Karl von Vierordt: Innovations in Blood Chemistry

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Summary

Karl von Vierordt (1818—1884), a mid-19th C. physician and physiologist, developed and applied quantitative chemistry techniques to innovate the measurement of the ratio of blood corpuscles in a volume of blood. His determinations, performed using his own blood, stand to the present as accurate representations of the number of red blood cells found in a cubic millimeter of blood. While his methods may seem rudimentary from a presentist historical perspective, he understood that the methods chemists had been employing in other areas of chemistry and quantitation were applicable to the measurement of blood corpuscles.

Keywords: Blood, corpuscles, volumetry, microscopy, replicate analysis

Objectives: To describe the innovations in analytical chemistry Karl von Vierordt, a physician and physiologist, developed to determine the ratio of red blood cells in a volume of blood.

Introduction

In 1851, Karl von Vierordt (1818—1884) published the first of what became several important papers focused on the analytical chemistry techniques required for quantitation of blood cells in a volume of blood (Pagel, 1895) (Vierordt H. , 1885). Vierordt was a German physician and professor of theoretical medicine working at the University of Tubingen. In his initial hematological paper, Vierordt states plainly that "…science is not in possession of useful counts about the numerical ratios of the blood corpuscles in one given blood volume" (Vierordt, 1851, p. 1). This initial publication was republished as two articles a year later (Vierordt K., 1852) (Vierordt K., 1852). His efforts towards rectifying this situation earned him the esteem of future clinical chemists (Verso, 1964). In his 1969 paper, Verso describes Vierordt's contribution as "such an integral part of everyday knowledge that their discoverer tends to be forgotten" (Verso, 1971).

Vierordt's Chemistry Methods

The 1851 paper was divided into two sections. The first section— New method of quantitative microscopic analysis of blood—dealt with quantitation of blood corpuscles using a microscope and some specific sample preparation techniques. It describes a new method that would go on to form a foundation for hemocytometric methods by Malassez (Malassez, 1873), Hayem (Hayem, 1878), and Gowers (Gowers, 1877) (Henry & Nancrede, C.B., 1879). Vierordt's microscopic method would provide the numerator of the corpuscle-to-blood fluid ratio. In doing this work, he used microvolumetric methods that surpassed the techniques of his time. He provides meticulous detail so that others may replicate his work. Aspects of his microvolumetry will be presented.

An unusual aspect of Vierordt's work on blood corpuscle quantitation is that he provides a list of possible sources of error in his microvolumetric measurements. Although these lack a statistical approach, instead relying on estimates of possible error, they provide a sense of the precision and accuracy of his measurements.

The second section— New method of chemical analysis of blood—would provide the denominator: volume. While previous chemical analyses of blood had been performed, Vierordt found that they fell short of his needs as a physiologist. He states the primary reason for this shortfall: "…the inadequacy of the previous procedure does not lie in the actual chemical procedures, but rather in the fact that what was to be analyzed did not properly fall into the hands of the chemist" (Vierordt, 1851, p. 29). Vierordt starts by dismissing the prevalent method of the day—that of Jean-Louis Prevost and Jean-Baptiste Dumas—as introducing several sources of error into measurement of the "blood cake"—the evaporated and condensed sample created from blood samples. Vierordt also provides a basis for rejecting a method developed by Carl Schmidt[1]. Key to the dismissal of Schmidt's method is his use of constant coefficients that make incorrect assumptions as to the ratio of corpuscles to liquid volume (i.e., water, electrolytes, fats, soluble and insoluble extracellular proteins, and other non-corpuscular components). Vierordt's principal criticism is summarized in the following: when "…the multiplicator and multiplicand are hypothetical quantities, what can become of the product?" (Vierordt, 1851, p. 26).

In a follow-up article (Vierordt K., 1852), Vierordt reports his blood corpuscle measurements. He had received criticism, not the least from Dr. Schmidt, for failing to report the results. He responds that he had been too busy lecturing on the method and sharing it with colleagues. Vierordt drew his blood by lancing a finger and drawing the blood into a capillary—the "finger prick" technique. The capillaries were no ordinary glass tubes; he designed them to ensure a reproducible set of measurements. He had found in his earlier work that dilution with some "menstruum"—a solvent that provides for the solution or suspension of solids—was best done with egg white. For this work, he developed a gum Arabic preparation to stabilize the corpuscles on a microscope slide. He documented the empty volume of each capillary tube, date, time, and room temperature at collection, the volume of blood collected, then placed the capillary on a microscope stage and counted the number of blood corpuscles he saw. The number of corpuscles in the capillaries varied from 21,008 to 68,099. He then calculated the number of blood corpuscles in a cubic millimeter (in German, abbreviated as "K.M.M.") by dividing the number of corpuscles he counted by the volume of blood collected in the capillary. The results are in line with what hematologists measure in our present day. A table of his results will be presented.

Vierordt would develop a method for analyzing the absorption spectrum of red blood cells using techniques developed by Fraunhöfer, Bunsen, and Kirchoff. He also developed the first sphygmograph to measure blood pressure. He changed the landscape of quantitative methods used in medicine in ways that inform practices to this day.

Conclusion

Vierordt saw that chemical methods were the appropriate solution to earlier issues besetting the quantitation of blood corpuscles. His innovations in microvolumetry using

[1] A previous version of this summary suggested Alexander Schmidt (1831-1894), not Carl Schmidt (1822-1894), was the University of Dorpat physiologist with whom Vierordt argued. They were contemporaries but Carl was older by about eight years. Vierordt made this difficult by referring only to "Schmidt" in his papers.

special capillary tubes and diluents led to blood corpuscle measurements that are similar to those found by cell counting instruments today.

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