


# A comparison of manual and automated cell counting instrumentation

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## Abstract

Cell counting is a routine, necessary task in cell-based laboratory experiments and tissue culture facilities. Researchers count cells at the beginning of experiments to standardize the starting material to reduce experimental error and variation. Currently, the hemocytometer is the most widely used device for determining cell concentrations, requiring consistent criteria and tenacity to obtain accurate and reproducible measurements. Regrettably, because the manual method is so tedious, researchers often skip the critical step of cell counting. To facilitate this necessary procedure, a number of instruments and methods have become available to researchers to facilitate cell counting in routine cell culture maintenance and experimentation. In this study, five different automated cell counting instruments were examined, and the ease-of-use, throughput capability, cost, accessories and consumables, and performance of these instruments were compared to each other and to glass and disposable hemocytometers. All instruments were operated according to the manufacturers' instructions, first using a standardized bead solution, then observing relative cell counting and viability data. Several instruments were easy-to-use but the actual counting and viability data were significantly different from the standard bead solutions as well as other instrument results. Throughput capabilities were represented by instruments with rapid analysis time (less than one minute) and multiple-sample, hands-off processes. In terms of cost, prices ranged from under \$5,000 to more than \$40,000. Higher prices were not an indication of performance; in fact, some of the lower priced instruments were found to perform better than the more expensive instruments in terms of counting and viability determination. All instruments required the use of consumable accessories. For any given laboratory or core facility, choosing the right instrument will predominately depend upon ease-of-use, needed throughput, and cost.

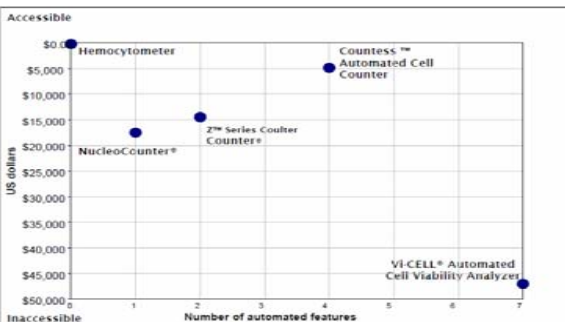
Figure 1- Comparison of instrument abilities and requirements



Hemocytometer	Countess™ Automated Cell Counter	Z™ series Coulter Counter®	NucleoCounter®	Vi-CELL® Automated Cell Viability Analyzer
\$200	\$4,850	\$15,000	\$17,500	\$47,000
manual	automated			
range <2.5 x10 <sup>6</sup> cells/mL	range >2.5 x 10 <sup>6</sup> cells/mL			
90 sec/sample	30 sec/sample		2.5 min/sample	
viability data	no viability data		viability data	
20 uL load volume	200 uL load volume	100 uL load Volume	1 mL load volume	
no image generated	image generated	no image generated		image generated
no cell size data	cell size data	no cell size data		cell size data
microscope required	stand alone		requires computer	

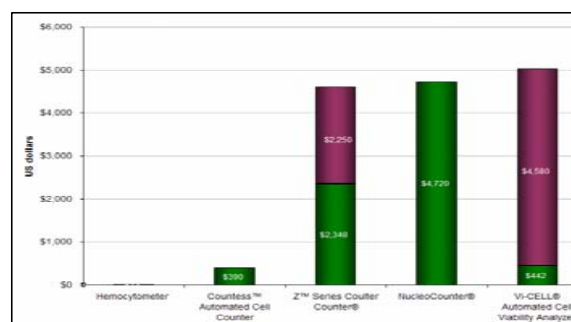
In the Table above, the features of five cell counting instruments have been compared for ease-of-use, throughput, cost and level of automation. Color has also been used to indicate benefits or subjectivity; green indicates an instrument alleviates user error while orange indicates a disadvantage or subjectivity. Information has been collected from manufacturer quotes and publications. Z™Series Coulter Counter® are trademarks of Coulter International Corp. Vi-CELL® is a registered mark of Beckman Coulter. NucleoCounter® is a registered mark of ChemoMetec A/S.

Figure 2 – Instrument accessibility vs automation



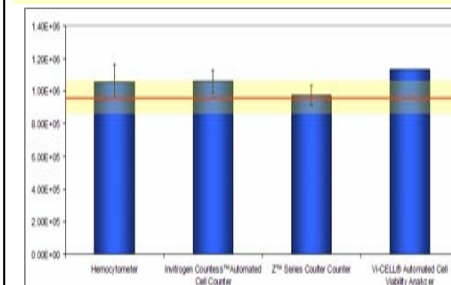
The price of each instrument has been plotted against the number of automated features each instrument has to offer. Automated features include count, viability, focusing, data archiving, cell size information, sample preparation, and image generation. For more specific information on each instrument's features refer to figure 1.

Figure 3 – Cost of consumables per year



The cost of consumables for one year was calculated assuming 500 samples per year including reagents for sample processing and reagents for maintenance of instrument as indicated by a green bar. If a service contract or extended warranty is available, it is indicated by a purple bar.

Figure 4 – Counting comparison



A standard bead solution (Beckman Coulter, Aperture Instrument Concentration Control, part number 177495) was counted with four instruments. The known concentration was 9.6x10<sup>5</sup> beads/mL +/- 10% as indicated by the red line in figure 4 with the yellow band representing the percent variability. Most instruments came within range with the exception of the Vi-CELL® instrument. Error bars may have helped the Vi-CELL® instrument come within range, but due to the large sample size required (1mL) we were unable to perform more than one count. The NucleoCounter® instrument has been excluded from this experiment due to the necessity of a fluorescent count, making it unable to be directly compared with this bead standard.

## Summary

Cell counting is a necessity in cell culture facilities and experimental assays. Due to the tedium of manual counting, this step is often skipped. In this study, we have compared five instruments for cell counting. We found that some of the less expensive instruments can be just as effective and easy to use as the Vi-CELL® instrument. We have also found that some of the mid range instruments, in the long run, cost more per year and offer fewer features than other cell counters available. Over all, most of the cell counters studied performed well but the Countess™ Automated Cell Counter had the most features for the lowest price, and performed just as well as more expensive instruments.

## References

Information for the Vi-CELL® instrument and Z™series Coulter Counter® was obtained from: <http://www.beckmancoulter.com>  
Information for the NucleoCounter® instrument was obtained from: <http://www.nbsc.com>