Introduction

Myeloperoxidase (MPO) is a heme enzyme present in abundant quantity in neutrophils and expressed specifically in cells committed to granulocytic differentiation including the CD34-positive myeloid progenitors in normal marrow (1, 2). MPO protein expression is considered myeloid lineage-specific by the recent WHO classification of myeloid neoplasms and acute leukemia and more precisely the only single marker listed as a myeloid lineage determinant when assessing acute leukemia of ambiguous lineage/ mixed-phenotype acute leukemia (3). MPO expression can be assessed by cytochemical functional staining of cytologic smears (e.g. blood or bone marrow smears) that detects the enzymatic activity of MPO or by immunological staining that detects the presence of the MPO protein regardless of the enzymatic activity (4). The latter is typically performed by utilizing intracellular flow cytometry immunophenotyping or tissue-based immunohistochemical staining. There is currently no preferable method of detection denoted in the recent WHO classification (3). Therefore, any or a combination of the aforementioned methods can be performed to assess the expression of MPO by the neoplastic blasts when working up the diagnosis of acute leukemia. However, multi-parameter flow cytometry immunophenotyping is the method of choice when assessing mixed-phenotype acute leukemia (MPAL) due to the obvious advantages of high-throughput and ability of simultaneously assessing of multiple antigens on the population(s) of interest (e.g. CD34-positive or CD19-positive blasts). In addition, although there is various medical literature in regard to the threshold needed for positive MPO expression by flow cytometry such as about 5% (5), 10% (6), or 28% (7) based on the cited studies, there is no precise recommended threshold of MPO expression specified by the WHO classification.

MPO expression is not required for the diagnosis of acute myeloid leukemia (AML). A diagnosis and lineage assessment of AML can be established without performing MPO if the case has sufficient surface myeloid-associated markers, such as CD13, CD33 and CD117, and lacks expression of B and T-lineage specific markers. The utility of assessing MPO expression is mainly critical when working up neoplasms of ambiguous lineage, such as potential acute undifferentiated leukemia, blastic plasmacytoid dendritic cell neoplasm, and MPAL.
In addition, variable MPO expression may also be seen in B lymphoblastic leukemias (B-ALL) of pediatric and adult patients. In this instance, MPO expression should not necessarily prompt the diagnostic consideration of MPAL if it is the only positive myeloid marker in an otherwise typical B-ALL (8, 9).

Finally, a myriad of factors may affect the technical and interpretational aspects of the assessment of MPO expression by flow cytometry immunophenotyping. These include the challenges of intracellular staining, the use of multiple fluorochrome-conjugated antibodies targeting surface and intracellular antigens, identifying a homogenous neoplastic blast population without the presence of remaining normal population/s, and the inconsistent use, selection or presence of isotype-matched controls, internal negative control (e.g. mature lymphocytes) and internal positive control (e.g. maturing granulocytic cells).

Module objectives

The ICCS Quality and Standards committee initiated this MPO survey to gain a better understanding of the technical and interpretational challenges of flow cytometric testing for MPO expression. The survey was based on 21 questions, which were answered by 34 clinical laboratories in the US, Canada, and Europe. Sixteen of the 34 respondents also provided a ‘typical’ example of their MPO data (plots, gating, statistics, etc.). This module aims to identify potential sources of technical and interpretational pitfalls and provide some suggestions, guidance, and recommendations based on CAP requirements, personal experience of authors and relevant medical literature.

Survey Questions, Results, and Comments

Q1: How many Acute Leukemia panels per year do you perform?

Results and Comments:

44% of the participating laboratories perform acute leukemia panel at least twice a week.
Q2/Q3: When do you set up MPO? If you do NOT perform intracellular staining of MPO, please list reasons.

**Results and Comments:**
Most participating laboratories perform MPO staining during the work-up of every acute leukemia. It appears that some participating laboratories do not utilize MPO by flow cytometry due to technical issues with the stain or the use of alternative assessment methods such as cytochemistry.

Q4: What MPO antibody do you use?

**Results and Comments:**
Approximately half of the laboratories choose either the Beckman Coulter clone CLB-MPO-1 or the BD clone 588 conjugated to PE. A slight majority of the laboratories have their antibody conjugated to a PE fluorochrome and FITC is the second choice. The only other fluorochrome selection reported in the survey is PC5.5 by Beckman Coulter with the CLB-MPO-1 clone. In total the survey showed a total of six different clones used by the laboratories. Of note one small laboratory performing less than 20 cases per year uses both the Beckman Coulter CLB-MPO-1 PE clone as well as their own in-house developed clone as a PE-conjugate.
Q5: Did you have any problems with any particular MPO antibody?

Results and Comments:
The majority of the labs (82%) did not report problems with MPO antibodies. There was no complaint about any particular antibody. The main complaint of the laboratories that reported problems was a dim expression in blasts as compared to neutrophils.

Q6: What products do you use for intracellular staining?

Results and Comments: The most reported product used for intracellular staining was the FIX & PERM® from Life Technologies (now ThermoFisher).
Q7: How do you (usually) process your peripheral blood samples for MPO testing?

Q8: How do you (usually) process your bone marrow samples for MPO testing?

Results and Comments:

For both peripheral blood and bone marrow specimens, there are slightly more labs staining with surface markers first, then proceeding with adding cytoplasmic markers following the intracellular protocol (no extra lyse) method for specimen processing. Whichever method is chosen, it is advisable to follow the recommendations of validation of cell-based fluorescence assays practice guidelines from the ICSH and ICCS (10) and CAP guideline during the assay validation. Instrument setting should be optimized based on different specimen processing methods. It is important that labs optimize and standardize these steps during validation with external controls to make sure that internal negative and positive control cells meet criteria of acceptability for this assay.

Q9: What type of sample do you use for routine external quality control?
Results and Comments:

Most labs are using some form of external control but a significant percentage of laboratories do not use any kind of external control. Although most samples will have the MPO+ granulocytes as internal positive control and the MPO-negative lymphocytes as internal negative controls, it is recommended to have an external control sample to verify antibody performance and overall assay performance prior to performing the assay on the patient.

CAP checklist item FL.23737* requires that “The performance of reagents and staining procedures are verified by the use of positive controls” at least monthly for leukemia/lymphoma immunophenotyping. Positive controls include two main types of controls, external and internal controls. They both verify the performance of reagents and staining procedures but "control" different aspects of the flow assays:

1. **External controls** are an integral part of every laboratory assay as they "control" the overall assay performance including instrument settings, antibody performance, and specimen preparation, etc. **BEFORE** the patient sample is tested. Beads are typically used to verify instrument performance. Patient cells (bone marrow, peripheral blood or commercial controls) can be used as external controls to verify antibody and/or reagent performance at least monthly. An approximate range of acceptable percentages and median fluorescence intensity can be used to determine if the performance of the antibody meets the acceptability criteria as determined by the laboratory.

2. **Internal controls** serve a slightly different role, as they verify the assay performance **WITHIN** the actual patient sample. **Internal control cells** verify that the correct antibodies were actually added to the patient sample and thus **verify the performance within the patient sample**. Internal controls are represented by the variable number of residual normal cells in the patient's sample and it should be a part of the interpretation of the patient's dot plots. The flow cytometrist will evaluate the "diagnostic dot plots" to identify possible abnormalities within the patient's sample. A targeted design of "control dot plots" for each panel tube will ensure that the correct antibodies or cocktails were added and verify the performance of each antibody.

Below is an example of assay control using a peripheral blood example which was bulk-lysed with ammonium chloride followed by staining and fix/perm procedure (Life technologies). Plot A clearly shows all relevant populations (lymphocytes, monocytes and granulocytes) on scale, verifying appropriate FS/SS settings for cytoplasmic staining. Plot C verifies appropriate staining of bright MPO staining on granulocytes (pink), intermediate staining on monocytes (blue) and negative staining on lymphocytes (red). Plot B allows for visual assessment of the relevant populations based on CD45 vs SS (back-gating).

* FLO.23737 QC - Reagents/Stain Phase II: The performance of reagents and staining procedures are verified by the use of positive controls. **NOTE:** The laboratory must define the number and type of quality control used and the frequency of testing in its quality control procedures. Control testing is not required on days when patient testing is not performed. The source (type) of positive control(s) and their frequency of evaluation will vary by the particular flow cytometric application. The frequency should be at least monthly for leukemia/lymphoma immunophenotyping.
Q10: What criteria did you use to determine your MPO antibody was acceptable for patient use?

**Results and Comments:**

The results of this question are difficult to interpret as people only had the option of selecting one answer although multiple answers would have been possible. Since MPO staining may be affected by multiple factors during specimen processing (antibody performance, specimen lysis and the process of permeabilization and fixation etc.). The 12% of respondents who answered “Other” listed the following acceptability criteria:

- Titration upon receipt of new antibody and yearly thereafter, lot to lot comparison with every new shipment
- Perform QC control every time one is run on patient sample (daily as needed)
- Using as internal controls the positive and negative cells for MPO expression of the sample itself, as well normal peripheral blood staining
- Internal neutrophil staining and against ALOT database in Infinicyt software
- Verify that internal control cells (lymphocytes) are negative for MPO and granulocytes are positive for MPO
It should be noted that CAP requires the performance of new lots/shipments of antibodies and reagents (e.g. lysing agents, permeabilization reagents) being compared with old lots/shipments before or concurrently with being placed into service (FLO.23325).

1. During validation of the MPO assay, titration of the MPO antibody using the same lysis and permeabilization/fixation process as used for the patient should be performed. Most vendors do not provide a recommended amount of antibody, so it is the lab’s responsibility to determine the optimal antibody volume for positive staining on monocytes (+) and granulocytes (++) and verify negative staining on the lymphocytes. Please note that higher antibody volume may increase the staining intensity of the MPO+ cells but also affect the MPO-negative cells (lymphocytes).

2. Once the optimal MPO antibody volume has been determined, a panel using the appropriate and relevant antibodies should be validated and criteria for acceptability should be established.

3. These criteria for acceptability can be used for QC and monitoring the ongoing performance of this panel using an external control specimen (peripheral blood, bone marrow sample or other - see question 9). This is important as it monitors the entire specimen prep process, not only the MPO antibody performance. It is helpful to have a standardized way to determine and interpret MPO expression (negative/dim/positive/brightly positive) based on plot examples or analysis templates.

4. Once this has been met, the patient sample is run and internal control cells should be used to verify assay performance in the patient specimen (lymphocytes and hematogones (if present) should be negative, monocytes moderately positive and mature granulocytes brightly positive.

**Q11: What type of sample do you use for initial validation of the assay?**

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<tr>
<td>Crisp cells</td>
<td>2%</td>
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<td>BD (frozen cells)</td>
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**Results and Comments:**

Most laboratories selected an MPO+ patient for the initial validation of the MPO assay. Respondents who answered “Other”, listed the following types of samples:
• Normal peripheral blood (neutrophils should be MPO++ and lymphocytes should be negative. Normal myeloblasts in bone marrow can be used to verify the dimmer expression of MPO (compared to neutrophils)
• Neutrophils (bright expression) and monocytes (dimmer expression) of peripheral blood sample (normal healthy donor)
• Correlation with reference lab during validation studies
• AML patients correlation with cytogenetics

A validation process needs to include known positive and known negative cell populations to verify the specificity of the antibody. In addition, all steps of the specimen processing should be validated. For instance, stain-lyse-no wash, stain-lyse-wash, lyse-stain-no wash and lyse-stain-no wash often produce very different results.

Q12: Which instrument settings do you adjust when running MPO intracellular tube?

![Bar chart showing instrument settings]

Results and Comments:
Approximately 50% of the participating laboratories adjust their FS/SS settings to allow all populations to be clearly visible and on-scale. Cytoplasmic staining typically requires different settings than surface marker assays (especially FS and SS).

Below is an example explaining the need for adjusting the FS/SS settings in a sample which was processed for cytoplasmic staining (performed on BC Navios).
A. The top row plots show the light-scatter and CD45/SSC characteristics of a sample run with the usual surface marker settings.

B. When the same sample was run following cytoplasmic staining with Fix-&-Perm procedure (bottom left) run with the same “surface” settings, all populations showed markedly decreased FS and certain populations (e.g. small cells like hematogones, CLL cells and degranulated myeloid cells) may be lost as they fall below the discriminator threshold.

C. The bottom right plot shows the data after the instrument settings are adjusted.

A: All populations are clearly visible in this lysed bm sample (lymphocytes in red, monocytes in blue, granulocytes in pink and small hematogones in green)

B - The same bone marrow sample after processing with Fix-&-Perm procedure and run with surface marker settings (No FS/SS adjustment) shows that some populations, especially the small cells such as hematogones as well as monocytes and some granulocytes have fallen below the threshold.

C - The same bone marrow sample was run with optimized FS/SS settings, clearly showing all populations visible including the small hematogones and monocytes.
Q13: What issues or pitfalls have you had with any aspect of MPO testing?

Results and Comments:

There are various issues with the MPO staining reported by the surveyed laboratories. These issues include mainly choosing the suitable antibody, processing of samples, lacking internal control (e.g. sample with dominant acute leukemic population and marked neutropenia), external control, and the observed dim staining of myeloblasts, especially the neoplastic forms.

Q14: Do you use isotype negative controls?

Results and Comments:

A slight majority of laboratories are no longer using isotype controls. However, the use of isotype controls in intracellular flow cytometric assays can be valuable. The plots and histograms below show MPO intracellular assay performed at a clinical lab that uses isotype controls.

The assessment is based on the percentage of the blast population that gains a positive expression with the MPO antibody above the threshold gate (P2) established in a separate aliquot sample that used the isotype control antibody. This can be traditionally reported as percentage.
The use of isotype controls in assessing MPO expression has its advantages and disadvantages as compared to the use of internal controls. Practical guidelines from the ICSH and ICCS suggests that it is generally better to use an internal cell population that lacks the target antigen as a negative control. One approach that has proven useful for phospho-epitope measurements is the use of targeted inhibitors that are specific for inhibition of expression of the target of interest (11).

Q15: What do you use for internal control?

Results and Comments:

Internally present granulocytic cells are suitable internal control for MPO staining QC. Lymphocytes in sample may serve as negative control.
Q16: How do you display your MPO assay?

Results and Comments:
The majority of the labs display their results with dot plots. However, a significant proportion (24% of respondents) are still using histograms.

Q17: What population do you use as ‘negative’ to assess the distribution of your blast population?

Results and Comments:
Less than a third of the labs use an isotype control to assess the distribution of the blast population. This is probably related to the numerous documented problems with the use of isotype controls (12). The use of populations internal in the experiment as negative controls has been found by a consensus of cytometry experts to be the most appropriate method to determine non-specific binding by the specific antibody. These cells are part of the experiment from the beginning and are exposed to all steps of processing and staining, although for intracellular staining, many believe that an isotype control is the
optimal way to assess the distribution of the blast population especially where the blasts are dim positive for MPO. The two respondents (5%) who chose ‘other’ indicated that they used the blast population itself (unstained with MPO as their control – as if running a FMO tube).

If a lab prefers using isotype controls, they need to be aware of the problems associated with their use. Using internal cellular controls is preferred; however, extra care should be taken when there are no/very few internal control cells, and when the auto-fluorescence of the 'blast' population is different to that of the MPO negative internal controls (lymphocytes).

Labs that use internal negative population (lymphocytes) to assess the distribution of the blasts need to be wary of the difference in auto-fluorescence between the lymphocytes and the blasts. For example, in the plots shown below, the dotted line (red arrows) would've been used as the threshold based on the lymphocytes. The data however shows that the lymphocytes and blasts have different fluorescence characteristic when using an isotype control. Therefore, using lymphocytes as the negative control, the blasts would have appeared to be dim positive. In this particular case, it probably would not make any difference since the blasts were strongly positive for MPO.
Q18: What threshold of expression do you use to distinguish that the distribution of MPO is positive?

Results and Comments:

The survey results showed, perhaps expectedly, that surveyed laboratories varied in their cut-off, if any, used to call MPO positive. The typical 3% or 10% cutoff values were used by almost half the labs. Respondents who chose “other” varied in their definition of MPO positivity between “any positivity” to not using any thresholds and allowing the pathologist to make the call at their discretion.

Several series have compared the detection of MPO by cytochemistry and flow cytometry, using different methods to assess positivity in FCM (isotype external control or residual lymphocytes as negative internal control) with cut-offs varying from 3 to 20% in various subtypes of acute myeloid leukemia (4, 13-15). The World Health Organization 2008 Classification (16) considers MPO expression as a myeloid-lineage specific marker but does not indicate a threshold for expression or establish recommendations for interpretation.

Published MPO positivity thresholds are 10% for flow cytometry (FCM) but 3% for cytochemistry (15). A multi-center retrospective trial was initiated to compare primary acute leukemia (AL) with homogenous blast populations defined as MPO-negative or -positive. 13% threshold was found to be relevant using an isotype control as background-reference (sensitivity 95.1%, specificity 91.7%). Residual normal lymphocytes proved to be an advantageous alternative reference, a threshold of 28% yielding improved 97.4% sensitivity and 96.1% specificity (7). Another study reported that 5.4% emerged with best sensitivity and specificity for accurately classifying AL cases into acute lymphoblastic leukemia, AML, and MPAL (5).

Examples of negative, dim positive, and bright positive MPO staining of myeloblasts is shown in the plots below (Lymphocytes in red, monocytes in blue, granulocytes in pink and myeloblasts in green):
The example plots above are interpreted as follows:

A. The left plot shows the lymphocytes clearly negative and the granulocytes as positive. The blasts are predominantly negative for MPO.

B. The middle plot shows the lymphocytes negative for MPO, the granulocytes brightly positive for MPO and the monocytes show intermediate MPO expression. The blast population (approximately 26% of total cells) is interpreted as dim positive since the entire population has shifted across the threshold as set by the lymphocytes (approximately 35-40% of the blasts are beyond the threshold).

C. The right plot shows the same expression of the internal negative control (lymphocytes) and internal positive control (granulocytes) while the blast population clearly is positive for MPO.

The interpreting pathologist needs to correlate the clinical and morphological findings with the immunophenotypic findings and consider the following:

- How well-defined is the blast population? Granulocyte contamination of the 'blast' gate based on SS vs CD45 may lead to higher percentages of MPO positivity. Using another marker for blasts such as CD34 and/or CD117 is recommended to avoid this potential misinterpretation.
- Cytochemistry results if available
- Clinical and morphological data
- Other immunophenotypic features of the blasts
- Experience with MPO patterns in the lab and in-house criteria for negative versus positive MPO expression.

Note: The survey did not include a question about how MPO is reported. It is uncertain how many labs continue to report percentages of expression versus a qualitative assessment distribution of “Negative” or “Positive”. Additional descriptions of “partial”, “dim”, and “bright” expression can be added in positive cases. However, the committee members strongly recommend that the report includes a qualitative assessment of MPO expression as either “Negative” or “Positive”. The 2006 Bethesda International Consensus recommendations on the immunophenotypic analysis of hematolymphoid
neoplasia by flow cytometry (17) recommended descriptions of antibody distribution as “Negative,” “Positive,” or “Partially expressed” and relative to an appropriate negative control population. The recommended descriptions of antibody fluorescence intensity are “Dim,” “Bright,” and “Heterogeneous,” with the intensity relative to the closest normal hematolymphoid population.

Q19: How do you best identify a homogenous blast population?

Results and comments:

Most of the labs use a combination of all three methods to identify blast population. Some labs use FSC/SSC, or the inclusion of other markers (e.g. HLA-DR, CD38, or CD15). CD15 may help to exclude more mature granulocytes that may fall into the blast gate with cytoplasmic staining.

Using multiple markers to identify the blast population makes sense, as this population is not always easily defined in the CD45/SSC plot, although this is typically the ‘first place to look’ for them. Attention is required to exclude debris or ‘unlysed’ RBCs that extend into the “blast gate”. Evaluate the initial phenotype and tailor the panel, e.g. adding CD34 and CD117 to the MPO assay may be helpful as it allows the laboratory to focus on the population of interest. Incorporation of more mature granulocytic markers such as CD15 and CD16 to exclude cells that may contaminate the CD45dim/SSC region, e.g. hypogranular granulocytes, and monocytic marker such as CD14 to exclude monocytes, or unique pattern for hematogones.
Q20: What issues or pitfalls have you had with the interpretation of MPO expression?

Results and comments:

40% of responders reported challenges in interpretation of dim vs non-specific MPO. Other pitfalls included difficulties in the interpretation of bilineal populations (two separate populations with different phenotype), the interpretation of biphenotypic populations (single population with a mixed phenotype), patterns seen in undifferentiated acute leukemia, or a combination of all of the above. Rare pitfalls included cases when the lab was unable to use the lymphocytes as internal negative control cells, or the myeloblasts showing a slight shift in staining without being truly MPO positive. Degranulated neutrophils contaminating the blast gate, and difficulties in the interpretation of low positive percent versus non-specific binding was also mentioned.

These challenges are likely contributed by how to measure and interpret MPO:

- Evaluation of intensity of expression of markers is an important component of analysis. Currently qualitative information is reported in most instances.
- Resolving dimly positive from negative populations is always a challenge. However, there is no consensus on methods that could reliably distinguish low intensity positive from negative distributions. A few points could be considered:
  - A prudent assay validation to ensure optimal instrument setting for the assay methods.
  - In general, lymphocytes are used as an internal negative control. Most of the labs are not running isotype control. Thus be aware of the fact that some blasts have higher auto-fluorescence than the lymphocytes within the same samples.
  - Sometimes the question of dim reactivity can be resolved by using another fluorochrome conjugate. But this may not be practical in clinical testing.
  - Whether low level fluorescence is due to specific antibody binding by attempting to block fluorescence with excess unlabeled antibody.
  - There is no consensus as what % of MPO is considered positive or what level of intensity is considered positive.
Q21: Is your lab correlating the flow the results with MPO aspirate smear cytochemistry?

Results and Comments:
Almost equal percentage of the labs reported that they do or do not correlate with their cytochemical studies, which is most likely due to the availability of the MPO cytochemical study. The presence or absence of cytochemical staining cannot differentiate leukemic blasts from normal myeloid blasts, although in a patient with a newly diagnosed acute myeloid leukemia, the presence of MPO staining in blasts is most likely occurring in leukemic blasts. The survey did not capture the use of immunohistochemistry studies for MPO in the paraffin core biopsy. However, literature reports that comparison studies between flow cytometry and immunohistochemistry show a slightly better sensitivity for the use of immunohistochemistry (18).

Summary
In summary, the results of this survey represent the current state of MPO staining across a number of clinical flow cytometry laboratories. It demonstrates the wide range of practices related to MPO testing by flow cytometry. Similar to what the committee reported in the ICCS Q&S Module 15 (TdT Survey results), the interpretation of the technical data was somewhat challenging due to the inherent variability between laboratories using different instruments, different processing and staining protocols, different types of controls used, as well as the interpretation of the staining results. A myriad of factors may affect the technical and interpretational aspects of the assessment of MPO expression by flow cytometry immunophenotyping. These factors include panel design, selected antibody-fluorochrome combination, instrument optimization, the challenges of intracellular staining including the simultaneous use of multiple surface and intracellular antibodies and cell fixation and permeabilization, measures used to identify the population of interest (blasts), analysis and gating strategy, internal and external controls, and finally interpretation and reporting.

Flow cytometry laboratories should ensure proper antibody panel design and optimal instrument settings especially those unique to intracellular staining and meet defined performance acceptability criteria based on internal and external controls to produce accurate and reproducible results.

As shown based on these survey results, MPO was not universally utilized for all cases of acute leukemia; however, the assessment of MPO expression is critically needed in certain subtypes of acute leukemia (e.g. acute undifferentiated leukemia, and MPAL) or occasionally to confirm the myeloid lineage (e.g. acute myeloid leukemia, not otherwise specified, with minimal differentiation).

It is advisable to utilize additional markers such as CD34 and CD117 in addition to MPO to better identify the neoplastic population of interest (blasts), and better characterize the internal normal negative and positive control populations (e.g. lymphocytes and granulocytes).
When reporting MPO expression, it is recommended to use qualitative designation as being negative or positive and the extent of positive expression as applicable (e.g. partial, dim, bright, etc.) based on the laboratory acceptability criteria. It also helps to incorporate and correlate the flow results with other relevant diagnostic information/ancillary testing results when available.

Overall, an optimal MPO flow assay is the result of combined vigorous technical and interpretational measures. It is advisable for a proper flow cytometry MPO assay to address the following issues:

1. Antibody panel purpose and design.
2. Antibody clones and conjugated fluorochromes.
3. Optimization of instrument settings for combined surface and intracellular staining.
4. Assay performance control to verify antibody performance and specimen preparation (external control) before patient sample is ran and on at least monthly basis for leukemia/lymphoma immunophenotyping.
5. Proper use of internal positive and negative controls within the patient sample.
6. Gating strategy and analysis template design.
7. Interpretation and reporting (e.g. specify examples of negative, dim positive, partial positive or positive results, etc.).

Example panels from authors:

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<td>nu-TdT</td>
<td>cy-MPO</td>
<td>cy-CD3</td>
<td>CD34 or CD117 or CD22</td>
<td>cy-CD79a</td>
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References:


For any questions on this module or any other suggestions, please email info@cytometry.org

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