Body Fluid Cell Counts by Automated Methods

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KEYWORDS

- Cell counting • Body fluids • Automated body fluid analysis • Hematology analyzers

KEY POINTS

- The introduction of body fluid modes on automated hematology analyzers is an important advance in automated body fluid analysis.
- The current limits of precision for low white and red blood cell counts pose barriers to wider acceptance of automated cell counts for cerebrospinal fluid.
- Improved analyzer flagging algorithms for abnormal cell distributions in body fluid samples will help define criteria for microscopic review.
- The impact of automated body fluid analysis on laboratory efficiency depends on many factors and will vary among laboratories.

BACKGROUND AND INTRODUCTION: WHY AUTOMATE BODY FLUID CELL COUNTS?

Cellular analysis of body fluids (BFs) is medically important in the diagnosis of infectious and other inflammatory processes, hemorrhage, and malignancies that may involve body cavities and the central nervous system (CNS). Historically, BF cell counts have been done by hemocytometer chamber counts. As with other manual microscopic techniques, this method is subject to high interobserver variability and poor reproducibility. The limitations of manual cell counts and the adaptability of automated hematology analyzers to the cellular analysis of BF specimens has led to greater interest and innovation in automated BF analysis in recent years. Many published studies have demonstrated that a variety of automated analyzers initially developed for blood or urine analysis can provide acceptable alternatives to manual cell counts for most BF sample types. Potential benefits of automation include improvements in accuracy, precision, laboratory efficiency, and cost-effectiveness. This article reviews the current state of automated BF cellular analysis and discusses its advantages, current limitations, and future directions.

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Abbreviations	
BF	Body fluid
CBC	Complete blood count
CNS	Central nervous system
CSF	Cerebrospinal fluid
CV	Coefficient of variation
ED	Emergency Department
LOQ	Limit of quantitation
MN	Mononuclear cells
PMN	Neutrophils
QC	Quality control
RBC	Red blood cell
TAT	Turnaround time
TNC	Total nucleated cell count
WBC	White blood cell

AUTOMATED METHODOLOGIES FOR BODY FLUID CELLULAR ANALYSIS

Currently available automated hematology analyzers use different combinations of technologies to quantify and classify the cellular components of blood. These methods include impedance technology, cytochemical reactivity, differential cell lysis, and flow cytometric analysis of light scatter and nuclear fluorescence staining intensity. Most published studies on automated BF analysis have evaluated the performance of hematology analyzers.[1–25] An automated analyzer that was initially developed for urinalysis uses flow through digital imagery and neural network software to quantify and classify cells and other particles, and has also been evaluated for automated BF analysis.[26,27] The aggregate evidence presented in these studies indicates that automated BF analysis has already become a reality in many clinical laboratories.

BFs differ from whole blood in their cellular composition, cellular stability, and matrix effects. The introduction of a BF mode is a major innovation that some manufacturers have incorporated into their hematology analyzers. The purpose of the BF mode is to optimize the analyzer's unique combination of technologies for the analyses of BF samples, taking into account their different cellular composition and matrix effects. It is important for users to understand the technological modifications and software algorithms of the BF mode for the analyzer under evaluation, as these features will determine the capabilities and limitations of the method. For example, a BF mode that has a gating strategy to exclude mesothelial cells from the white blood cell (WBC) count should produce more accurate WBC counts than the complete blood count (CBC) mode. Similarly, an extended counting capability can improve the accuracy for very low cell counts in BF samples by counting a larger volume of fluid than is used for CBC samples. On the other hand, the BF mode WBC differential count might be limited to 2 cell types (neutrophils [PMN] and mononuclear cells [MN]), in contrast to the whole blood differential capabilities of 5 or 6 cell types. **Table 1** lists features that might be present in some BF modes of currently available automated hematology analyzers.

VALIDATION OF AUTOMATED METHODS FOR BODY FLUID CELL COUNTS

Manufacturers are required to provide a statement of intended use, which indicates the types of BFs that have been validated on the analyzer, and the analytical measurement range for each BF type. Laboratories must verify the manufacturer's claims for each type of BF that they plan to run on the analyzer. Analysis of BFs that are not