Evaluation of full blood count stability in rural Scotland

Caitlin Davis, *Blood Science Laboratory, Lorn and Islands Hospital, Oban. UK*

Supervisor: Dr Eirini Meimaridou, *School of Human Sciences, London Metropolitan University.*

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Introduction

Full blood count testing is the backbone of the haematology laboratory, with results used to indicate additional reflex testing, and highlighting a variety of disorders (including iron deficiency). Delayed processing of samples in rural areas can lead to sample degradation, false elevation of MCV and generation of analyser "flags" which require manual blood film review [1]. In rural Scotland, samples are transported under non controlled temperature conditions which can affect the number and morphology of white and red blood cells and therefore impact on the interpretation of the blood test results and disease diagnosis [2]. Therefore, it is important to establish a reliable way of interpreting delayed blood samples that are safe and consistent to release to GPs, thereby reducing the need to re-bleed patients unnecessarily, and reduce the cost of repeating the blood testing.

Aims

To investigate how temperature variations over time affect full blood count parameters and develop approaches that can be implemented to improve quality of results given.

Methodology

Forty-two whole blood samples were processed using the Unicel DxH 800 full blood count analyser (Beckman-Coulter, California). Samples were anonymised then separated into three aliquots each of which was stored at different temperatures (2-6°C, 18-25°C, 35-37°C). Aliquots were retested at 24h, 48h, 72h, and 96h using the manual sample mode on the DxH 800. Statistical analysis was performed using IBM SPSS Statistics (version 29) (IBM, US).

Results/Discussion

This study highlighted significant changes in full blood count parameters from as little as 24h ($p<.001$). Degradation of samples is clearly shown by the white cell differentials produced by the analyser (Figure 1) with distinct groupings of cells becoming less defined over time for all temperatures.

Results/Discussion (cont.)

As the analyser struggles to differentiate between cell types there is a significant increase in the number of flags seen compared with time=0 ($p<.001$). This is significant to this laboratory as presence of analyser flags is a criterion for blood film referral, so comparing the analyser flags seen to the date of sample collection may reduce the number of blood films requiring review by laboratory staff.

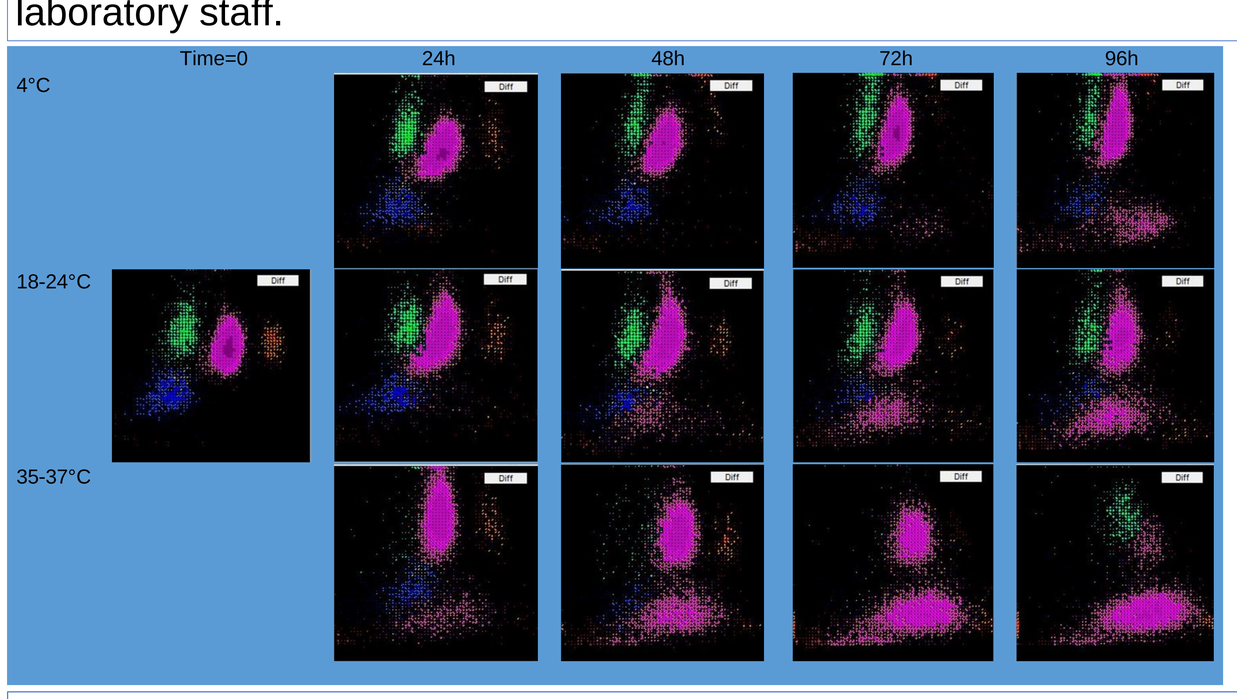

Figure 1: Image of white cell differentials. Colours are used to show distinct cell groups; neutrophils (pink), monocytes (green), lymphocytes (blue), basophils (white), eosinophils (orange). Cells located outside of these defined groups will cause analyser "flags"

There was a significant reduction in the platelet count when samples were stored at 2-6°C compared with those stored at 18-25°C ($p=.012$) over time. This suggests that if processing is to be delayed and TTP/HUS is suspected, samples should be stored at room temperature. Statistical analysis revealed a large significant difference in MCV given between time points, and different temperatures ($p<.001$) (Figure 2).

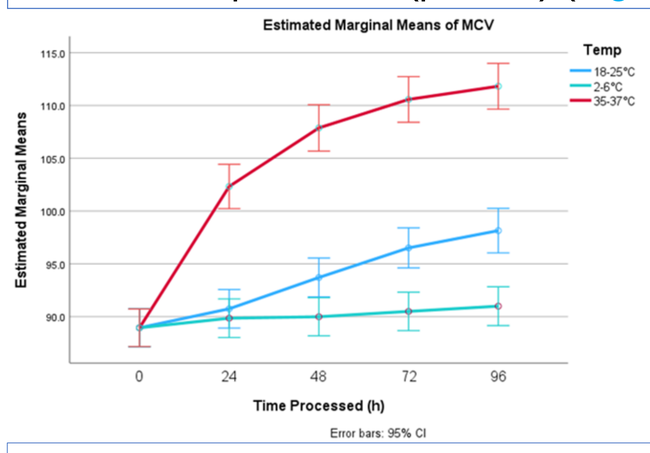

Figure 2: Graph of the estimated MCV over time and at different temperatures. The graph shows a significant effect on MCV in samples stored at 35-37°C, compared with results from time=0 at all time points ($p<.001$), storage at 18-25°C ($<.001$) and storage at 2-6°C ($p<.001$).

Results were also used to develop a predictive model (Tables 1 and 2) which could be used to interpret the MCV results for samples delayed in transit and avoid overlooking potential iron deficiency patients (BSH guidelines for laboratory diagnosis of Iron deficiency [3] recommend requesting iron studies when MCV <76fL is initially identified in a patient).

Sample age on analysis	Predictive MCV at time=0
24h	MCV_{24} - 5.364 (± .570)
48h	MCV_{48} - 8.247 (± .692)
72h	MCV_{72} - 10.249 (± .774)
96h	MCV_{96} - 11.376 (± .848)

Table 1*: Predicted initial MCV after storage at 2-6°C*

Sample age on analysis	Predictive MCV at time=0
24h	MCV_{24} – 0.9024 (± .507)
48h	MCV_{48} – 1.0452 (± .215)
72h	MCV_{72} – 1.5690 (± .257)
96h	MCV_{96} – 9.0829 (± .334)

Table 2*: Predicted initial MCV after uncontrolled/unknown storage*

Conclusion

Isolated communities face significant challenges accessing medical care, and sample stability may be impacted by factors out with NHS control (e.g. weather and mechanical disruption to sailing times). There is increasing pressure on laboratories to process delayed samples, whilst still providing meaningful results to clinicians. This study shows that with controlled storage of samples (at 2-6°C), most haematology parameters can be considered stabile for longer when compared to uncontrolled storage. We have highlighted recommend adjustments for the MCV which can be used to interpret the MCV results for samples delayed in transit and avoid overlooking iron deficiency, as well as identifying several analyser flags which were present solely due to sample degradation, reducing unnecessary blood film referral. Implementation of temperature-monitored rural transport boxes, or use of sample drones to cut transport times may be possible solutions for these remote island communities, allowing improved sample quality, reliable interpretation of results, and reduction in repeat testing for patients.

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References

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