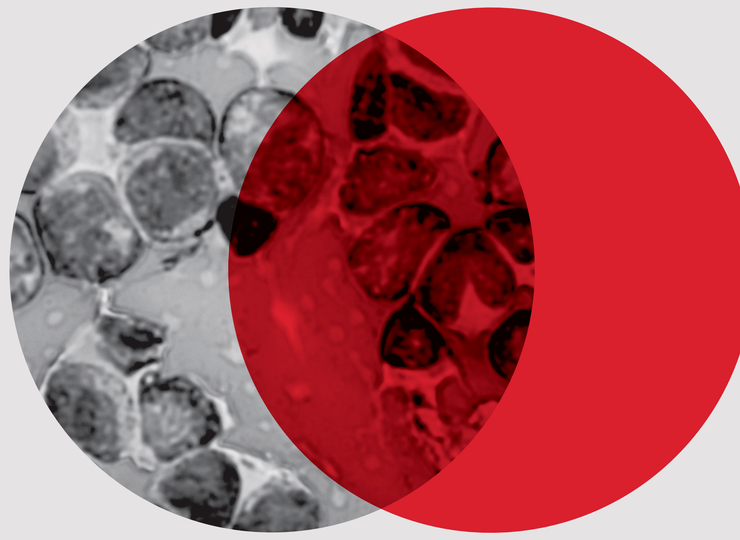
Bone Marrow Morphology Proficiency Testing – A Virtual Experience



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Introduction

The definitive diagnosis of haematological malignancies requires the examination of bone marrow aspirate / trephine biopsies. In the past, RCPAQAP were unable to provide an External Quality Assurance (EQA) program for bone marrow (BM) examination due to the difficulties in obtaining sufficient amounts of samples for conventional glass slide distribution.

Virtual images of blood and bone marrow have been in use for education, quality assurance and proficiency testing[1]. In this regard, a study was undertaken in 2015 to ascertain the suitability of virtual microscopy (VM) as a means to deliver an EQA program. Following the success of this trial, the RCPAQAP Haematology introduced an EQA program for BM Morphology in 2016.

An expert committee of haematologists evaluates donated case studies to ascertain suitability for survey material. Selected case studies are allocated a survey ID.

The BM Program is run twice a year with a single case study per run. Each case study comprises digital images of peripheral blood (PB), bone marrow aspirate (BMA), bone marrow trephine (BMT), iron stain, and a special stain on either the BMA or BMT if needed. In addition to the digital images, brief clinical details and limited full blood count results are provided.

Participants are asked to perform a differential count on the BMA, report on the morphological findings of the PB, BMA/BMT and provide the most likely diagnosis based on the information supplied. The assessment on the diagnosis is based on a predefined scoring system.
All results are displayed graphically, and a commentary on performance as well as educational content are provided on the report.

Methods

The results submitted by enrolled laboratories for 8 case studies from 2016 to 2019 were reviewed and compared to the correct responses (as determined by the expert committee). The growth in enrolments was also used as an indicator of the acceptance of a virtual image EQA. An example of one of the case studies is presented in more detail to demonstrate the images supplied.

Results

For the period from 2016 to 2019, the case studies included granuloma, megaloblastic anaemia, metastatic carcinoma, acute erythroid leukaemia, acute myelomonocytic leukaemia and essential thrombocythemia.

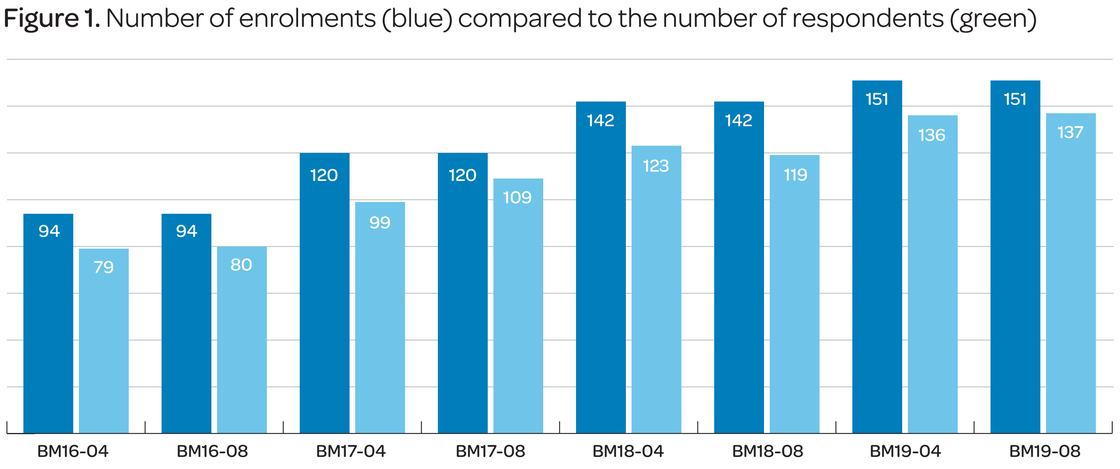
There was good overall performance (Table 1) with 7 of the 8 surveys achieving >75% correct responses. As expected, the complex cases (e.g. acute erythroid leukaemia) scored lower (62%) compared to the more easily identifiable conditions.

Figure 1 shows a steady increase in enrolments over the review period. The participation rate ranged from 85% to 90% since the survey was introduced in 2016. We have not ascertained why a minority of participants have enrolled but not submitted results, but they still receive a comprehensive report which can be used for educational purposes.

Table 1. Acceptable diagnoses for case studies supplied for the Bone Marrow Morphology program from 2016 to 2019

Survey	Diagnostic Interpretation	% Correct Response
BM16-04	Bone Marrow Granuloma-cause not specified	78
BM16-08	Megaloblastic Anaemia	79
BM17-04	Metastatic Carcinoma	96
BM17-08	Acute Erythroid Leukaemia	62
BM18-04	Acute Monoblastic and Monocytic Leukaemia	89
BM18-08	Essential Thrombocythemia	91
BM19-04	Plasma Cell Myeloma	99
BM19-08	Pure Red Cell Aplasia	89

Figure 1. Number of enrolments (blue) compared to the number of respondents (green)



BM17-08 Acute Erythroid Leukaemia – a complex case

- The overall features of this case were of a myeloid neoplasm with erythroid proliferation as well as dysplasia[2] (Figures 2–4).
- The most prominent morphological abnormalities clearly occurred in the erythroid cell line, so Acute Erythroid Leukaemia was considered the only correct response[2].
- The resulting morphological features attracted a wide range of differential diagnoses, decreasing the number of responses received for the target diagnosis to 62%.

Figures 2 to 4. Digital Images of case study BM17-08 Acute Erythroid Leukaemia.

Figures 2a and 2b: Peripheral blood showing red cell changes and dysplastic features most prevalent in the erythroid cell line.

Figure 3: Bone marrow aspirate showing the predominant population of erythroid precursors and demonstrating dyserythropoietic features such as N/C asynchrony, multinucleation and karyorrhexis.

Figure 4: Trephine showing marked hypercellularity with virtually no preservation of fat spaces. The marrow architecture is effaced by an infiltration of immature cells as well as mature and maturing erythroid precursors. Myelopoiesis was markedly hypocellular, and a few megakaryocytes, including normal and atypical/dysplastic forms, were seen.

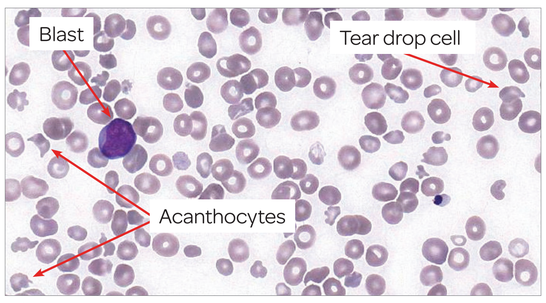


Figure 2a

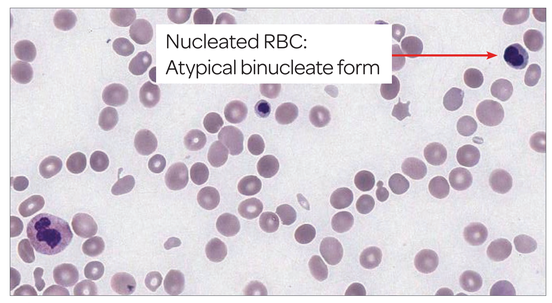


Figure 2b

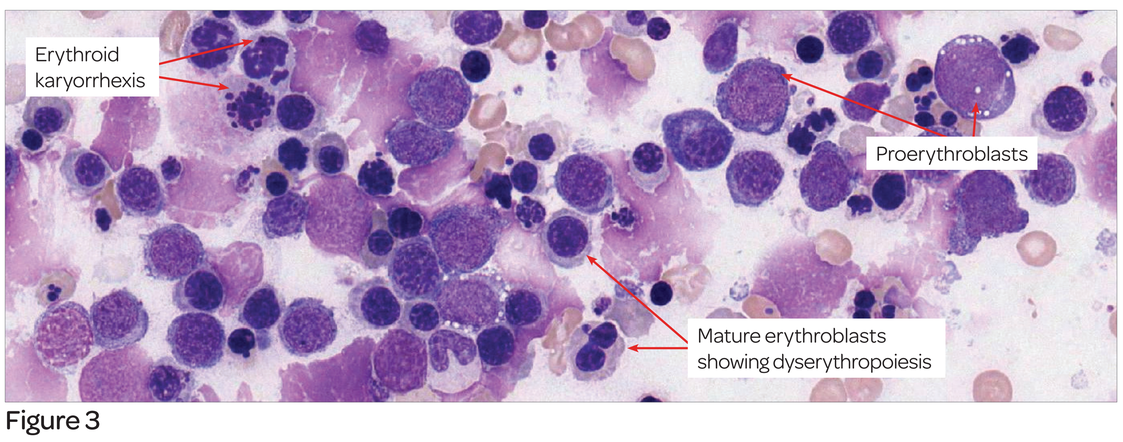


Figure 3

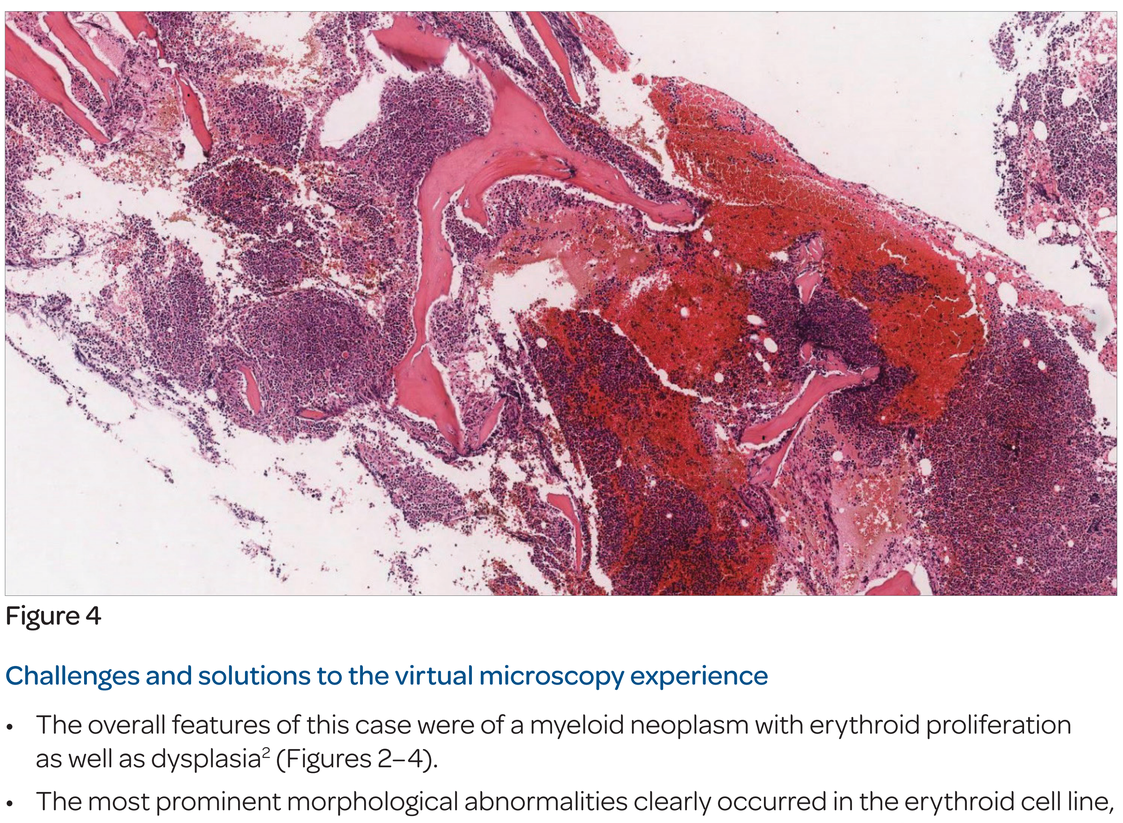


Figure 4

Challenges and solutions to the virtual microscopy experience

- The overall features of this case were of a myeloid neoplasm with erythroid proliferation as well as dysplasia[2] (Figures 2–4).
- The most prominent morphological abnormalities clearly occurred in the erythroid cell line, so Acute Erythroid Leukaemia was considered the only correct response[2].

Conclusion

- The number of enrolments for this program continued to increase, which paralleled improvements made to the program and acceptance of the virtual image technology.
- The high percentage of acceptable responses for most surveys is evidence of the suitability of virtual microscopy for an EQA Program in bone marrow morphology.

References
1. Digital Morphology in Haematology: An Update, Szu-Hee Lee, Pathology, 2018, 50 (S1).
2. WHO Classification of Tumours of Haemopoietic and Lymphoid Tissues, Revised 4th edition, edited by Steven H. Swerdlow et al, 2016, WHO Press.