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Protein Staining and Analysis with Artificial Intelligence Color Algorithm Analysis with 2-Dimensional Inkjet Printer to Identify Covid-19 Adhesion and Infected Properties on Artificial Body Fluid

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Abstract

In this study, the predictive modeling of Covid-19 viral contamination on artificial body fluids (simulated lung fluid, perspiration, saliva, and urine) was done by colorimetric analysis of protein staining on paper ground with henna ethanolic extract loaded on a 2-dimensional printer cartridge. The purchased artificial body fluids were left in the open-air atmosphere of sterile containers to the public places of pandemic hospitals, pharmacies, which are the most frequent places of Covid-19 patients for 2 weeks. These body fluids, which were then thought to be Covid-19 adsorption, were safely collected and placed in the cartridge chambers of the 2-D printer. The mixtures of artificial body fluids and henna plant extract in the cartridges were sprayed on the paper floor by ink painting. The algorithmic matrix code system was created by colorimetric predictive scaling between +1 and -1 about the images of viral transmission to artificial body fluids taken with a smartphone.

Highlights:

- Optimized printing colorimetric staining diagnostic system on artificial body fluids, firstly.
- Powerful detection limits combined mathematical matrix space.
- Using Printer technology and smartphone, simultaneously.

Keywords: covid-19; artificial body fluids; printing analysis; protein staining; algorithmic matrix system

Introduction

The spread of Covid-19 throughout China is evaluated with ecological factors such as population density, temperature, and precipitation [1]. Turkey, rapidly been exposed to a viral contamination spread through social contact with first Covid-19 case recorded in the March 11, 2020 because of its geographical position in the European and Asian transition point [2]. Although there is still no targeted therapy for Covid-19 patients, dynamic monitoring and supportive therapy systems are important for the restoration of organ function [3]. Healthcare professionals are at a much higher risk of infection than the general population due to contact with contaminated body fluids [4].

The use of masks in the community and healthcare settings can be important during pandemic [5]. Biosensors are emerging as sensitive and selective analytical diagnostic tools for early-stage disease detection for personal health management. Intelligent diagnostic tools that consider successful predictions are urgently needed to manage selective and precise detection of the Covid-19 pandemic, a life-threatening respiratory infection [6]. Although an increase in biomarkers such as D-dimer has been continuously reported in patients with severe Covid-19, the optimal value for diagnosis is unknown. It is important to develop algorithms to identify those who are prone to suffering severe Covid-19 with thrombotic complications, and to design biomarkers and scoring systems to classify the risk of patients [7]. A test tool using components of the complete blood count and patient gender for the SARS-CoV-2 PCR prediction showed that a 78% statistic can be generalized to emergency populations with an optimized sensitivity of 93% [8].

For the detection of coronavirus 2 (SARS-CoV-2) in patients with suspected Covid-19, posterior oropharyngeal saliva samples were evaluated with Pearson coefficient [9]. The etiological diagnosis of Covid-19 can be predicted in biological materials based on the direct identification of viral RNA by molecular biology techniques. However, whether body fluids such as blood, urine, saliva are valid alternatives, has not been precisely defined [10]. The presence of viral RNA targeting E and S viral genes in semen and urine samples was measured using a Real time PCR system. SARS-CoV-2 RNA was negative for semen and urine samples [11].

Chest computed tomography can play an important role in the diagnosis and treatment of the disease with higher sensitivity. Although some patients have significant shortness of breath, lesions observed in the lungs have been shown to be lighter with computed tomography [12]. Virus respiratory particles have been detected in feces, urine, and saliva, but it is not yet known whether non-respiratory body fluids such as vomit, breast milk, or semen contain live infectious viruses [13].

SARS-CoV-2 uses angiotensin converting enzyme 2 receptors, which have been reported in various human reproductive cells (seminiferous channel cells, Leydig cells) with higher binding affinity. This indicates the risk of SARS-CoV-2 infection in the reproductive system [14]. In a study, reverse transcription-loop mediated isothermal amplification was used to detect colorimetric changes with the naked eye within 30 minutes in SARS-CoV-2 detection [15]. The developed artificial intelligence software (Thoracic VCAR software) measures healthy and affected lesion lung parenchyma percentages with the help of a colorimetric map over the tomographic lung images [16]. In this study, the adsorption potential of Covid-19 to artificial body fluids (simulated lung fluid, perspiration, saliva, urine) placed in hospital environments with sterile containers was firstly investigated by colorimetric algorithm on paper platform from henna protein staining zone areas with 2-dimensional printer and smartphone technology.

Experimental

Developed Diagnosis Method: Artificial Body Fluids Test Solutions (simulated lung fluid, perspiration, saliva, urine), which are models containing representative components of the facts, were purchased from LC Tech Pickering Laboratories Company. Epson L3110 photo-ink sprayer printer (375 x 347 x 179 mm, AC 100 V - 240 V, print speed: 8 ppm) was used for staining protein with henna solution of Pickering artificial body fluids after and before Covid-19 adsorption. Positive or negative adsorption images were illuminated by colorimetric, algorithmic analysis on paper ground via smartphone. Quantitative and qualitative detection limits of adsorption due to henna staining intensity were quite good (LOD: 0.15 ppm, LOQ: 0.5 ppm). The adsorptions of four different artificial body fluids (simulated lung fluid, perspiration, saliva, urine) on a 2-dimensional paper floor were expressed in a [2x4] matrix linear coordinate plane consisting of -1 to +1 algorithmic variables (Table 1). Covid-19 contamination was achieved by exposing artificial body fluids to open air aerosols in pandemic hospitals and pharmacies where the patient density is high. Propellers providing negative airflow simultaneously with antiviral aroma therapeutic essential oil nebulizers were used to prevent contamination when transferring contaminated artificial body fluids to the printer cartridge chambers (Figure 1).

Statistical Analysis: Color analysis of the adsorbed Covid-19 interactions zone areas were analyzed with SPSS statistics program based on 3-repeat smartphone photographic measurement results. Mann Whitney U test was used and Significance was indicated by the (#) sign according to $p < 0.05$ (Table 1).

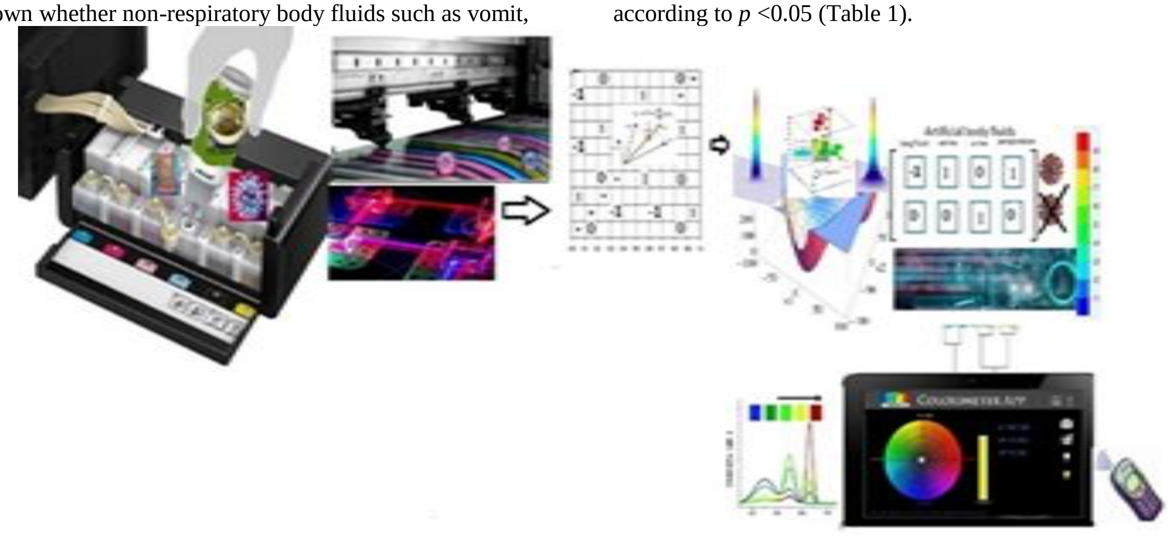

Figure 1. Colorimetric Covid-19 adsorption diagnostic system for artificial body fluids with 2-D-printer technology and smartphone.

SAMPLES	[2X4] Matrix System Dimension Space	[2X4]$^{-1}$ Matrix System Dimension Space	CIELAB Pixel Color Depth Smartphone Analysis					Covid-19 Diagnostic Limits			Infection adsorption speed
	x, y, z Coordinate 3-D Plane		L*	a*	b*	h°	K/S	% Error	LOD (ppm)	LOQ (ppm)	
Simulated Lung Fluid	[illegible]	[illegible]	48±0.03	18±0.02	22±0.01	2.5±0.02	11±0.01	0.25	0.15±0.04 (#)	0.5±0.03 (#)	Sigmoidal
Artificial Perspiration	[illegible]	[illegible]	57±0.04	21±0.05	36±0.02	3.4±0.03	17±0.02	0.45	0.24±0.02 (#)	0.45±0.05 (#)	Sigmoidal
Artificial Saliva	[illegible]	[illegible]	33±0.02	24±0.05	41±0.03	5.8±0.04	21±0.05	0.15	0.11±0.01 (#)	0.35±0.02 (#)	Holoenidal
Artificial Urine	[illegible]	[illegible]	25±0.01	35±0.04	16±0.01	1.8±0.01	13±0.02	0.33	0.13±0.03 (#)	0.43±0.02 (#)	Holoenidal

L*: Light-dark difference; a*: Red-green difference; b*: Yellow-blue difference; h°: Light angle; (K/S): ratio of absorption and scattering coefficients. *SD: Standard deviation of triplicate determinations. (#): Meaning for Mann Whitney U test ($p < 0.05$). LOD: Limit of detection, LOQ: Limit of Quantification, ppm: Parts Per Million.

Table 1. Identification of Covid-19 adsorption in artificial body fluids by mathematical matrix modeling.

Result and Discussion

Due to the lack of critical resources in personal equipment, proper distribution of virus diagnostic tests and ventilators was impaired in the Covid-19 pandemic. Chest radiography and thoracic imaging are key tools for the diagnosis and treatment of pulmonary disease, but their roles in the management of Covid-19 are multivariable conditions among risk factors for disease progression [17]. In a few minutes instead of hours / days after an invasive swab, a pandemic response is critical for Covid-19 patients. In the current strategy, test accuracy and test capacity for result is limited [18]. In addition to this, FebriDx® is a rapid diagnostic test designed to help differentiate bacterial and viral acute respiratory infections [19]. However, a selective "naked eye" detection of SARS-CoV-2 without using any advanced instrumental technique is highly desirable. In a study, the colorimetric test based on gold nanoparticles was developed when the N-gene (nucleocapsid phosphoprotein) of SARS-CoV-2 was coated with thiol modified antisense oligonucleotides. Positive Covid-19 cases were identified in isolated RNA samples within 10 minutes [20].

In the other study, by using a panel of equine respiratory infectious diseases as a model system for diseases such as Covid-19, a smartphone integrated system was developed to detect live virus from the nasal swab environment. Five pathogen nucleic acid sequences were isothermally amplified onto a microfluidic chip and the result of the reactions was detected by smartphone [21]. In the current smartphone-based GPS and social media technology, a mini program was developed within the WeChat application. The data of all users were analyzed and the close contacts of the patients and early sources of infection were monitored. The data in the mini-program will provide accumulation of how the disease has spread, forecasting outbreak trends, calculating risks and developing recommendations for population protection action [22].

Covid-19 can seriously affect your pregnant births. 68 births with maternal infections were reported between February 10, 2020 and April 4, 2020. No significant results were obtained in the real-time polymerase chain reaction of cord blood, vaginal swab, amniotic fluid, neonatal blood, breast milk or placenta for the detection of severe acute respiratory syndrome coronavirus 2. In order to determine whether the infection has occurred perinatally or congenitally, the type of delivery, perinatal exposure, and the time until diagnosis of neonatal infection were important [23].

During Covid-19 period, aerosol production during open corneal phacoemulsification surgery was evaluated using a human cadaver corneoscleral model mounted on an artificial chamber. Visible aerosol production was recorded using a high-speed 4K camera. Apparent aerosol production was removed using hydroxypropyl methylcellulose that covers the cornea by directing the blowing air aerosol to the ocular surface [24].

The using of X-ray lung images for Covid-19 is one of the most common and effective methods applied by researchers. Alternative fast scan method nCOVnet based deep learning neural network, which can be used to detect Covid-19 by analyzing X-ray images of patients with chest radiography, was proposed [25]. Normalized data of different blood parameters from SARS-CoV-2 positive patients show a decrease in eosinophils, platelets, basophils, leukocytes, and lymphocytes and an increase in monocytes. Clinical data were standardized to have mean zero and unit standard deviation. Artificial neural network, machine learning, and simple statistical testing were used to identify SARS-CoV-2 positive patients with complete blood counts without symptom information. This methodology has great potential for patients with limited PCR-based diagnostic tools [26]. In a new Covid-19 detection method, the Residual sample region was presented by binary pattern selection (ResExLBP) and attributing iteration selection technique (ReliefF). Support vector machine, decision tree, subspace discriminant, linear discriminant methods were used in the classification phase. The proposed method achieved 100 % classification accuracy in Covid-19 detection with lung x-ray images [27].

Recently, medical applications and surgical protective face mask production with 3-D printing have become revolutionary in healthcare, especially against coronavirus. In order to minimize health risks by avoiding bacterial biofilm formation, acrylic acid was applied in petri dishes with 3-D printing via polylactic acid filament by plasma-polymerization [28].

ELISA capturing IgG for anti-SARS-CoV-2 serological detection in serum samples has been developed. The developed ELISA had a high sensitivity and was specific, reproducible method with 97.9 percentage. This method could be used to determine the seroprevalence of SARS-CoV-2 in the virus population [29]. Proteasomal activator, PA28γ regulates the intracellular density of SARS-CoV-2 N protein. Immunofluorescent staining revealed that nCoV N moved from the nucleus to the cytoplasm. Covid-19 pathogenesis is important in checking proteasome activity that regulates the levels of critical nucleocapsid protein [30]. In this study, specific nucleocapsid protein was stained with henna solution on Covid-19 adsorbed artificial body fluid with the help of a 2-dimensional printer, and the dyed zone areas were analyzed with a smartphone colorimetric program (Figure 1). The color intensities of the zone diameters were positioned in the colorimetric program on the input command [2x4] matrix fields with a switch button on the scale of -1 and +1. Then, an output command was created by switching the splitter with the control panel and converting it to the $[2x4]^{-1}$ matrix (Table 1).

The value 2 represents with Covid-19 or without, while the value 4 represents 4 different body fluids (simulated lung fluid, perspiration, saliva, urine). With the color string that can be seen by printing with the naked eye on paper, Covid-19 detection limits are LOD: 0.15 ppm, LOQ: 0.5 ppm respectively, and its sensitivity is higher than gold nanoparticle and PCR tests (Table 1). In the photo Image J studio analysis of the Apple iPhone 8 smartphone, Covid-19 adsorption for artificial body fluids by the CIELAB (L*: Light-dark difference, a*: Red-green difference, b*: Yellow-blue difference, h°: Light angle and t (°C: temperature) color pixel depth measurement parameters was evaluated in the MATLAB 3-D matrix space geometry. In space geometry, Covid-19 contaminations of artificial sweat and saliva body fluids are in the negative z conformation while Covid-19 contaminations of urine and lung fluid are in the positive y conformation. Conformation x represents the effective or ineffective Covid-19 contamination. The colorimetric color scale contributed to the measurement of the 4-dimensional Covid-19 henna-painted zone diameters. Red indicates intense contamination while yellow indicates less intense, green indicates non-contaminated zones. The most intense red colored areas in the colorimetric color triage were artificial sweat Covid-19 contaminants. Artificial urine sample with a diameter of 0.5 A° in the smallest zone area had the lowest Covid-19 contaminant. During the measurement, opposite turbulence fans were used to prevent cross contamination and aroma therapeutic orange peel essential oils were sent to the medium in the vapor phase. While Covid-19 is mostly highly adsorbed to artificial sweat and lung fluid, artificial urine and saliva adsorption is lower. All kinds of light sources can be used in colorimetric analysis (Ultra violet, infrared).

Conclusions

Via printer technology, Covid-19, which is adsorbed to artificial body fluids, was introduced with a mathematical matrix space color distribution. High-sensitivity present-none analysis was performed in x, y, z dimension space. Sigmoidal and holozoidal zone areas on the color scale were determined by adsorption radar analysis. Especially the crystallized structure in artificial urine affects colorimetric analysis. To resolve this situation, the sensitivity was increased by passing the detection through different beams filter. The study is a new and cheap technique that successfully enables the diagnosis of Covid-19 through artificial body fluids.

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Conflicts of Interest

I hereby declare no conflicts of interest.

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