1	Partially Acceptable
Haemoglobinopathy / thalassaemia + Hyposplenism	1.1	Partially Acceptable
Bone marrow infiltration + Hyposplenism	1.1	Partially Acceptable
Hereditary spherocytosis + Hyposplenism	29.7	Not Acceptable
AIHA warm + Hyposplenism	14.3	Not Acceptable
Megaloblastic anaemia + Hyposplenism	6.6	Not Acceptable
AIHA warm + Bacterial infection / sepsis	4.4	Not Acceptable
AIHA warm + Post-transfusion	3.3	Not Acceptable
Megaloblastic anaemia	3.3	Not Acceptable
AIHA warm + Haemolysis	2.2	Not Acceptable
AIHA warm	2.2	Not Acceptable
MDS associated with isolated del(5q) abnormality	1.1	Not Acceptable
MAHA	1.1	Not Acceptable
Hereditary pyropoikilocytosis + Hyposplenism	1.1	Not Acceptable
Cold agglutinin disease + Hyposplenism	1.1	Not Acceptable
DIC + Haemolysis	1.1	Not Acceptable
Liver disease + Hyposplenism	1.1	Not Acceptable
Congenital dyserythropoietic anaemia	1.1	Not Acceptable
Mechanical / valve haemolysis + Haemolysis	1.1	Not Acceptable
South-East Asian ovalocytosis + Hyposplenism	1.1	Not Acceptable
DIC	1.1	Not Acceptable
Mechanical / valve haemolysis + Hyposplenism	1.1	Not Acceptable
Hereditary spherocytosis	1.1	Not Acceptable
ITP + Hyposplenism	1.1	Not Acceptable
Refractory anaemia with ringed sideroblasts	1.1	Not Acceptable
Total	100.0	



**CASE STUDY 3**

<b>GLASS SLIDE (Survey MP7-07a)</b>		
<b>DIAGNOSIS</b>	<b>PERCENT OF PARTICIPANTS (%)</b>	<b>ASSESSMENT</b>
Myelofibrosis + Splenectomy	31.9	Acceptable
Good description	21.4	Acceptable
MDS/MPD unclassified + Splenectomy	12.2	Acceptable
MPD + Splenectomy	7.3	Acceptable
MPD in transformation + Splenectomy	0.8	Acceptable
CML + Splenectomy	0.4	Acceptable
RARS + Splenectomy	0.4	Acceptable
Myelofibrosis	5.2	Partially Acceptable
MDS/MPD unclassified	2.9	Partially Acceptable
Bone Marrow infiltration + Splenectomy	1.0	Partially Acceptable
Myelofibrosis + Myeloproliferative disease	0.4	Partially Acceptable
Myeloproliferative disorder	0.4	Partially Acceptable
Chronic myeloproliferative disease + AIHA	0.2	Partially Acceptable
MDS + Sideroblastic anaemia	0.2	Partially Acceptable
Myeloproliferative disease on treatment	0.2	Partially Acceptable
MDS in transformation	0.2	Partially Acceptable
Miscellaneous diagnosis	5.7	Not Acceptable
Unacceptable description / diagnosis - Scientist only	4.4	Not Acceptable
Megaloblastic anaemia +/- Splenectomy	2.3	Not Acceptable
Splenectomy / Hyposplenism	1.3	Not Acceptable
AIHA + Splenectomy	1.1	Not Acceptable
CMML + Splenectomy	0.2	Not Acceptable
Haemolytic anaemia + infection	0.2	Not Acceptable
Total	100.0	

FIGURE 1

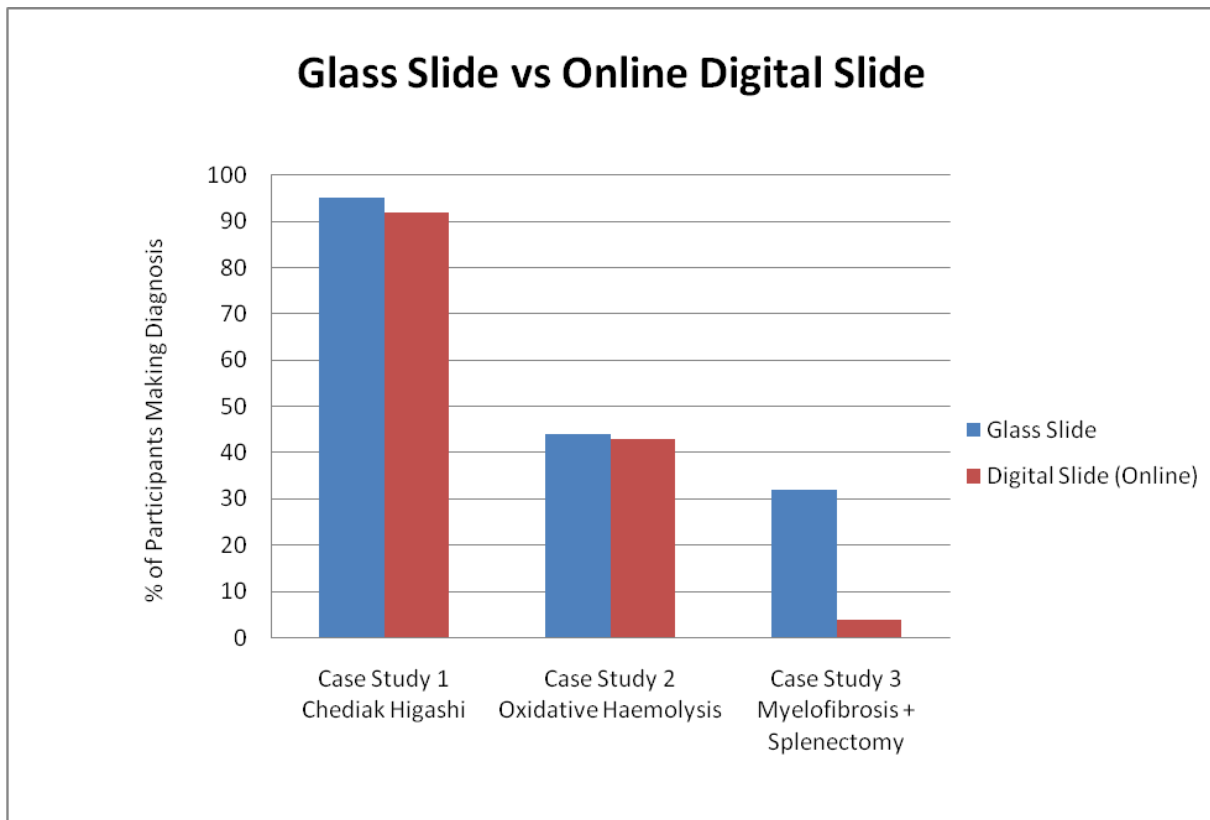


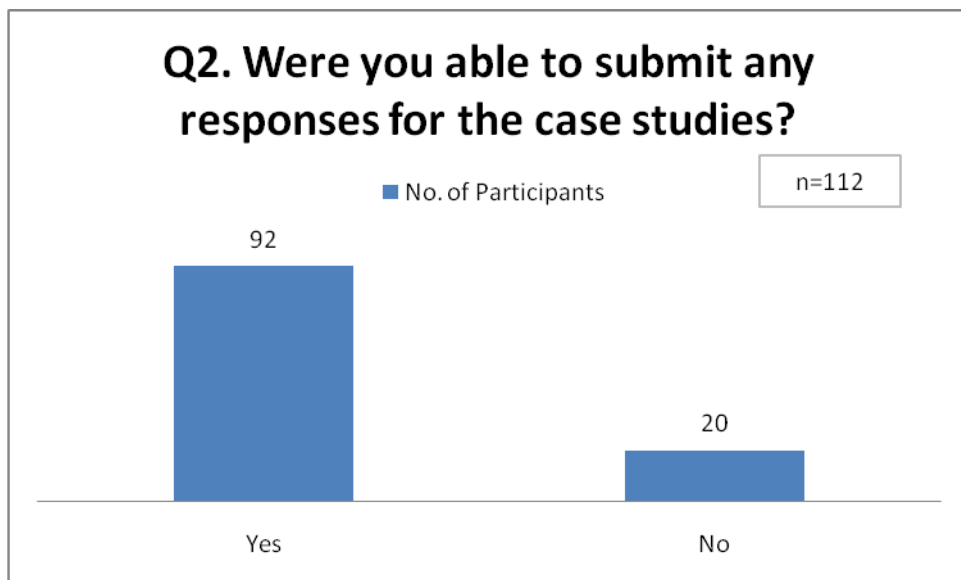
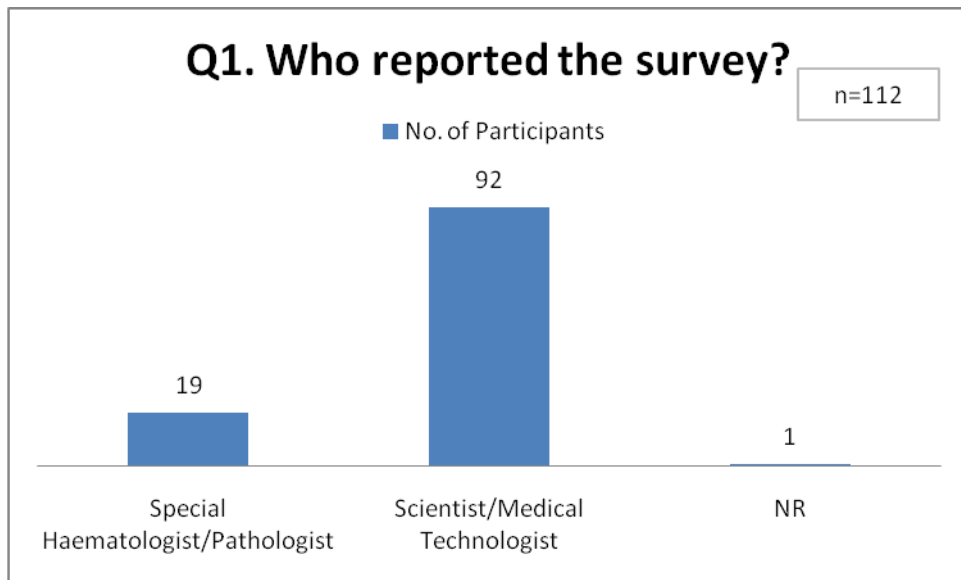
Figure 1. Summary of the online survey result. Participant diagnoses for the unknown cases were similar to those submitted for a previous glass slide survey in 2 of the 3 online cases. Subsequent review of the online scan area of the third case online deemed it not sufficiently representative of myelofibrosis compared with the glass slide. However the participants did successfully view and identify the intracellular inclusions, namely Howell Jolly bodies and they correctly diagnosed the concurrent hyposplenism.



**PART B**

The RCPA Haematology QAP wished to ascertain participants' experience of viewing images online. Participants were asked to provide the feedback even when they could not access the images. Responses are listed below.

Please note that NR = No Response.



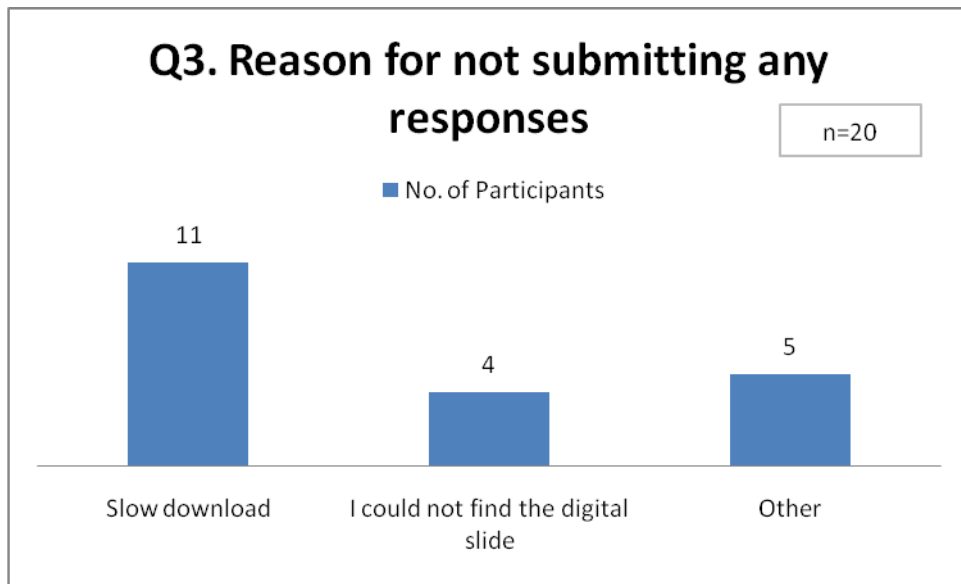


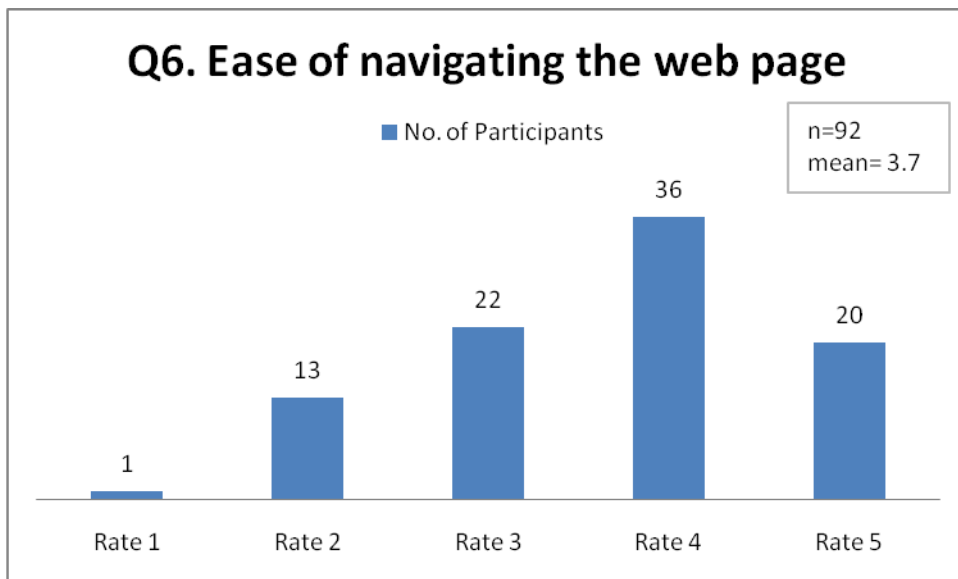
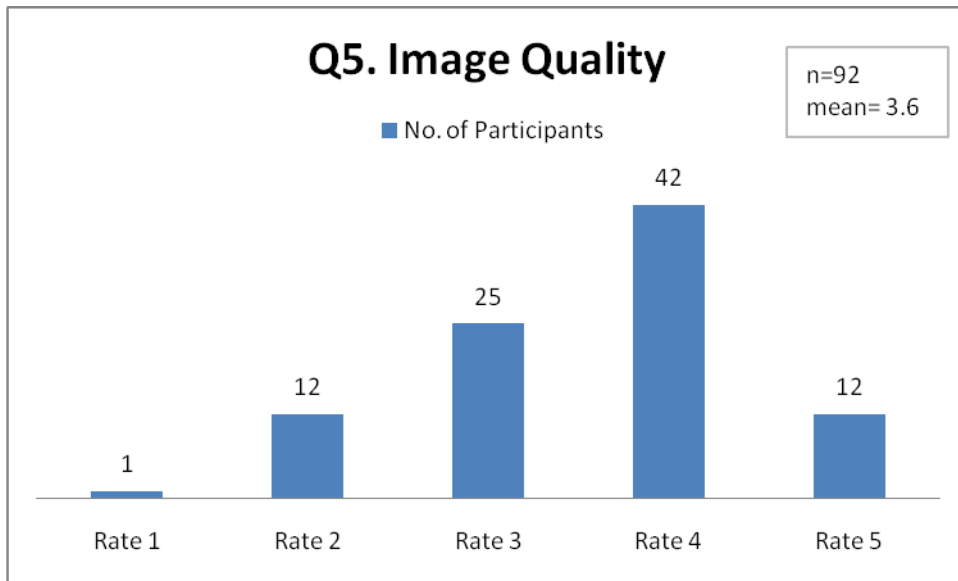
Table 1 and 2 show the geographical distribution of participants who could respond online to virtual microscopy cases

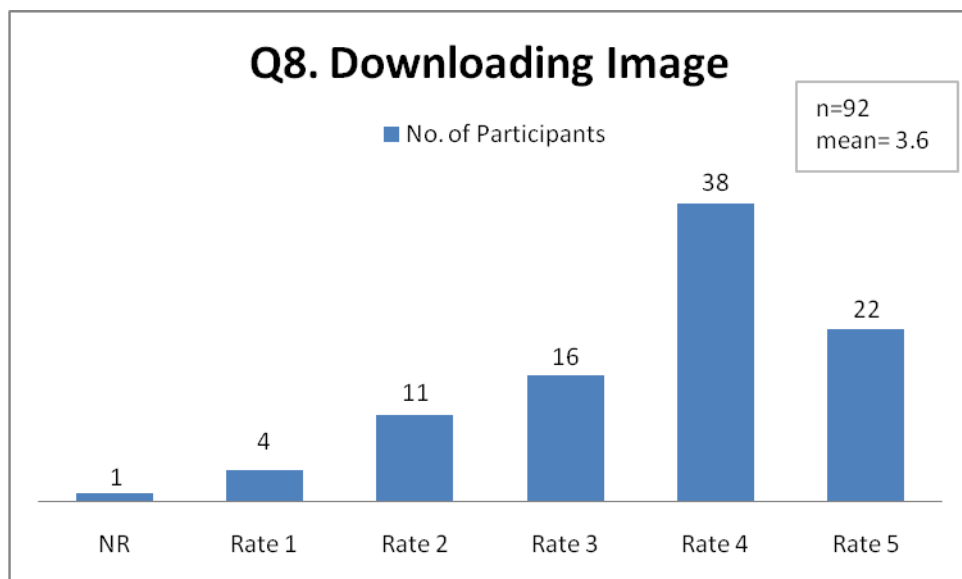
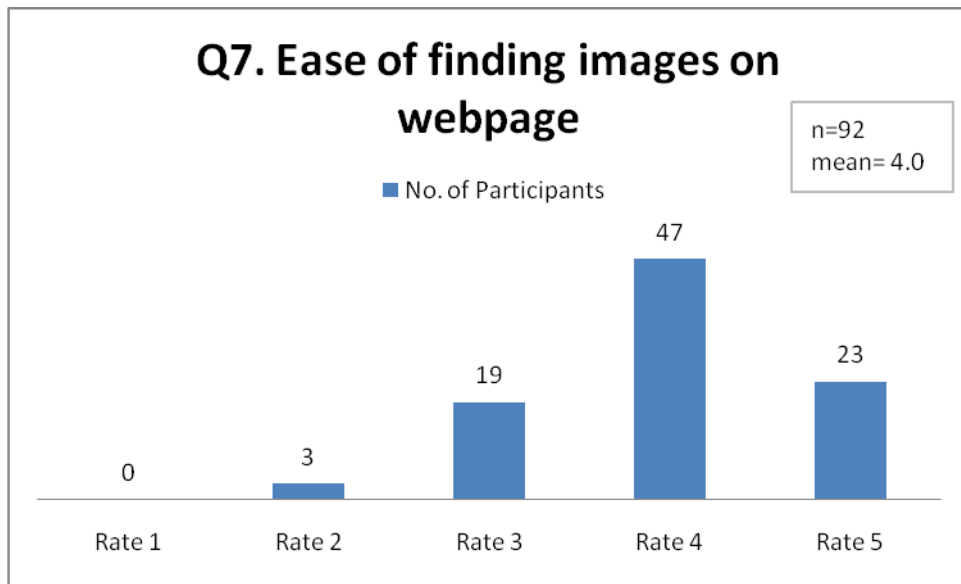
Table 1 : Australian Participants	
Region	Submitted response for the case study
Victoria	25/28 (89%)
South Australia	8/9 (89%)
New South Wales	27/31 (87%)
Western Australia	5/6 (83%)
Queensland	13/17 (76%)
Tasmania	1/3 (33%)

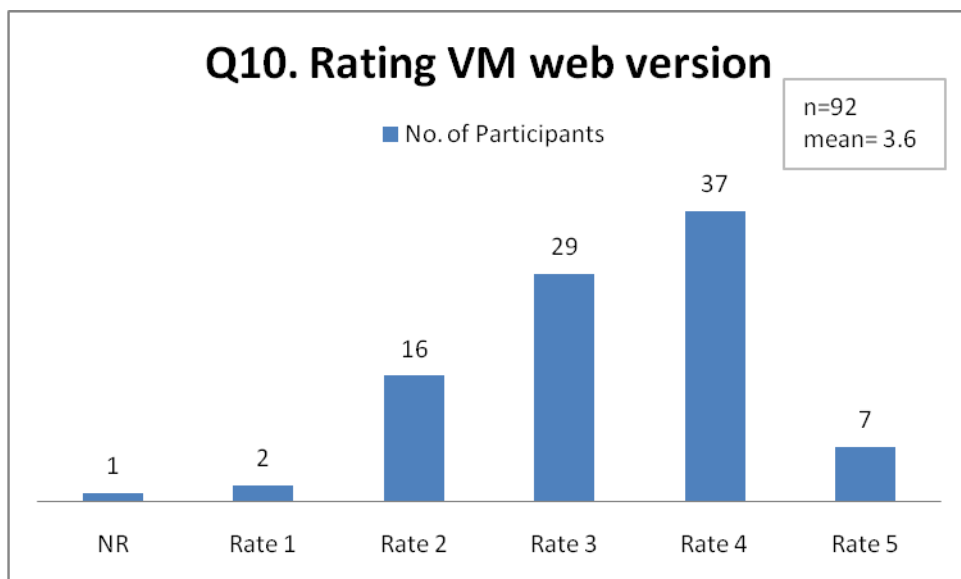
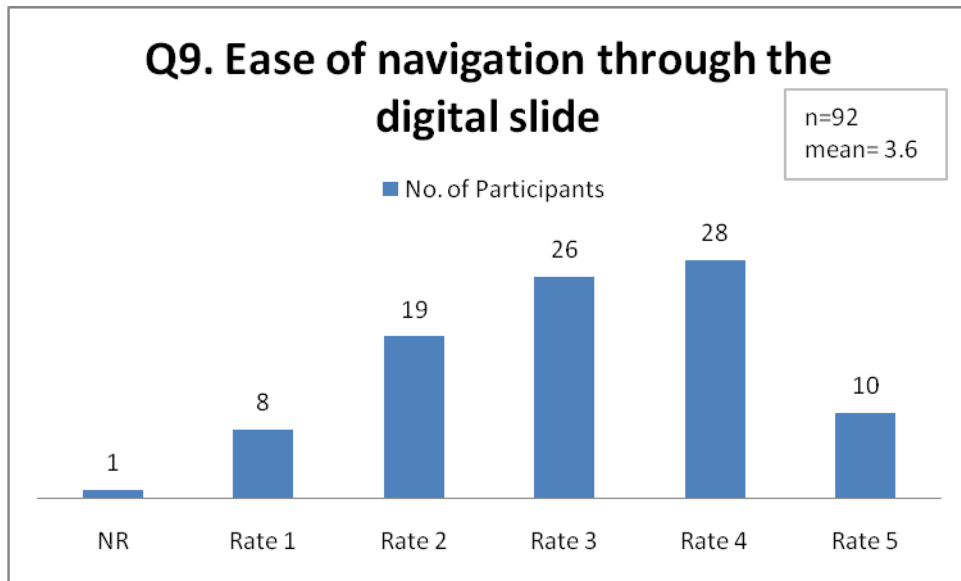
Table 2 : Overseas Participants	
Region	Submitted response for the case study
Hong Kong	2/3 (67%)
Malaysia	1/3 (33%)
New Zealand	7/8 (88%)
Singapore	2/2 (100%)
South Africa	0/1 (0%)
United Kingdom	1/1 (100%)

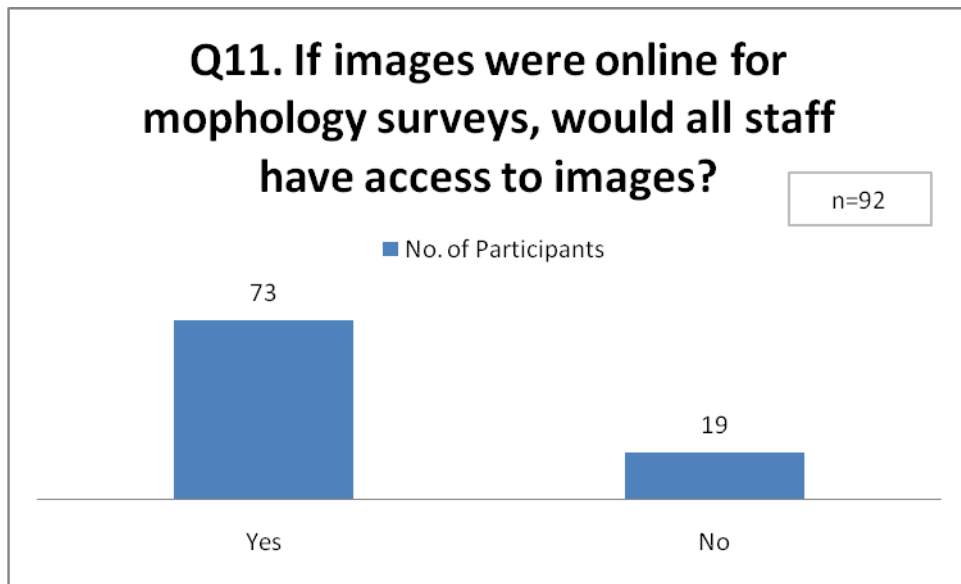


Participants who were able to submit responses for at least one of the case studies were asked to rate the online virtual microscopy system using a worst to best grading (1 = poor, 5 = excellent). Responses are listed below.



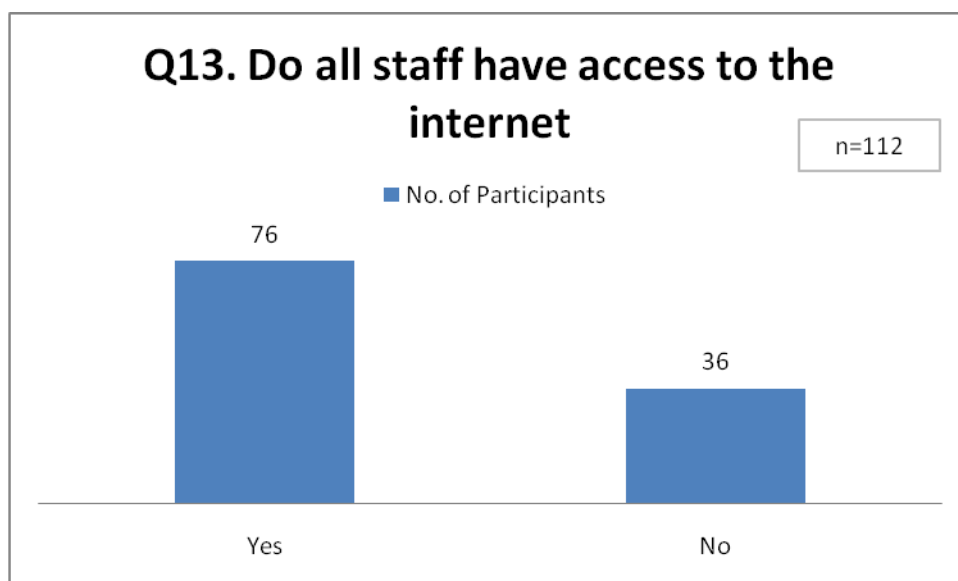
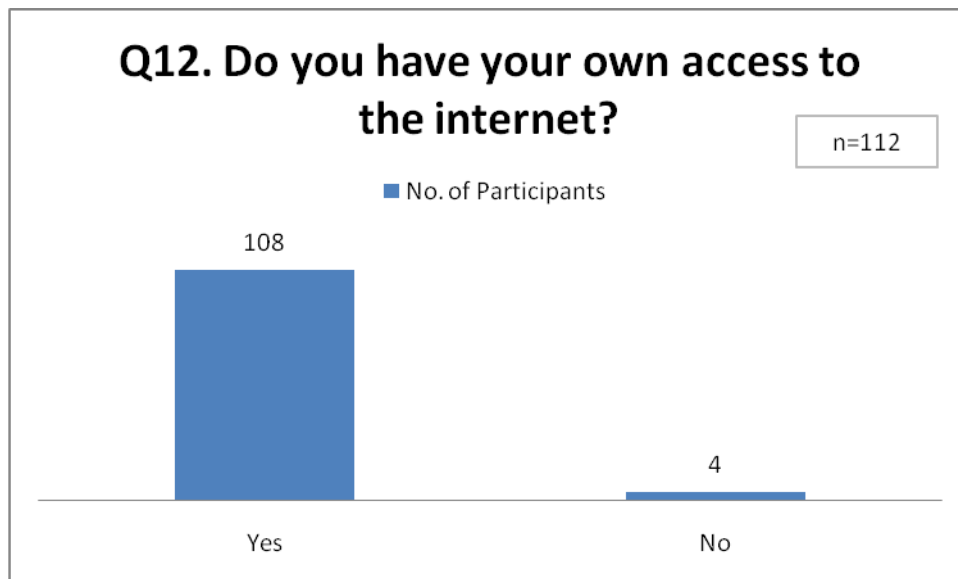






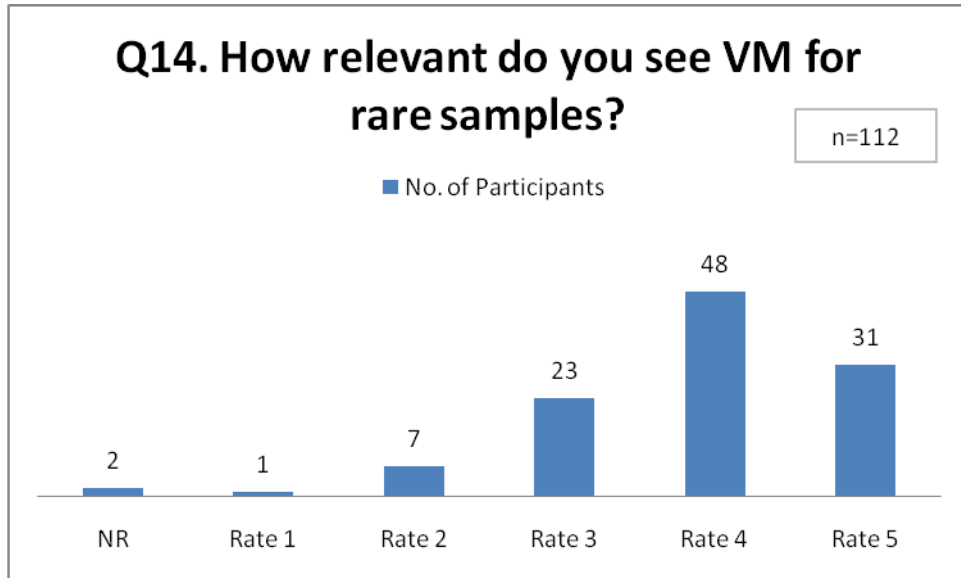


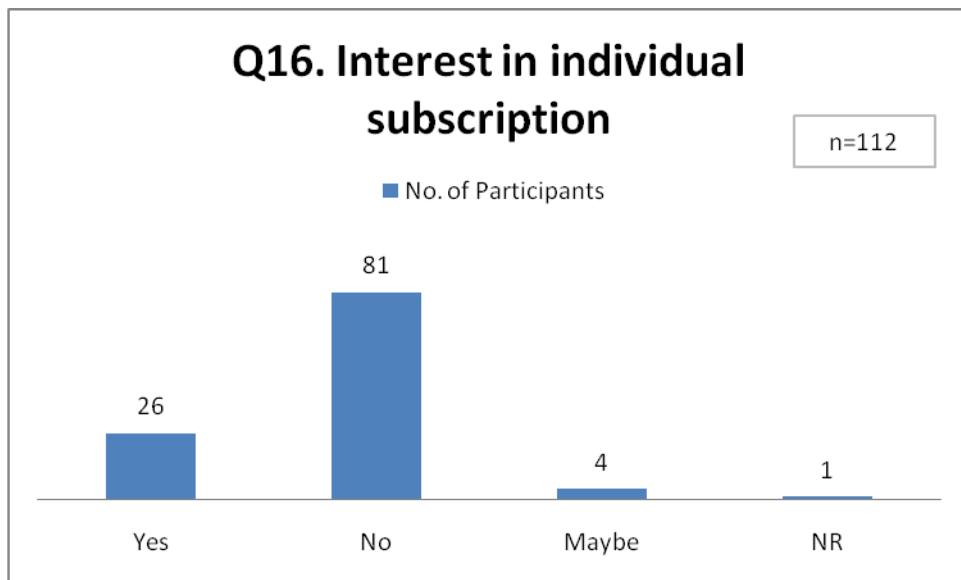
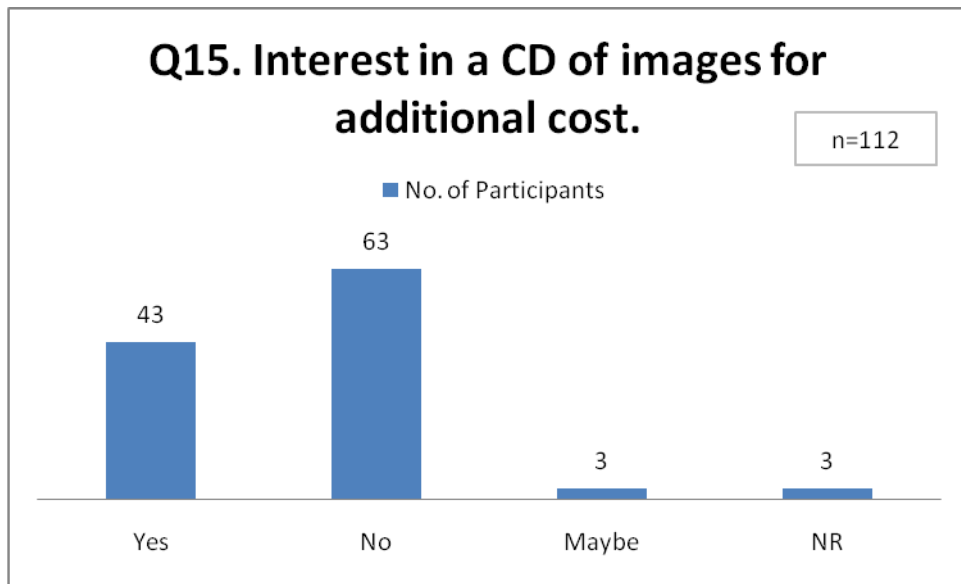
The RCPA Haematology QAP was also interested in the accessibility of the images online by its participants and their staff members. Responses are listed below.





The RCPA Haematology QAP sought the degree of interest in the use of virtual microscopy and participants' opinions on its potential uses. The responses to this section are listed below.







## **DISCUSSION**

### **Part A**

#### **Comparison of online survey results with those of the same glass slides in previous surveys**

The participant diagnoses for the unknown cases were similar to those submitted for a previous glass slide survey in 2 of the 3 online cases (Figures 1 and 2).

On review, the scan area in case 3 was deemed not sufficiently representative of myelofibrosis compared with the glass slide and few participants made this diagnosis online. However the participants were able to successfully view and identify intracellular inclusions, namely Howell Jolly bodies and correctly diagnose the concurrent hyposplenism.

### **Part B**

#### **Overall assessment of online method**

82% of the participants were able to submit responses, 18% were not able to access the images or submit a response because the image download was very slow, presumably related to their internet speed.

Participants were asked to rate the quality of a number of features of the online delivery of digital slides on a scale of 1 to 5. Image quality, ease of navigation through the web page, ease in locating the images, speed of display and ease of navigation through the slide were all rated above average with mean scores ranging from 3.1 – 4.0. The experience of the delivery of the online digital images received a mean score of 3.3 out of 5.

Most participants indicated a reluctance to subscribe to individual VM programs for each of their staff members, due to the costs and/or slow internet connection speed.

## **CONCLUSIONS**

Overall, the results give qualified support for the use of virtual microscope images in future quality assurance surveys particularly for the type of material that cannot be included in surveys at all at present. It is essential that the scanned area is sufficiently representative of the whole glass slide.

We hoped to take the technology to its full potential, which is to utilise the internet for ease of access and efficiency in delivery of digital images. The results of this pilot survey revealed that images delivered online cannot yet completely replace glass slide surveys because of slow internet connection in some laboratories. However there is interest in virtual microscope images for education, for rare cases or for those cases with limited material.