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# Analysis By Touch: An Initial Study With The Progenos® Instrument

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***Abstract:***
***Background****: A blood test is critical to assess overall health and identify possible disorders such as anemia, infections, leukemia, diabetes, etc. However, currently available techniques involve invasive blood collection, which is very uncomfortable for patients. Near infrared (NIR) spectroscopy is a highly flexible form of analysis that can be applied to a wide range of analytical applications. Chemometrics is an area that refers to the application of statistical and mathematical methods, including those based on mathematical logic, to more complex data treatments. The Nanotimize Company developed a new portable instrument, Progenos®, based in NIR spectroscopy and using chemometric algorithms to performed blood analysis without blood, ie an analysis by touch. The instrument collects the data in vivo using the subjects' left palm. In order to investigate Progenos®, we present in this paper the initial clinical studies.*
***Materials and Methods****: The set (in total, 3,265 subjects) contained a group of patients known to be healthy and a group of patients who had comorbidities (including cancer patients). The individuals' ages varied between 0 and 95 years old, and the measurements were performed using several pieces of Progenos® equipment. The data were treated using principal component analysis (PCA).*
***Results****: The results, graphically reported, show that the two groups of patients can be distinguished.*
***Conclusion:*** *The initial clinical study with Progenos® technology shows that it is possible to distinguish the groups, that is, patients with comorbidities, from those with healthy people.*
***Key Word****: NIR; chemometrics, blood, non-invasive analysis, Progenos®.*

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## I. Introduction

It´s very known that blood is composed of plasma and blood cells. The blood cells - erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets) -are suspended in the plasma with other particulate matter. Plasma is a clear straw - colored fluid that makes up more than half the volume of blood. It is distinguished from serum, which remains liquid after blood clotting. Nowadays, blood analysis is usually performed on a blood sample taken from the arm or finger vein. Hundreds of tests and procedures have been developed, and many can be carried out simultaneously on a blood sample. However, the invasive blood collection is very uncomfortable for patients and the analytical methods present relatively long time to get the results[1].

NIR is a type of vibrational spectroscopy that corresponds to the wavelength range of 750 to 2,500 nm (wavenumbers: 13,300 to 4,000 $cm^{-1}$). The analytical methods resulting from the use of the NIR spectroscopic region reflect its most significant characteristics, such as: fast (one minute or less per sample), non-destructive, non-invasive, with high penetration of the probing radiation beam, suitable for in-line use, nearly universal application (any molecule containing C-H, NH, S-H or O-H bonds), with minimum sample preparation demands. The principal advance in the technological applications of this technique was possible by computation development and the new discipline of Chemometrics[2,3].

Chemometrics involves the application of statistical and mathematical methods, as well as those based on mathematical logic, to chemical analysis, providing the tools for gathering information and its wise use. Within chemometrics, principal component analysis (PCA) allows the graphical visualization of the entire data set, even when the number of samples and variables is high. The use of this algorithm is mainly aimed at increasing the understanding of the data set by examining the presence or absence of natural groupings among the samples. It is classified as exploratory, since no information regarding the identity of the samples is considered. The presentation of experimental results in the form of graphs facilitates the interpretation of data and, consequently, the identification of groups of samples with similar characteristics, that is, the recognition of patterns or trends[4, 5].

The Nanotimize Company developed a new portable instrument, Progenos®, based in NIR spectroscopy and using chemometric algorithms to performed blood analysis without blood, ie an analysis by touch[6, 7]. The instrument collects the data *in vivo* using the subjects' left palm**.** The equipment was validated *in vitro* against the VIAVI MicroNIR®, a commercial device that has technological components originally developed for

interplanetary spacecraft by the National Aeronautics and Space Administration (NASA) of the United States of America[8]. In this paper, we present the initial results of clinical studies obtained with the Progenos® device.

## II. Material And Methods

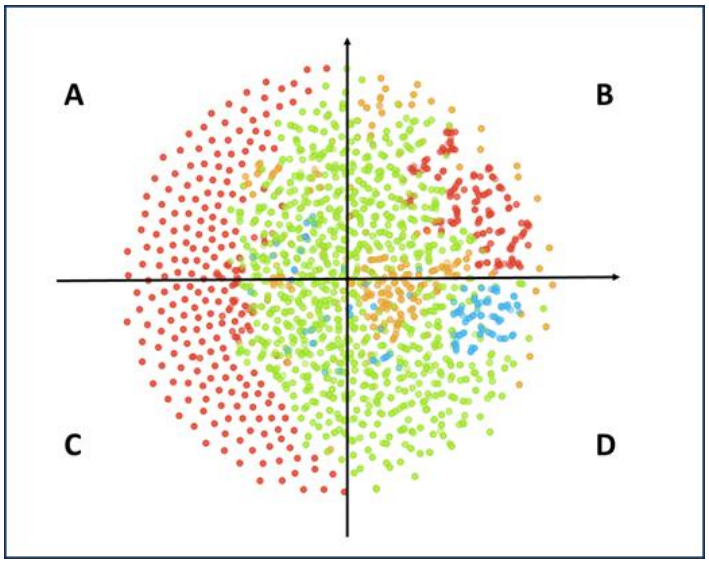
Progenos®, Nanotimize Company, has a plurality of photodetectors arranged in a circular gridded geometry that covers the wavelength range from 960 to 1,600 nm. The instrument collects the data *in vivo* using the subjects' left palm at intervals between two and five minutes, Figure 1.


**Figure 1. Progenos® instrument.**

In present study, the set (in total, 3,265 subjects) contained a group of patients known to be healthy and a group of patients who had comorbidities (including cancer patients). The individuals' ages varied between 0 and 95 years old, and the measurements were performed using several pieces of Progenos® equipment. The units of the collection centers were outpatient, basic, and hospital units, located in the states of São Paulo (SP) and Minas Gerais (MG), Brazil. The data were treated using the chemometric method PCA.

## III. Results and Discussions

Figure 2 shows the results of the PCA treatment of data obtained with the Progenos® instrument.




In Figure 2, the points in red refer to healthy people. Individuals with comorbidities coming from the hospital are marked in green. In orange are the data collected in the laboratory, and the points in blue are people who practice sports (soccer athletes). As can be seen in Figure 2, the results for healthy people (in red) are on the outer edge of quadrants A, B, and C. For people with comorbidities (hospitalized), they are centered (in green) in quadrants A, B, and C and dispersed in quadrant D. Data collected in the laboratory are within and in the center of quadrants B and D (in orange). As for the practitioners of sports (in blue), soccer athletes who, therefore, are

subjected to stress are distributed mainly in the outer edge of quadrant D. Therefore, the experimental data processed by PCA show that Progenos® was able to group individuals in groups.

## IV. Conclusion

The initial clinical study with Progenos® technology shows that it was possible to distinguish the groups, i.e., patients with comorbidities, from those with healthy people.

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