Factors Leading to White Blood Cell Misidentification

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PURPOSE

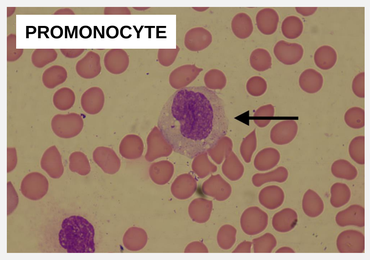
Manual white blood cell (WBC) differentials performed in clinical laboratories contribute important diagnostic information for the care of patients. In order to improve the accuracy of those who perform this procedure, potential sources of WBC misidentification must be investigated. The purpose of this study is to elucidate factors that lead to WBC misidentification in clinical laboratories.

METHODS

Through an online survey, participants were shown images of 19 WBCs, one at a time, asked to identify each cell, and provide reasoning. Two images were identical, only rotated, allowing for observation of consistency of identification. Information regarding participants' level of education and years of experience were collected. The reasoning for each WBC identification was evaluated for factors leading to correct and incorrect WBC identifications. 26 of the 46 participants provided identification for at least 14 of the 19 cells, their responses were scored quantitatively.

RESULTS

Significant results to note: Cells with high accuracy (above 90%) correct included monocytes, a lymphocyte, segmented neutrophil, and eosinophil. Two cells, a reactive lymphocyte and promonocyte, were identified with low accuracy (11% and 8% respectively).

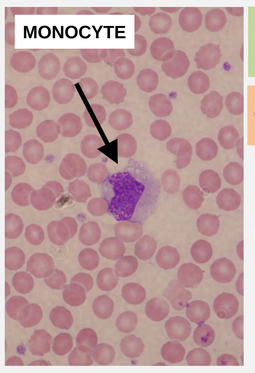


Assistive factors
Nucleus shape (kidney bean)
Chromatin (lacey)

No obvious misleading factors

8% correct

Most commonly misidentified as: **monocyte**

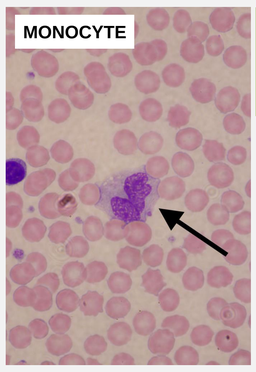


Assistive factors
Vacuoles
Chromatin (lacey)

Misleading factors
Cytoplasm (grainy)

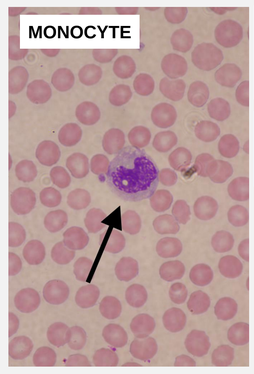
93% correct

Most commonly misidentified as: **neutrophil**



Assistive factors
Cytoplasm color (purple)
Nucleus shape (irregular)
Vacuoles
Chromatin (lacey)

100% correct

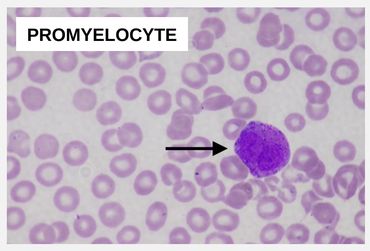


Assistive factors
Vacuoles
Cytoplasm color (purple)
Chromatin (lacey)

Misleading factors
Nucleus shape (indented)
Cytoplasm (pink)

93% correct

Most commonly misidentified as: **metamyelocyte** or **neutrophil**

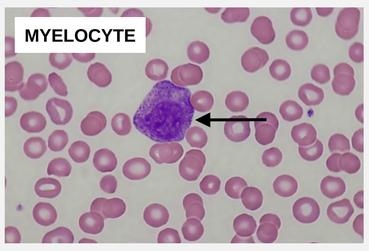


Assistive factors
Granules (primary, azurophilic)
Cell size (large)

Misleading factors
Granules (dark, many)
Nucleus shape (two lobes)

52% correct

Most commonly misidentified as: **basophil**

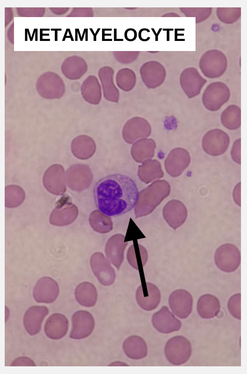


Assistive factors
Granules (primary and secondary)
Nucleus shape (round)

Misleading factors
Granules (dark)

54% correct

Most commonly misidentified as: **promyelocyte**



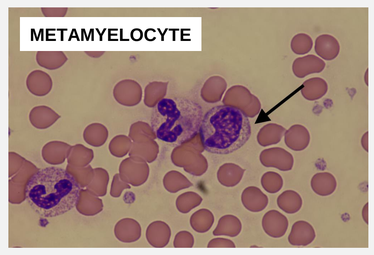
Assistive factors
Nucleus shape (kidney bean)
Granules (secondary observed)

Misleading factors
Vacuoles
Nucleus shape (irregular)

54% correct

Most commonly misidentified as: **monocyte**

*Significant number of responses identified as lymphocyte or neutrophil



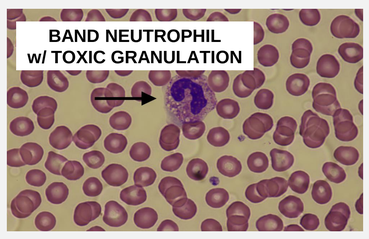
Assistive factors
Nucleus shape (kidney bean)
Granules (pink)
Cytoplasm color (pink)

*The presence of other myeloid cells in view was significant

Misleading factors
Chromatin (lacey)

88% correct

Most commonly misidentified as: **monocyte** or **segmented/band neutrophil**

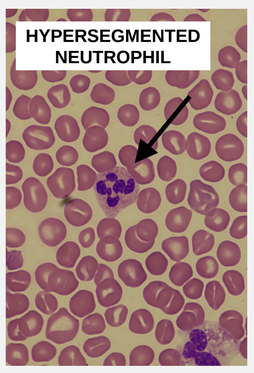


Assistive factors
Vacuoles
Nucleus shape (horseshoe)
Granules (pink, toxic)

Misleading factors
Nucleus shape (pinching)

14% identified as band w/ vacuolization or toxic granulation
Additional 65% identified as band

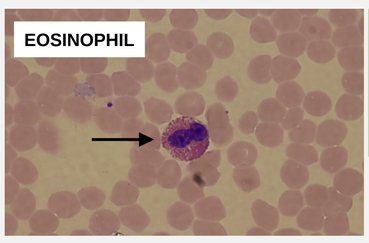
Most commonly misidentified as: **segmented neutrophil**



Assistive factors
Nucleus shape (6 segments)
Granules (pink)

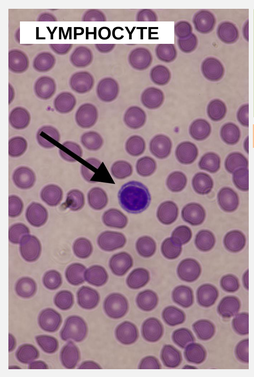
Misleading factors
Disregarded counting segments

33% identified as hypersegmented
Additional 67% identified as segmented neutrophil



Assistive factors
Nucleus shape (segmented)
Granules (red)

100% correct

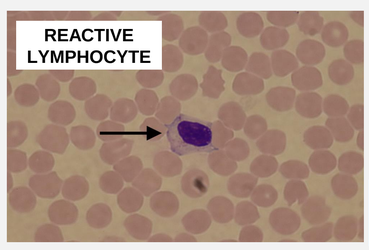


Assistive factors
Size (small)
N:C ratio (high)
Chromatin (condensed)
Cell shape (round)

No obvious misleading factors

97% correct

Most commonly misidentified as: **nucleated red blood cell**

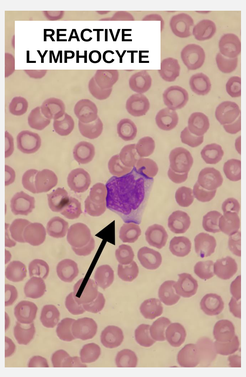


Assistive factors
Cytoplasm edge (dark, skirting)
Chromatin pattern (condensed)

No obvious misleading factors

53% correct

Most commonly misidentified as: **lymphocyte**

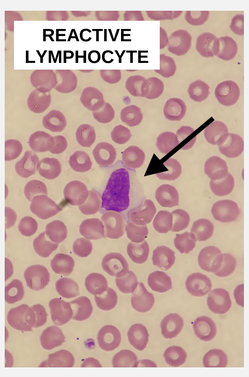


Assistive factors
Cytoplasm edge (dark, skirting)

Misleading factors
Nucleus shape (irregular)

50% correct

Most commonly misidentified as: **lymphocyte** or **monocyte**

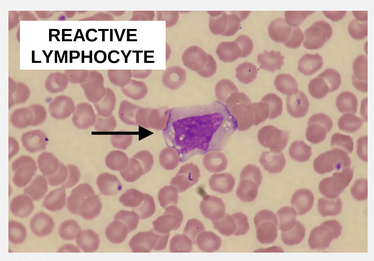


Assistive factors
Cytoplasm edge (skirting)
Cytoplasm color (light blue)
Chromatin (smooth)

No obvious misleading factors

68% correct

Most commonly misidentified as: **lymphocyte**

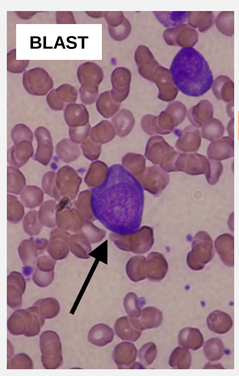


Assistive factors
Cytoplasm edge (dark, skirting)

Misleading factors
Vacuoles
Cell size (large)
Chromatin (lacey)
Color (purple)
Nucleus shape (irregular)

11% correct

Most commonly misidentified as: **monocyte**

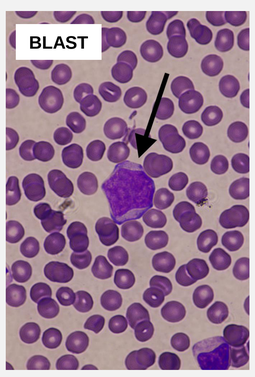


Assistive factors
Nucleoli
Cell size (large)
Cytoplasm color (dark purple)

No obvious misleading factors

85% correct

Most commonly misidentified as: **promyelocyte**



Assistive factors
Nucleoli
N:C ratio (high)
Cell size (large)

Misleading factors
Cytoplasm edge (dark, skirting)

Most commonly misidentified as: **reactive lymphocyte**

**See Repeat cell

**Repeat cell
This image appeared two times in the survey. First, in the orientation shown, second, rotated 90 degrees counterclockwise. The accuracy of responses was **78%** the first time and **76%** the second. 23 participants provided identification for the cell both times. Of the 23, 5 participants' identification differed.

3 Blast → reactive lymphocyte
1 Blast → prolymphocyte
1 Reactive lymphocyte → blast

Those holding a bachelor's degree represented the majority of respondents. Experience varied between 20 years and <1 year. The data showed a slight inverse correlation between score and experience, and no correlation between score and education level. *(See Figure 1 for data)*

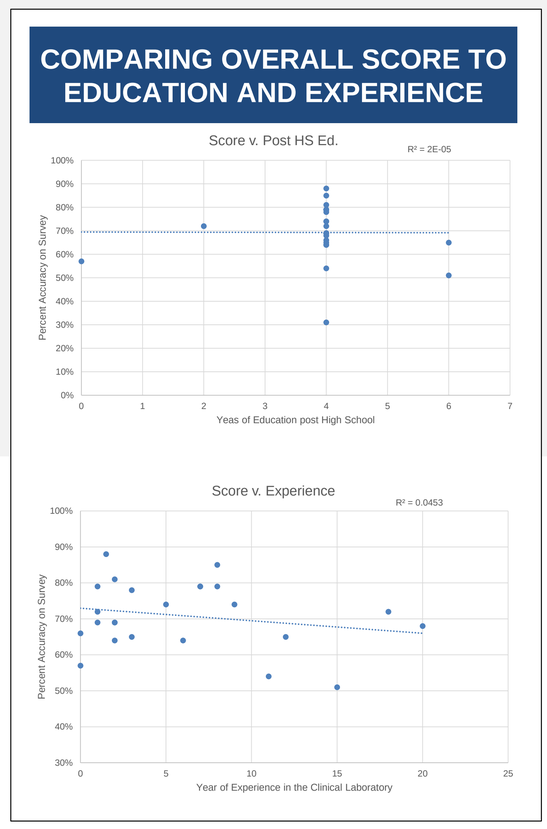


Figure 1

CONCLUSION

Overall accuracy of survey respondents in identifying WBCs was 69%. Reactive lymphocytes and immature cells were the most difficult cells to identify. Mature cells that are frequently encountered by medical laboratory scientists were identified with high levels of accuracy. Overemphasis of minor morphological features at the expense of more significant features was the predominant cause of WBC misidentification. There was no correlation between education or years of experience in the clinical laboratory and accuracy in cell identification. One cell image was repeated to evaluate the consistency of cell identification in the survey respondents. 22% of respondents (5 of 23) gave different responses after seeing the cell image for the second time. Further research will need to be done to determine ways to improve consistency and accuracy in identifying immature cells and reactive lymphocytes.