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Patient self-testing of white blood cell count and differentiation: A study of feasibility and measurement performance in a population of Danish cancer patients

Running title: Cancer patients can test own white blood cells

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Conflict of Interest
All authors declare no financial or non-financial competing interests in relation to the work described.

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Setting and ethics
The study was conducted at the Department of Oncology, Odense University Hospital, Denmark, covering the Region of Southern Denmark, one of five highly specialized oncology departments in Denmark with 3.600 admissions and 126.000 ambulatory visits annually (2016). The hospital is part of the Danish tax-funded universal healthcare system. The study was approved by the National Committee on Health Research Ethics project (id S-20160184) and the Danish Data Protection Agency via the Region of Southern Denmark (id 2012-58-0018). The study was performed in accordance with the Declaration of Helsinki.

Additional information
Authorship
TOM, JH and LF-H designed the study. TOM was in charge of the data collection. TOM and JS analysed the data and JH and LF-H provided advice on the data analysis. All authors contributed to the interpretation of data. TOM drafted the manuscript. All authors participated in the revision of the manuscript and all authors have read and approved the final manuscript.
Patient self-testing of white blood cell count and differentiation: A study of feasibility and measurement performance in a population of Danish cancer patients

Keywords
Medical Oncology, Patient education, Point-of-care testing, febrile neutropenia, antineoplastic agents, aged, patient comfort.

Abstract

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Objective

Patients in anticancer treatment with a known side effect of neutropenia are monitored closely with laboratory measurements of white blood cell count (WBC) and differentiation. This study sought to evaluate measurement properties and feasibility of patients' self-testing using a Point-of-care Testing (POCT) device.

Methods

A prospective feasibility and measurement study comparing standard measurement of cancer patients' WBC and neutrophil count with POCT measurements. The study included 60 outpatients and 22 inpatients from a department of oncology at a university hospital.

Results

Patients successfully conducted 106 measurements using the POCT device. 46% of the patients were >70 years. Weighted Deming regression analysis showed minimal yet significant proportional bias between methods, with POCT increasingly underestimating both total WBC and neutrophils compared to the standard method the higher the count. Over 90% of patients reported they were willing and considered themselves able to use the POCT device at home.

Conclusions

The instrument can be used for self-testing of post anticancer leucopenia and has sufficient measurement precision for patient risk stratification. Patients are able and willing to conduct measurements including when in a situation of acute illness. Further studies are needed to confirm safety and value within patients own home.
Introduction

A 30% increase in cancer incidence is anticipated over the next 20 years and more than 90% of the estimated future increase is expected to be in the population of those 70-years-old and older (Ewertz et al., 2016). Hence, with an increasing cancer population and within this an increasing elderly and more vulnerable population, the economic burden of cancer is rapidly increasing (Tangka et al., 2010). One of the resource demanding procedures is keeping patients safe during anticancer treatment. Most patients today are followed in hospital outpatient clinics with multiple blood tests, physical evaluations, registration and treatment of possibly life-threatening adverse effects, all in order to provide a safe antineoplastic treatment and supportive care. Due to increased comorbidity and polypharmacy, elderly patients are at a higher risk of adverse effects (M. Sharma, Loh, Nightingale, Mohile, & Holmes, 2016), including febrile neutropenia (Legrand et al., 2012). Therefore, treatment in this population often requires more extensive monitoring and supportive care, including shorter or longer hospital admissions (Legrand et al., 2012).

Monitoring the white blood cell (WBC) count is essential in many cancer patients since a low neutrophil count (neutropenia) can be a dose-limiting toxicity of systemic anticancer therapy and life-threatening when complicated by fever and sepsis (Klastersky & Paesmans, 2013; Legrand et al., 2012). All patients in anticancer treatment with a known side effect of neutropenia are therefore monitored closely (Klastersky & Paesmans, 2013). A white blood cell count including a neutrophil count is required prior to initiating or continuing treatment or in cases of acute fever with suspected neutropenia. A neutrophil count is currently obtained by venepuncture by a health-care professional, requiring the patient to visit their general practitioner or a hospital laboratory facility. A point-of-care solution for measurement of leucocyte and differentiation may benefit both patients and oncologists in several ways. The main advantage is the possibility of testing without having to go to the nearest hospital i.e. prior to treatment or when experiencing an episode of fever during treatment. In case of fever a normal white blood cell neutrophil count measured by the patient at home, may even prevent an acute hospital admission. Also, a low WBC and neutrophil measured at home could spare the patient an outpatient visit. Hence it would benefit patients and reduce pressure on the hospital outpatient clinics.

The HemoCue® WBC DIFF is a point-of-care-testing (POCT) instrument for measurement of leucocyte and differentiation. The technology is CE marked and currently approved for use by healthcare personnel, i.e. general practitioners. It has shown acceptable reliability and reproducibility and good correlation when compared to standard measurement methods in different patient populations (Bogers, Bui, Herruer, & Cohen, 2015; Bui, Bogers, Cohen, Njo, & Herruer, 2016; Ivaska, Niemela, Leino, Mertsola, & Peltola, 2015; Karawajczyk, Haile, Grabski, & Larsson, 2017; Spaeth, Shephard, McCormack, & Sinclair, 2015). Yet none of the studies have tested cancer patients or patients with severe neutropenia or febrile neutropenia. Furthermore, the studied WBC DIFF POCT was developed for use by professionals and therefore the solution has not yet been tested for use by patients for self-testing white blood cell count.
This study aims to 1) evaluate feasibility; including acceptability, demand and practicality of cancer patients using a POCT (WBC DIFF) to self-test white blood cell counts, as well as possible related differences between younger and older cancer patients 2) evaluate the measurement properties of the POCT WBC DIFF unit when used by cancer patients for self-testing, compared to standard laboratory tests.

Methods

Setting and ethics
The study was conducted at the Department of Oncology, Odense University Hospital, Denmark, covering the Region of Southern Denmark, one of five highly specialized oncology departments in Denmark with 3,600 admissions and 126,000 ambulatory visits annually (2016). The hospital is part of the Danish tax-funded universal healthcare system. The study was approved by the National Committee on Health Research Ethics project (id S-20160184) and the Danish Data Protection Agency via the Region of Southern Denmark (id 2012-58-0018). The study was performed in accordance with the Declaration of Helsinki.

Study design
We performed a feasibility and measurement property study of patients' capillary blood self-testing when using a POCT vs. standard laboratory venous blood test to measure total white blood cell count and neutrophil counts. The POCT device was chosen by the test centre of the Innovative high-tech cancer treatment Denmark-Germany project (InnoCan) among other potential POCT devices. The specific POCT unit was chosen for further clinical testing based on its ease of use and the fact that it carried the CE mark for use by professionals. The specific POCT technique is based on cell counting by image analysis on a small volume of capillary blood (10 μl) drawn from e.g. a finger prick. The red blood cells are lysed in the cuvette and the nuclei of the white cells are stained. 37 images are taken of the stained white cells and the cells are identified. The number of cells is counted by image analysis in the analyzer and the concentration calculated from the 2 μl (of the 10 μl) volume in which the cells were examined (HemoCue, 2017). The unit also provides analysis of lymphocytes, monocytes, eosinophils and the basophils, yet in this study these were not recorded since counts are considered too low to be measured reliably, and these measures are seldom used in risk stratification of solid tumours. The standard laboratory test to measure total White Blood Cell count and neutrophil count on venous blood sample used is SYMEXXN-1000. An automated haematology analyser using direct current sheath flow for red cell count, haematocrit and impedance platelet count. Fluorescence flow cytometry is used for leucocyte differential, nucleated red blood cells, reticulocytes and fluorescence platelet count (Briggs, Longair, Kumar, Singh, & Machin, 2012).

Study population
The study included both in- and outpatients to test feasibility, acceptability and measurement properties in both
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instruction material at their bedside. In the following admission days an observer would approach the patient
and ask them to perform an observed self-test. These tests were guided by the written material from the initial
instruction and with the possibility to ask for assistance from the observer but did not include a prior
demonstration. As on the first test day, a biomedical laboratory technician drew the standard venous blood test
after the self-testing.

Statistical methods
All data were entered to a secure database within the OPEN network using RedCap. All data were analysed using
R statistics. Descriptive statistics were used in evaluating demand, acceptability and feasibility. Differences
between younger and older patients regarding their subjective POCT experience and their ability to perform the
POCT measurements themselves were evaluated using chi-squared tests. The level of agreement between
standard laboratory measurements and POCT measures were assessed using Bland-Altman plots of
measurement differences (Bland & Altman, 1996). Grading of leucopenia (counts below 3.0 \(10^9/L\)) and
neutropenia (counts below 1.5 \(10^9/L\)) is commonly assessed using the Common Terminology Criteria for
Adverse Events (CTCAE) (“Common Terminol. Criteria Advers. Events Version 5.0,” 2017) since intervals
between grades of leucopenia and neutropenia are respectively 1.0 and 0.5, we defined acceptable limits of
agreement as \(\pm 1.0 \times 10^9/L\) and \(\pm 0.5 \times 10^9/L\). We used weighted Deming regression to test the statistical significance
of systematic- and proportional disagreements between the laboratory and the POCT measurement, considering
known measurement error in both methods. The measurement error for each method was quantified using the
test-retest coefficient of variation (CV). For the SYSMEX measures, the CVs have been calculated from repeated
measurements on the blood samples. From the daily production the samples at concentrations covering the
measuring interval were chosen, tested 10 times and mean and CV calculated: 2.7\% @ 2.9 \(10^9/L\), 2.0\% @ 6.8
\(10^9/L\) and 1.5\% @ 16.1 \(10^9/L\). For the POCT, the CVs reported by the manufacturer was used. Repeated
measurements on inpatients from day two until discharge were omitted from the analysis to meet the
independence assumption of the Deming regression. Measures of leucocytes below 0.3 and above 30 were
removed due to the censoring function of the POCT device.

Results
The study included 60 outpatients and 22 inpatients, 36 female and 46 male patients. 38 (46\%) patients were
older than 70 years and 44 (54\%) younger. Patients’ mean age was 67 years, range 39-86 years. All patients
were diagnosed with solid tumours and receiving active anticancer treatment within the department. No
patients were excluded due to inability to handle the lancet or the cuvettes, but one patient was excluded due to
insufficient Danish language skills.

User observations and feasibility
Outpatients measured once and inpatients once a day (weekdays only), this resulting in 46 single POCT
measurements by inpatients and 106 single POCT measures in total. None of the patients failed to complete the
filling and placement within the instrument of the lancet. 95 of 106 (90%) measures were successful on the first try, the other 11 (10%) measures yielded an error code. All error codes were non-critical, with the most common error being code 04 (Acceptable light cannot be achieved – suggested solution; repeat measurement). In six cases a second measure yielded a result (yet these results were disregarded in the analysis). No significant difference was observed between younger and elderly patients on the number of POCT error codes, hence successful tests. Mean test time was 4 minutes and 19 seconds, (range 1-16 minutes). Table 1 show the subjective judgments placed by the observer on the patients' ability to conduct self-testing and the patients' answers on their own ability to conduct self-testing within their own home, as well as patients' previous experience with self-testing.

A majority of the patients were judged comfortable conducting the test (93%) and 57% were able to conduct self-testing by using the illustrative guide without any other help after just one demonstration. The other 43% needed guidance; oral instructions from the project staff or direct assistance in opening the cuvette, using the lancet or operating the device. 87% of the patients were judged able to conduct self-testing within their own home following further instruction, and 96% of patients reported they were willing and considered themselves able to do so following further instruction. Again, there was no significant difference between the elderly and younger patients regarding judgment by observer or answers on patients' ability and willingness to perform the test. Also, there was no significant difference between elderly and younger patients in their prior experience with self-testing.

Measurement properties

Point-of-care measurements of the POCT WBC DIFF unit of total number of WBC were compared to standard measurement of the hospital lab unit. A total of 106 single measurements were conducted. The standard white blood cell measures from the SYSMEX XN-1000 unit ranged from 0.61 x 10^9/L to 53.7 x 10^9/L with a mean of 5.8 x 10^9/L. We registered 43 measures below normal, 48 measures within the normal range (3.5-8.7) and 15 above normal. Standard measures of neutrophil counts ranged from 0 x 10^9/L to 15.5 x 10^9/L with a mean of 3.1 x 10^9/L.

The analysis of measurement properties requires independent, non-censored measurement pairs. Among the 82 independent measurement pairs (60 outpatients plus 22 inpatients) ten pairs were excluded due to error of the POCT device and seven pairs due to censoring of high and low measurements by the device, leaving 65 complete and independent measurement pairs suitable for analysis. All censored results were correctly censored when comparing the POCT result with the SYSMEX result.

The Bland-Altman analysis of differences between all complete pairs of leucocytes measures showed a small but significant systematic disagreement between methods, with point-of-care yielding measures which on average are lower by -0.37 (95% CI -0.63, -0.13) (Figure 2a). When examining the below average (<3.5 x 10^9/L) measures of leucocytes there is a small, non-significant systematic disagreement between methods with POCT yielding measurements which on average are lower by -0.11 (95% CI-0.3, 0.09) (Figure 2b). Limits of agreement are
within the predefined accepted range of $\pm 1.0 \times 10^9/L$ (Fig 2b), with no significant trend or inconsistency of variability across the plot.

Weighted Deming regression analysis on total WBC showed minimal yet significant proportional bias of 0.92 (0.86, 0.97) between methods (Figure 3b), with POCT increasingly underestimating the WBC compared to the standard method the higher the count (Figure 3a). When examining the below average ($<3.5 \times 10^9/L$) we found no significant proportional bias or difference (Figure 3c).

Bland-Altman plots for the neutrophil counts revealed a small significant systematic disagreement between both methods with POCT yielding measurements which on average are lower by -0.38 (-0.64, -0.13) compared to standard measures (Figure 4a). When examining the below average neutrophil counts ($<1.5 \times 10^9/L$) we found a non-significant systematic difference of 0.05 (-0.11, 0.21) (Figure 4b). Limits of agreement are within the accepted range of $\pm 0.5 \times 10^9/L$, with no significant trend or inconsistency of variability across the plot (Figure 4b).

Weighted Deming regression analysis on neutrophil counts showed a significant systematic difference of 0.23 (0.13, 0.40) and proportional bias of 0.86 (0.79, 0.91) between methods (Figure 5b) with increasing underestimation of the higher the neutrophil count (Figure 5a). The regression analysis conducted on the neutrophil counts below average ($<1.6 \times 10^9/L$) showed significant systematic difference of 0.23 (0.11, 0.66) and a non-significant proportional bias of 0.84 (0.37, 1.11) (Figure 5c).

**Discussion**

Total WBC count and, absolute Neutrophil Count (ANC) are monitored following induction of anticancer therapy to adjust doses and plan treatment course but are also used to assess the risk of neutropenic fever. All cancer patients at risk are therefore closely monitored especially when they experience fever and prior to initiating new treatment cycles. Monitoring currently takes place at planned visits to outpatient clinics, or as acute admissions in the case of fever episodes, and all blood samples are examined at hospital laboratories.

We found that patients, using a small POCT analyser, can obtain clinically useful and reliable WBC- and neutrophil counts and data that are just as useful as those produced by larger hospital analysers, to assess if patients have normal or below normal WBC and neutrophil counts. Hence, ability to stratify patients for further examination prior to initiating/reinitiating antineoplastic treatment or treatment of suspected infection.

Our study showed the total WBC measurements and neutrophil counts of the POCT on average are respectively lower by -0.37 and -0.38 x10^9/L compared to the standard measurements with increasing underestimation for measurements in the higher range. This increasing underestimation is in accordance with what is reported by the manufacturer (HemoCue, 2017) and prior studies of the specific POCT WBC DIFF measurement properties (Bui et al., 2016; Heffler, Crimi, & Crimi, 2017; Ivaska et al., 2015; Karawajczyk et al., 2017; Osei-
Leucocyte and neutrophil counts are used through the entire measuring range, but identification and grade of leucopenia/neutropenia are of greatest importance for cancer patients, as this is used for risk stratification when receiving antineoplastic treatment. We therefore closely examined the below average counts: WBC range 0-3.5 x 10^9/L and neutrophil range 0-1.5 x10^9/L. The measurements of WBC below 3.5 x 10^9/L are not significantly different from the standard measures and has acceptable variability. Data show neutrophil measures in the lower regions, especially below 1 are quite unreliable, yet this is also the case with standard measurement methods for WBC differentiation(Briggs et al., 2012). One of the factors contributing to this is, that the immature granulocytes in the samples make up a greater fraction of cells when measures are low and, in this case, the two different measurement technologies (POCT is based on image recognition and standard lab on flowcytometry) also have slightly different cut offs for the different classes of cells. But in a clinical setting, patients with fever and measures of WBC below 3.5 x 10^9/L would likely be evaluated in hospital, with standard laboratory measures and physical evaluation by a physician. The use of the POCT will therefore be for stratification of patients with normal WBC counts vs. low counts. Since, patients with fever and normal counts are at lower risk and may be treated within their homes with oral antibiotics(Talcott et al., 2011). In the case of measurement prior to antineoplastic treatment even a WBC count of below normal in combination of a normal neutrophil count would be acceptable.

At neutrophil counts above 1.5 we found reliable results, yet the POCT starts underestimating as with WBC. There could be several reasons for this underestimation. One could be due to sampling/pre-analytical conditions that are known to influence the measurements. For instance, the techniques used, and the order of the blood drops has also been shown to affect measurements(Yang et al., 2001). Furthermore the chosen reference instruments could also affect the comparison as there are minor differences in ANL and ANC(Meintker, Ringwald, Rauh, & Krause, 2013).

However, a slight systematic underestimation of the WBC and neutrophil counts during leucopenia will not expose the patients to any danger as it will lead to a slight overestimation of the risk and subsequently admission to the hospital for physical examination and lab re-evaluation(Klastersky & Paesmans, 2013)(Talcott et al., 2011). On the contrary, an overestimation could be a potential safety hazard with a risk of overlooking neutropenia and therefore underestimating the need for treatment of side effects or the risk of continuing the anticancer treatment.

Our study is lacking samples with elevated WBC and neutrophil counts. In contrast, a measuring error in leucocytosis or neutrocytosis will have minor or no clinical importance in the clear majority of the clinical settings and is often a result of treatment with leucocyte stimulating agents or a corticosteroid.

Some of the challenges regarding the random variability presumably are due to that the instrument has been
developed for doctors’ offices in order to diagnose infections in non-leucopenic patients. Therefore, the instrument has been developed with a 10 µl chamber for the sample. However, only cells 2 µL are counted. In severe leucopenia e.g. 1.0 x 10^9/L only 300 cells will be counted and less at lower leucocyte counts. At this low number the statistically uncertainty begins to be a major component. Therefore, it may be an advantage in the future if POCT instruments for home monitoring of post chemotherapy patients counted the cells in a larger volume.

We found that given proper instructions both younger and elderly cancer patients were able to deliver safe and high-quality self-monitoring of WBC DIFF within the hospital. For many years self-monitoring has been the backbone of diabetes treatment, helping patients achieve and maintain target blood glucose levels to reduce the risk of diabetes related complications (Bailey et al., 2016). Also, self-monitoring of anti-coagulation therapy (P. Sharma et al., 2015) and more recently, irritable bowel disease (Vinding et al., 2016) has become feasible.

We found, in this study that cancer patients are eager to learn how to use the POCT instrument, and more than 90% expressed immediate interest and a positive attitude towards evaluating the benefit of taking the instrument home. Meeting our predefined acceptability measure of minimum 75% by far. Patients in the study were able to measure using the POCT, both in the calm ambulatory setting and in the acute setting when experiencing acute illness, this with no difference in success rate, and within an acceptable time of 4 minutes on average. Meeting our pre-set acceptability measures. This is again similar to what has been seen for other self-monitoring programs including point-of-care self-monitoring of blood sugar levels (Bailey et al., 2016) and coagulation status (P. Sharma et al., 2015).

Yet future trials need to explore if this can be translated into safe home monitoring of hematologic toxicity and even into full management of antineoplastic therapy within the patients’ homes.

One concern is that the error rate of 10% on first measures by this POCT, reported in this study, could potentially be a barrier towards efficient home measurement causing patients distress and extra trips to the hospital for evaluation of the POCT instrument.

Our study has also uncovered an unexpected challenge. Currently all instruments are only approved to be handled by healthcare professionals. Therefore, even though our study has clearly demonstrated that the instruments delivers an acceptable analytical quality and that measurement is feasible and acceptable by patients, there are major regulatory challenges that need to be addressed and solved, before this technology can be implemented in routine setting.

Thus, it seems likely that self-monitoring of WBC Diff post anti-cancer treatment can be introduced. Initially this must be done as part of carefully designed trials under strict surveillance and constant monitoring, so that the safety of these regimes can be evaluated. However, it seems likely that like the above-mentioned programs self-monitoring in oncology will be beneficial for both patient and hospital. For the patient and or the relatives, it
could be empowering to self-manage the blood test and the responsibility hereof and maybe provide a feeling of control of their disease and treatment. Furthermore, reducing the time spent on patients commuting back and forth to blood sampling/outpatient clinics will allow them to live a more normal life, less impacted by their disease. It may also play into other initiatives such as "home anticancer therapy". For the hospitals, only admitting those in need could free up time in the outpatient clinics in cases where therapy can be postponed prior to the patients’ appointment.

Conclusion
The POCT studied can be used for self-testing of leucopenia induced by antineoplastic therapy. The instrument has sufficient precision for patient risk stratification when operated by patients. Measurement is both feasible and acceptable in younger and elderly patients. Further studies are needed to confirm acceptability, feasibility and value of self-monitoring within patients own homes as well as assess unforeseen drawbacks associated with patients’ in-home self-monitoring.

Additional information
Authorship
TOM, JH and LF-H designed the study. TOM was in charge of the data collection. TOM and JS analysed the data and JH and LF-H provided advice on the data analysis. All authors contributed to the interpretation of data. TOM drafted the manuscript. All authors participated in the revision of the manuscript and all authors have read and approved the final manuscript.
Reference List


neutropenic patients with severe sepsis or septic shock. Crit Care Med, 40(1), 43–49.


### Tables

#### Table 1

Observations and patient answers to post test questions by younger and elderly patients

<table>
<thead>
<tr>
<th>Observers questions and judgment at each test (N=106)</th>
<th>Age</th>
<th>p-value for age-effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All (%)</td>
<td>0-70</td>
</tr>
<tr>
<td>1. Was the patient able to conduct the test without any help?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>60 (57%)</td>
<td>37</td>
</tr>
<tr>
<td>No</td>
<td>46 (43%)</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Did the patient seem comfortable with the self-testing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>99 (93%)</td>
<td>58</td>
</tr>
<tr>
<td>No</td>
<td>7 (7%)</td>
<td>4</td>
</tr>
<tr>
<td>3. Do you think the patient at this point would be able to conduct self-testing in their home?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Yes</td>
<td>93 (87%)</td>
<td>54</td>
</tr>
<tr>
<td>No</td>
<td>13 (12%)</td>
<td>8</td>
</tr>
</tbody>
</table>

Patients questions and answers (N=82)

<table>
<thead>
<tr>
<th>1. Do you think you could do self-testing within your own home following this instruction?</th>
<th></th>
<th></th>
<th></th>
<th>0.81</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>79 (96%)</td>
<td>44</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>No/(maybe)</td>
<td>2/(1) (4%)</td>
<td>0</td>
<td>2(1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Do you have any experience with self-testing using other point-of-care technologies e.g. blood sugar testing etc.?</th>
<th></th>
<th></th>
<th></th>
<th>0.09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>20 (24%)</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>62 (76%)</td>
<td>34</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

|   |   |   |   | 0.71 |

**Legends to Figures**

**Fig. 1**
Laminated illustrative guide for patient instruction and use

**Fig. 2ab**
Bland-Altman plots of differences between point-of-care and standard measures of leucocytes, including separate analysis of counts below $3.5 \times 10^9/L$ (fig. b)
Fig. 3abc
Weighted Deming regression analysis on the total number of white blood cells.

Fig. 3b
Point-of-care leucocyte measurements versus standard measurements with added Deming regression line.

Fig. 3c
Point-of-care leucocyte measurements versus standard measurements with added Deming regression line. Sub-group analysis for below average leucocyte counts <3.5 x 10⁹/L.

Fig. 4ab
Bland-Altman plots of differences between point-of-care and standard measures of neutrophil counts, including separate analysis of counts below 1.5 x10⁹/L (fig. 4b)

Fig. 5abc
Weighted Deming regression analysis on the total number of white blood cells, including separate analysis of the neutrophil counts below 1.6 x10⁹/L.

Fig. 5b
Figure 5b. Point-of-care leucocyte measurements versus standard measurements with added Deming regression line.

Fig. 5c
Point-of-care leucocyte measurements versus standard measurements with added Deming regression line. Sub-group analysis for below average leucocyte counts <3.5 x 10⁹/L.
<table>
<thead>
<tr>
<th>YOU NEED...</th>
<th>HOW TO TEST...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Disinfection wipes</td>
<td><img src="ecc_13189_f1.tif" alt="Illustration" /></td>
</tr>
<tr>
<td>2 - Lensclot</td>
<td><img src="ecc_13189_f1.tif" alt="Illustration" /></td>
</tr>
<tr>
<td>3 - Tissue</td>
<td><img src="ecc_13189_f1.tif" alt="Illustration" /></td>
</tr>
<tr>
<td>4 - Microcurette</td>
<td><img src="ecc_13189_f1.tif" alt="Illustration" /></td>
</tr>
<tr>
<td>5 - Tissue paper</td>
<td><img src="ecc_13189_f1.tif" alt="Illustration" /></td>
</tr>
</tbody>
</table>
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