Educational cost-effective intervention to reduce pathologist's peripheral blood smears reviews with non-contributory findings: an academic institution experience

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ABSTRACT

Peripheral blood smear (PBS) review by a pathologist is a necessary and invaluable diagnostic tool. However, innovative highly sophisticated haematology analysers that flag peripheral blood abnormalities have decreased the need for a PBS review. Ordering practices including PBS reviews lumped as part of an 'order set' or with complete blood count (CBC) constituted most PBS requests at our institution. A retrospective review of all PBS review orders from 1 April 2016 to 31 January 2017 was performed to investigate the ordering practices at our institution. A total of 2864 PBS were ordered during the above study period. In many cases, the PBS report did not add any significant clinical information beyond that acquired by the CBC and differential count. These findings inspired policy changes within our institution for pathologist PBS reviews. Within the electronic order system, all PBS orders for inpatients were linked to a pop-up window with criteria for peripheral smear review and instructions on the approval policy. Outpatient orders required clinicians to request pathology approval. This implementation reduced total number of PBS orders by 42.5% with no adverse effect on patient management. Empowering pathologists and clinicians with guidelines on PBS review orders is a beneficial educational exercise of resource utilisation. Discussion with physicians regarding clinical indications reduces non-contributory PBS reviews, provides guidance to appropriate testing, and aptly allocates pathologist and laboratory staff time and resources.

INTRODUCTION

Clinical laboratory test results play a vital role in 70% of all clinical decisions and are ordered in approximately 30%–40% of all primary care visits.[1] However, laboratory tests are often ordered routinely or lumped in an ordering set without clear rationale.[2] In a retrospective meta-analysis across 108 studies, an average of 30% of all tests were reviewed as unnecessary.[1] These unnecessary tests amount to about 20% of the 5 billion laboratory tests performed annually.[2] Nonetheless, unnecessary laboratory tests have been cited as the biggest contributor to the estimated US$750 billion excess in hospital costs driving the need to improve resource utilisation.[2]

The two most frequently performed haematology tests are the complete blood count (CBC) and white cell differential count due to its ability to give a broad overview of the blood picture and initial diagnostic screen.[2–4] Modern automated haematology analysers generate reliable results with the ability to detect additional parameters in addition to CBC such as white cell differential, abnormal white cells, red blood cell (RBC) morphology and pseudothrombocytopaenia.[5] Peripheral blood smear (PBS) reviews are performed on selected cases to detect clinically significant morphologic abnormalities that are flagged by the analysers and also serves as an additional quality control tool.[3 4] The commission of laboratory accreditation of the College of American Pathologists (CAP) requires that laboratories establish their own list of specific criteria and documentation for PBS review.[3 4 6] The workflow for a peripheral blood CBC and smear review in the haematology lab at our institution are referenced in figure 1. Briefly, blood specimens with abnormal findings are flagged by the automated haematology analyser, XN9000 Sysmex America, Lincolnshire, Illinois, USA. A PBS is generated on these specimens, which are then scanned and images are reviewed on a cell analyser (D160 CellaVision AB, Lund, Sweden) by an experienced clinical laboratory scientist (CLS). Based on our laboratory set protocols for flagged specimens (figure 1), the CLS may then request for a pathologist PBS review for concerning smear findings.

PBS review orders performed by pathologists at our tertiary care institution were increasing at a rate that was disproportionate to their added clinical value, further compounded by the rapid expansion of over 200 outpatient clinics. On review, we found that in most cases, the peripheral smear reviews by pathologists did not provide additional information beyond that generated by the automated analyser. In addition, it became apparent that in most instances, the peripheral smear reviews were part of a predetermined 'order set' and the ordering clinicians were not aware of the already set laboratory protocols for smear review. The aim of this study is to improve utilisation of PBS review by a pathologist and assess the effectiveness of laboratory consultation in haematology. In addition, this study addresses the challenges of navigating different electronic medical records (EMR)/laboratory information systems (LIS) due to factors such as hospital expansion and having different electronic systems for our outpatient and inpatient populations.

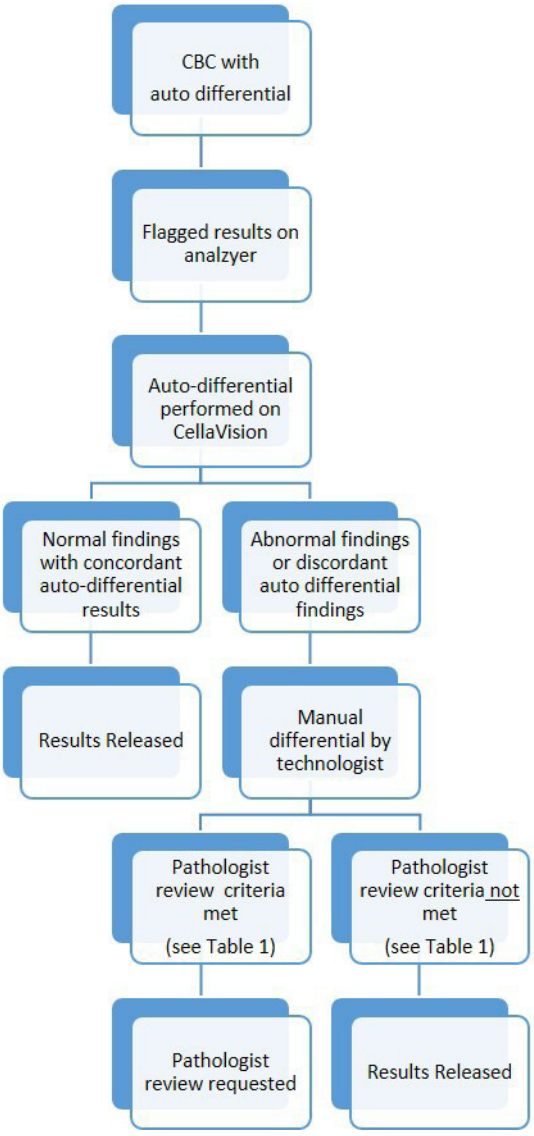

Figure 1 Laboratory protocol for peripheral blood smear review. CBC, complete blood count.

METHOD

Prior to 1 September 2016, all outpatient and inpatient PBS clinical orders by clinicians were automatically reviewed by haematopathologists. Based on review of institutional ordering practices, a new protocol was implemented for inpatient and outpatient satellite facilities to improve resource utilisation. All inpatient orders were linked to a 'comment box' which opens on order entry in CareConnect (Epic LIS) which states laboratory guidelines for pathologist PBS review (box 1). Since our LIS was unable to render the same comment box for outpatient orders, outpatient clinicians were required to obtain haematopathology approval for pathologist PBS orders by providing clinical history and clinical indication. The pathology team in-charge of the PBS approval were educated on the lab approval criteria (box 1) and additional recommendations in lieu of a peripheral smear review (table 1). This new system went into effect 1 September 2016.

We retrospectively reviewed our medical centre's EMR database for all inpatient and outpatient pathologist PBS reviews ordered between 1 April 2016 and 31 January 2017. Data included case number, brief clinical history, ordering clinician, ordering department and finalised report generated from each PBS order. The ordering clinician and department were obtained from requisition forms. No patient identifiers were included. Normal workflow for all CBC with auto differential orders and criteria for pathologist's PBS review at our institution is demonstrated in figure 1.

Box 1 Pathologist peripheral blood smear review criteria

Blasts or atypical mononuclear cells at initial encounter.
Recurrent abnormal/atypical cells see after remission.
*2 week look back.
'Hairy' cells.
'Sezary' cells.
Possible cell transformation.
Greater than 5% plasma cells.
Dysplastic changes (eg, Pelgeroid cells).
Abnormal leucocytes findings.
1. Auer Rods.
2. Alder-Reilly bodies.
3. Chediak-Higashi inclusions.
4. May-Hegglin inclusions.
5. Increased vacuolisation of lymphocytes (eg, lipid storage disease).

Abnormal red blood cells findings
1. Spherocytes (moderate to marked).
2. Acanthocytes (moderate to marked).
3. Shistocytes (moderate to marked).

Megakaryocytic fragments.
Intracellular/extracellular parasites (eg, malaria, spirochetes).

RESULTS

More than 600 000 CBCs with differential counts and 2864 pathologist PBS reviews were reported from 1 April 2016 to 31 January 2017. The samples included both in-patients and satellite outpatient clinics. PBS review based on haematologic cell type and clinical indications are illustrated in figure 2. Assessment of RBC morphology (53%), platelets (24%), leucocytes (22%), and no information (1%) were the most common morphologic cell line requests. Concordantly, clinical indication correlated with the cell line morphology with requests for anaemia (45%), thrombocytopaenia (16%) and leucocytosis (10%). Within the inpatient setting, the majority of PBS orders were requested by medicine wards (51%), intensive care units (ICU; 22%), surgery (8%), paediatrics (8%), haematology (6%), emergency department (ER; 4%) and obstetrics (1%).

Total number of inpatient and outpatient PBS orders from 1 April 2016 to 31 January 2017 are shown in figure 3. The number of peripheral smear requests before and after the implementation of the policy on 1 September are also shown in figure 3. The overall outpatient requests declined by 66% from 150 requests/month to 50 requests/month. Inpatient requests were reduced by 35.56%, decreasing from 225 requests/month to 145 requests/month.

DISCUSSION

Historically, microscopic PBS evaluation has been engrained throughout medical education as a reflexive screening tool to quickly evaluate a wide range of diseases including leukaemias, myeloproliferative disorders, haemolysis, hemoglobinopathy and parasitic infections. The additional benefit of being a rapidly available, easily accessible, and minimally invasive test accounts for why it is one of the most commonly ordered laboratory

Table 1 Common indication and recommendations for peripheral smear review

Clinical indications	PBS review approval	Additional recommendation
Myelodysplastic syndrome	Yes	Recommend molecular studies
Pseudothrombocytopaenia	Yes	Alternatively, resend CBC in citrate
Malaria	Yes	Order thick and thin smears to microbiology lab
Microcytic/normocytic anaemia	Per discussion	Iron studies, reticulocyte count
Leukaemia/lymphoma	Yes	Flow cytometry
Thalassaemia	No	Mentzer index, previous CBC values, HPLC
Haemolysis/RBC membrane disorder	Yes	Order stat red blood cell morphology test

At our institution, PBS review are concurrently performed for all flow cytometry, bone marrow biopsy and HPLC orders.
CBC, complete blood count; HPLC, high performance liquid chromatography; PBS, peripheral blood smear; RBC, red blood cell.

tests. With the introduction of highly sophisticated haematology analysers, the role of a manual PBS review by a pathologist is limited. The current day haematology analysers have improved the ability to detect morphological abnormalities on peripheral smears with great precision and accuracy to the point where manual review provides limited additional information.[7] Correspondingly, a CAP Q-probe study reported that more than one third (35.7%) of participants believed that PBS review did not provide any additional clinical information.[8] However, there are few instances where PBS reviews screened by analysers may miss significant findings that impacts patient care, which necessitate the expertise of a second review by a pathologist. These criteria are highlighted in box 1 and table 1, based on our institution's experience. Reassuringly, abnormal CBC values at our institution are flagged automatically by our analysers, and are manually reviewed by a CLS. This prompts a laboratory requested pathologist PBS review based on the guidelines set by the individual lab (box 1). Furthermore, laboratory requested PBS review flagged by analysers have been shown to have higher sensitivity of detecting novel and clinically relevant information compared with clinician requested pathologist review.[9]

To understand the clinical need for PBS review in our patient population and the impact of our new policy implemented on 1 September 2016, we reviewed the indications for all PBS orders within our inpatient facilities and outpatient clinics. Finalised reports from 1 April 2016 to 31 January 2017 were grouped into diagnostic categories and generally paralleled clinical indication patterns. Clinical indications for RBC, platelet, and white blood cell morphological evaluation were the most common request for PBS review in descending order, with anaemia and thrombocytopaenia listed as the most common indications. In most cases, pathologist PBS review did not provide additional clinical information beyond that inferred by the CBC and differential count parameters. For example, in cases of anaemia, basic red cell indices provided by the CBC such as haemoglobin, mean corpuscular volume and reticulocyte count could easily be used to make a preliminary assessment of the type of anaemia without a PBS review. Similarly, the CBC and differential count parameters could be used in clinical indications of 'cytopaenia' or 'cytosis' without a peripheral smear review. With the understanding of clinical need and limitation of PBS reviews, pathology trainees at our institution were educated on PBS approval criteria in order to instruct clinicians, recommend appropriate ancillary testing and prevent duplicate orders (box 1 and table 1). Our new policy reduced unremarkable PBS reviews by screening for appropriate indications and educating clinicians on best testing practices. We believe that our institutional policy change did not impact patient care adversely, since there were no complaints from clinicians after the policy was implemented. Correspondingly, appropriate ancillary testing was recommended in lieu of cases that

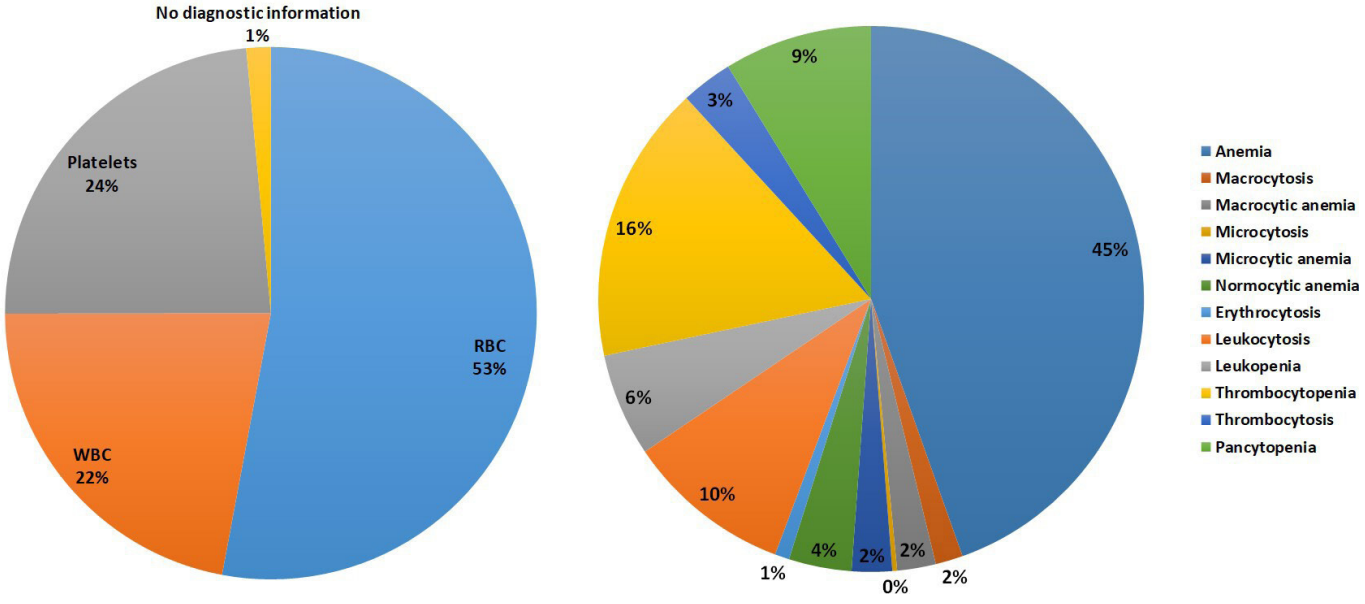

Figure 2 Signed out reports based on the haematological lineages (left) and reports based on diagnosis (right). RBC, red blood cell; WBC, white blood cell.

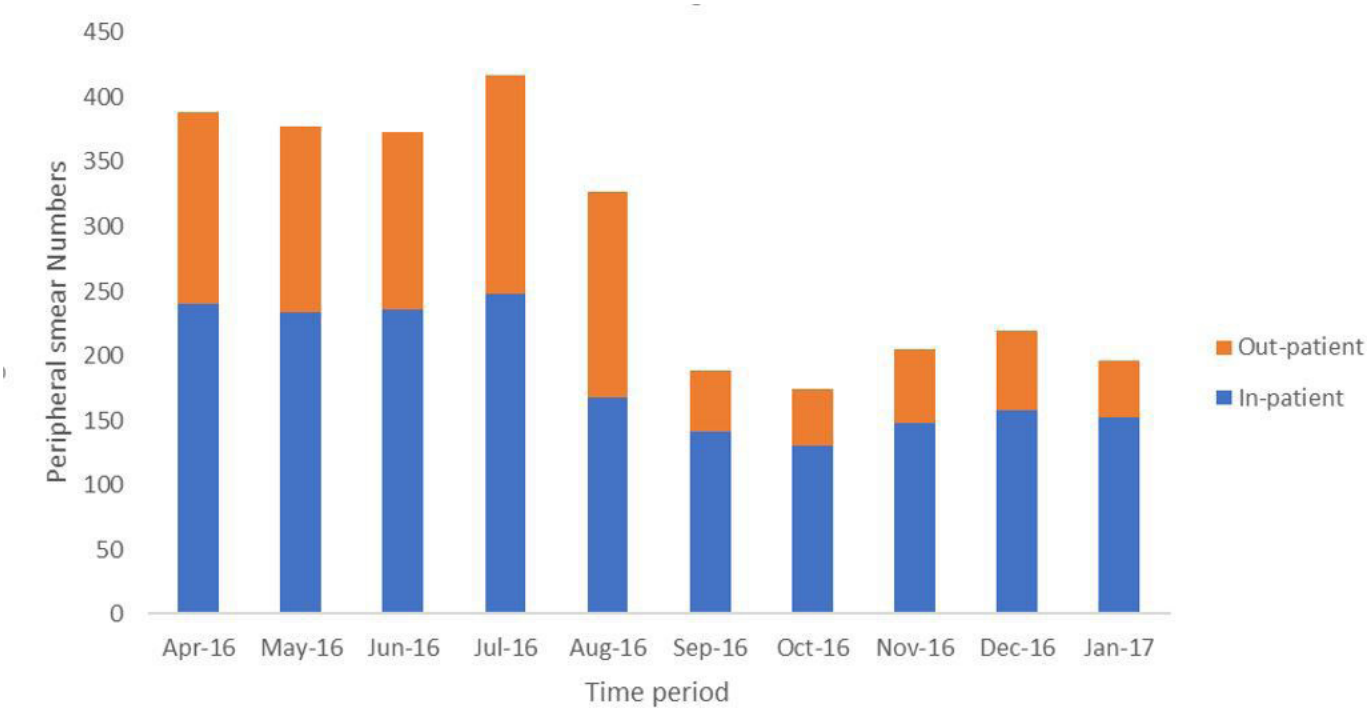

Figure 3 Peripheral smear requests inpatient and outpatient service.

did not meet indication for a pathologist PBS review. Thus, we believe that the recommendations improved resource utilisation without compromising patient care.

Interestingly, Beckman *et al* reported that the added clinical value of PBS review did not align with clinician ordering practices and noted that orders for pathologist review for white blood cell morphology had the most added clinical value, yet assessment for RBC morphology was the most commonly requested order. To evaluate the added value of PBS, Sandhaus *et al* retrospectively interviewed ordering physicians within 48 hours of 64 signed out cases.[10] Surprisingly, 51% of ordering physicians replied that they had not seen the results, 30% replied that they had seen the results, 6% did not remember the results, and 13% were contacted directly regarding urgent findings. Possible explanations for poor follow-up within the study included ordering physicians going off service, designating staff to check results, following up results after 2 days, orders from the emergency department when the patient was already discharged, or denial of knowledge of the order.[10] Due to lack of urgency and inadequate follow-up of results from ordering clinicians, these studies question the clinical utility of PBS review.

Time for pathologist PBS review is abstractly underestimated. On average, morphologic review of PBS by a pathologist can take approximately 3 min per PBS, and longer when there are abnormal findings. The pathologist then issues a report that includes the clinical history, detailed characterisation of each haematopoietic cell line, summary of findings, final interpretation with differential diagnosis and recommendation of additional tests if needed. Overall, it may take an average of 10–15 min per PBS review to analyse morphological findings, review the patient's clinical history, and generate a written report. These findings have also been documented in previous published papers.[9 11]

Education has been shown as an inexpensive effective way of changing practice habits, with increased promising effects when combined with feedback.[1 2] In a study to optimise CBC with differential ordering practices within the ICU, Shen *et al* implemented *Choosing Wisely*, a 2-week education intervention that recommended replacement of the CBC with differential test with a CBC test only during the first 48 hours of inpatient care in the ICU. This educational session was implemented after initial analysis that indicated that the majority of the frequently repeated CBC with differential testing was being used in the ICU. Educational sessions reminded clinicians of the 2 day half-life of granulocytes and provided ordering algorithms, which were reinforced throughout the unit. This intervention decreased the total number of CBC with differential test orders and increased the total quantity of CBC tests without differential orders. Although educational interventions may only have temporary effects, Shen *et al* noticed that ordering practices continued well beyond the 2-week intervention and were also unexpectedly adopted by other units.[2] While our institution does not provide educational seminars or handouts for PBS review indications, we rely on educating pathology trainees to provide constant verbal feedback and rapport with our outpatient providers, along with automated EMR popup boxes of PBS request guidelines for in-patient providers to promote ongoing lasting change in practice habits.

There were some limitations to our study. Clinical indications and diagnostic categories were obtained retrospectively from review of our EMR. We also did not document the actual diagnostic time saved by ordering recommended tests in lieu of PBS review; however, the pathologists interviewed at our institution have reported notable time savings and it is assumed that the recommendations improves resources for definitive diagnosis. Ordering sets are periodically reviewed during weekly clinical pathology lab meetings when notable trends deviate. From these reviews, PBS smears were removed from linked ER ordering sets, where patients are often discharged before results are released, and all CBC orders. In these scenarios, PBS smears must be requested separately. However, ordering sets containing PBS reviews are not routinely reviewed due our overwhelming

volume. This is an intervention that should be addressed in future quality improvement projects to proactively catch misutilisation of PBS orders.[12]

The request for PBS review reflects an unmet need for clinical consultation to explain unusual laboratory findings and their clinical relevance. Accurate diagnosis of PBS abnormalities requires the integration of CBC values, additional laboratory findings, clinical history and morphological findings that can either lead to diagnosis or guide cost-effective workup. One interesting approach to quickly communicate clinical correlation of abnormal PBS findings was explored by Jaso *et al* by the use of a web-based synoptic reporting system that generates a detailed templated report generated by selection of PBS findings, which resulted in decreased turnaround time and reduced typing errors.[13] This need opens the possibility of developing a venue for a tailored billable pathology consultation report to promote effective communication and improve communication clinical outcomes.

Clinicians may also want reassurance from secondary PBS review of abnormal CBC findings. Educating clinicians about the low rate of missed information provided by advanced analysers and the sensitivity of laboratory-initiated pathology PBS review may provide comfort through the awareness of a built-in mechanism to screen for haematological abnormalities. While our implemented policy provides a venue for clinicians to inquire about best testing modalities for abnormal PBS findings, it may be valuable to extend this practice to advise on best testing modalities for other pathology services. Future studies may look into optimising visibility of results in the EMRs and re-evaluation of ordering sets. In conclusion, adopting polices to request PBS approval reduces the number of noncontributory tests, serves as a beneficial educational exercise of resource utilisation for both trainees and clinicians, and reduces hospital costs.

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