# Korotkoff Sounds – The Improbable also Occurs

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## Abstract

Very few discoveries have had such a large impact on and relevance to clinical medicine as the noninvasive measurement of the diastolic blood pressure. A number of gifted physiologists and clinicians were ineffectively in search of a noninvasive method to determine the diastolic pressure. Nonetheless, the quantification of the diastolic BP was not achieved by any of these clinical or physiological researchers, but by an unlikely and unexpected figure: Nikolai Sergeevich Korotkoff (1874-1920), a young Russian army surgeon, working under precarious conditions in the hardship of diverse wars. It is easy to dismiss the achievement of Korotkoff as a serendipitous discovery, similar to that of Alexander Fleming in the discovery of penicillin. However, Nassim N. Taleb's recent black swan theory may serve to illustrate his discovery in a new and, perhaps, surprising way.

## Historical Sketch

Every second throughout the world, someone is measuring the systolic and diastolic blood pressure (BP) by means of Korotkoff's auscultatory method. It is worth noting that very few discoveries have had such a large impact on and relevance to clinical medicine as the noninvasive measurement of the diastolic BP. The systolic and diastolic BP had been accurately measured with an intra-arterial catheter after Friedrich Goltz (1834-1902) and Justus Gaule (1849-1939) introduced their ingenious valved device in 1878[1]. Two years later, Bohemian physician Samuel S. K. von Basch (1837-1905), former ordinary physician to the Mexican Emperor, presented his groundbreaking apparatus, consisting of a rubber bulb connected to a mercury manometer[2]. He compressed the radial artery with the bulb until the pulse was obliterated and, at that point he measured the systolic BP[2]. The Bohemian physician compared the systolic BP measured with his method in a dog, with the intra-arterial technique and found that BP figures were comparable with both approaches[2]. He established the maximum value of the systolic BP at 150 mmHg; anything beyond this figure in the adult was considered to be abnormal[2,3]. He introduced the term *sphygmomanometer*, which derives from the Greek word "sphygmos," meaning "pulse"[4]. The term was, in fact, a misnomer, but it is still used in most countries.

The brilliant Italian physician Scipione Riva-Rocci (1863-1937) introduced a bracelet that was connected to a mercury column and, by increasing the pressure until the pulse was obliterated, he was able to measure the systolic BP with great precision[4]. He used the tactile sense of his fingers to detect the moment when the pulse disappeared or appeared[4]. This method was accurate, inexpensive and soon became highly popular.

Nevertheless, the diastolic BP could not be precisely determined by this procedure, and when Harvey Cushing introduced Basch's and Riva Rocci's methods into clinical medicine and surgery only the systolic BP was being assessed[3]. A number of gifted physiologists and clinicians were ineffectively in search of a noninvasive method to determine the diastolic BP[5]. Nonetheless, the quantification of the diastolic BP was not achieved by any of these clinical or physiological researchers, but by an unlikely and unexpected figure: Nikolai Sergeevich Korotkoff (1874-1920), a young Russian army surgeon, working under precarious conditions in the hardship of diverse wars[6]. He did his amazing feat using the Riva-Rocci bracelet and a child's stethoscope[6,7].

Korotkoff was not a BP researcher and his main concern, as a war surgeon, was to know if collateral blood supply was undiminished, so as to resolve whether a wounded artery could be securely ligated when an amputation was likely[6]. He knew that the onset of the palpable pulse was the systolic BP and he reasoned that the time of disappearance of the sound signaled the onset of the laminar flow and, therefore, of the relaxation of the arterial wall. He hence proposed that diastolic BP might be estimated by the disappearance of all sounds[8].

### Some Philosophical Remarks on the Epistemology of the Unexpected in Science

It is easy to dismiss the achievement of Korotkoff as a serendipitous discovery similar to that of Alexander Fleming in the discovery of penicillin[9]. While looking for one thing, he found something entirely different. However, Nassim N. Taleb's recent black swan theory may serve to illustrate his discovery in a new and, perhaps, surprising way[10]. In his book, Taleb persuasively argues about finding the unexpected in life and science. Many great discoveries and inventions in science and art have been unexpected

## Keywords

History of Medicine; Arterial Pressure; Sphygmomanometers / utilization.

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and unpredictable, though easily explained in retrospect. In fact, many of these findings have compelled scientists to change their theoretical framework to accommodate new facts. It is true that a discovery is made within the context of what is already known, and this serves as part of retrospective explanation: without the Riva Rocci's bracelet and without the pediatric stethoscope, the young Russian surgeon could not have developed his auscultatory method. It is then easy, but probably wrong, to assume that the discovery would have been made sooner or later; that similar discoveries may be made simultaneously in different parts of the world (synchronicity) does not entirely confirm this, for the majority of discoveries are not synchronous, and we cannot know all the discoveries that remain to be made, even though the facts have been known for centuries. It has been said that the scientist discovers and the artist invents, but in the case of Laennec, Korotkoff and others, both concepts are correct. The Russian surgeon not only produced an unexpected result but he himself was an unlikely actor in the drama. The odds favored that clinicians and physiologists working in the field of BP measurement would come up with the discovery, and it was improbable, to say the least, that a young surgeon, physically and emotionally overworked, with a large numbers of acute wounded patients, would make such a momentous discovery.

Perhaps it is as simple as observing what everyone has seen, while having some new thoughts about it and it is possible that fatigue played a part in this altered perception. Nevertheless, at some moment after his discovery, Korotkoff became keenly aware of its significance, although he could not yet envision its enormous practical future. He published his report in a single page to the Imperial Military Medical Academy of Saint Petersburg in 1905[7,8]. In this brief presentation he described his discovery. In the following month, he made a new presentation. In 1910 he defended his Ph.D. dissertation on the collaterals of peripheral circulation[8]. Subsequently, he worked in different hospitals[6,8]. He did not publish anything else on the subject of BP measurement and died of pulmonary tuberculosis, at the early age of 46 years, in 1920[6,8].

## Author contributions

Conception and design of the research, Acquisition of data, Analysis and interpretation of the data, Writing of the manuscript and Critical revision of the manuscript for intellectual content: Estañol B, Delgado G, Borgstein J; Statistical analysis: Delgado G; Obtaining funding: Borgstein J.

### Potential Conflict of Interest

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