VILNIUS TECH
Vilnius Gediminas Technical University

12th International Scientific Conference

BUSINESS AND MANAGEMENT 2022

May 12–13, 2022, Vilnius, Lithuania

ISSN 2029-4441 / eISSN 2029-929X
ISBN 978-609-476-288-8 / eISBN 978-609-476-289-5
Article Number: bm.2022.726
https://doi.org/10.3846/bm.2022.726

ADVANCED ECONOMIC DEVELOPMENT *http://vilniustech.lt/bm*

EMPIRICAL ANALYSIS OF THE EFFECTS OF DIFFERENT SPECTRUM UV AND HINS RAYS ON COVID-19 AND IMPACT OF ECONOMIC PROCESS AND FOR THE MANUFACTURE OF PRODUCTS

Vaidas GAIDELYS*, Emilija NAUDŽIŪNAITĖ

School of Economics and Business, Kaunas University of Technology, Donelaičio 73, Kaunas, Lithuania

Received 25 January 2022; Accepted 13 April 2022

Abstract. In late 2019, a new coronavirus, known as a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was identified as a cause of numerous pneumonia cases in Wuhan, a city in Hubei Province, China. This virus quickly spread and caused a global pandemic. 2020, the World Health Organisation (WTO) named the new coronavirus disease COVID-19. Most coronaviruses are non-hazardous, but the new virus that causes COVID-19 is an exception to the rule. The purpose of this article was to evaluate the effects of different spectra of UV and HINS rays on COVID-19 and their market introduction in the context of global demand. There are three main tasks of the study. First, verification of the latest COVID-19 virus studies in terms of accuracy and test duration, depending on whether a sample is taken from surfaces or from an aerosol. Second, comparison of COVID-19 identification by employing viral polymerase chain reaction (PCR), antigen detection and other methods. Third, economic description and justification of the testing algorithm. The results indicate that SARS-CoV-2 is a highly contagious coronavirus that causes COVID-19 and is transmitted through air droplets and aerosols as well as through close contacts. The high risk of SARS-CoV-2 spread in confined spaces and through aerosol-generating medical procedures has been confirmed. SARS-CoV-2 can remain viable in air in liquid droplets <1 μm in diameter for up to 3 hours. Aerosol (<5 μm) SARS-CoV-2 persists longer on plastic and stainless steel than on copper and cardboard. SARS-CoV-2 is sensitive to ultraviolet light. The use of UV and HINS rays in the production of COVID-19 products also has a significant impact on national economies.

Keywords: HINS, COVID-19, dentistry, virus spread prevention, virus survival, ultraviolet rays, clinical trials, national economies.

JEL Classification: 014, 03, 04.

Introduction

First identified in 1960, coronaviruses are common pathogens in humans and animals (e.g. birds, bats, reptiles) and belong to the order *Nidovirales,* the family *Coronaviridae* and the subgroup *Coronaviridae*. Based on phylogenetic methods, this subgroup is divided into four genera: alpha-coronaviruses, beta-coronaviruses, gamma-coronaviruses and delta-coronaviruses (Weiss & Leibowitz, 2011; Woo et al., 2010). The whole-genome sequencing and comparative genetic analyses indicate that the coronavirus causing COVID-19 is a beta-coronavirus that belongs to the same group as the severe acute respiratory syndrome (SARS) and several bat coronaviruses (Lu et al., 2020a). The available data suggest that bats are natural hosts for SARS-CoV-2, while pangolins are intermediate hosts (Perlman, 2020; Zhou et al., 2020; Zhai et al., 2020). Coronaviruses are the viruses spherical in shape with crown-like glycoprotein growths (spikes) surrounding the outer envelope; they consist of a single-stranded ribonucleic acid (RNA) genome and at least four structural proteins: envelope (E) protein, membrane (M) protein, nucleocapsid (N) protein and spike (S) protein (Yu et al., 2020). SARS-CoV-2 is a virus between 60 and 140 nm in diameter with spikes between 9 and 12 nm in length (Zhu et al., 2020). When spike's glycoprotein attaches to a receptor – angiotensin-converting enzyme 2 (ACE2), the virus enters the epithelial cells of the airways, where the synthesis of viral proteins takes place (Zhou et al., 2020; Hoffmann et al., 2020). The entire cycle of the viral replication, characterised by frequent mutations and recombination, lasts

* Corresponding author. E-mail: *Vaidas.Gaidelys@ktu.lt*

up to 48 hours in the cell, and the incubation period for the COVID-19 disease is 1 to 14 days. Based on the research data, SARS-CoV-2 is highly contagious (Yu et al., 2020; Rothe et al., 2020). The source of the COVID-19 infection is a person with a symptomatic or asymptomatic form of the disease (Hoehl et al., 2020). It has been proved that SARS-CoV-2 can reproduce efficiently in the nose, throat and airways (Zou et al., 2020). The infection can be transmitted even during the incubation period (14). The virus is transmitted through air droplets and aerosols as well as close contacts (Li et al., 2020; Lu et al., 2020b; Galbadage et al., 2020; Van Doremalen et al., 2020). SARS-CoV-2 is spread by breathing, speaking or coughing through exhaled droplets, by touching the mouth, nose or eyes, and after the contact with virus-contaminated substances (Zhou et al., 2020; Deng et al., 2020). Previous studies revealed that the virus can be detected in faecal samples and therefore faecal-oral transmission cannot be ruled out (Holshue et al., 2020). A higher risk of SARS-CoV-2 was identified in confined spaces and during aerosol-generating medical procedures (Wax & Christian, 2020). Studies revealed that SARS-CoV-2 can survive in the environment for much longer than most other viruses transmitted through air droplets. Human coronaviruses can remain viable on a variety of ambient surfaces at room temperature for up to 9 days. (Kampf et al., 2020). At temperatures of 30 °C or higher, infectivity lasts shorter (Kampf et al., 2020). The survival duration of a viable and infectious virus in aerosols and on surfaces depends on the dose of infection (Van Doremalen et al., 2020; Kampf et al., 2020; Han et al., 2020). It has been proved that SARS-CoV-2 can remain viable in air, in liquid droplets <1 μm in diameter, for up to 3 hours (Van Doremalen et al., 2020). Aerosol (<5 μm) SARS-CoV-2 persists longer on plastic and stainless steel than on copper and cardboard. In an experimental study, a viable and infectious virus was detected up to 72 hours after the contact with plastic and stainless steel surfaces, although the viral titer decreased significantly (Van Doremalen et al., 2020). The estimated median half-life of SARS-CoV-2 was nearly 5.6 hours on stainless steel surfaces and 6.8 hours on plastic surfaces (Van Doremalen et al., 2020; Kampf et al., 2020; Han et al., 2020). No viable SARS-CoV-2 was detected on copper surfaces after 4 hours and on cardboard surfaces after 24 hours (Van Doremalen et al., 2020). Previous studies showed that SARS-CoV2 is sensitive to ultraviolet light (UV-C 254 nm inactivates the virus within 15 minutes) and heat. Coronaviruses are inactivated at 56 °C within 30 minutes, and treated with ethyl ether, 75% ethanol, chlorine disinfectant, 0.5% hydrogen peroxide and other lipid solvents – within 1 minute (Zhao et al., 2020).

The use of HINS beams to kill the COVID-19 virus is new on the market and has an advantage in the market for its efficiency. Because technology solves a global problem, market segmentation is no longer needed to bring such a product to market.

1. Literature background

COVID-19 is highly contagious and spreads rapidly in society. One year after announcement of the pandemic, according to the WHO, COVID-19 related epidemiological situation in the world on 18 March 2021 was as follows: the number of the confirmed COVID-19 cases amounted to 120,915,219; the number of deaths recorded was 2,674,078, and the number of countries where COVID-19 was identified reached 223 (World Health Organization, 2021). COVID-19 mortality rate is 3.4 percent and increases significantly with a person's age. Meta-analyses show that every ten years of a person's age, mortality rate is increasing by 5.6 percent and amounts to 13.9 percent (95 percent CI 6.2 – 21.5 percent) for hospitalised patients (Khalili et al., 2020; Rodriguez-Morales et al., 2020; Onder et al., 2020). According to the data for 18 March 2021, the number of the confirmed COVID-19 cases in Lithuania amounted to 207,469, and the number of deaths – to 3,442 (Amin et al., 2011). The clinical course of the COVID-19 disease can range from asymptomatic infection to the critical and complicated disease. A study of the asymptomatic infection rate in 16 different cohorts under consideration (urban population, health care workers, nursing home residents, etc.) concluded that the prevalence of asymptomatic COVID-19 cases can be a significant factor in the spread of SARS-CoV-2 (Van Doremalen et al., 2020). The likelihood that approximately 40–45 percent of SARS-CoV-2 infected individuals will remain asymptomatic indicates that a virus has a high potential for silent spread in human populations (Van Doremalen et al., 2020). It is important to understand and consider the difference between a true "asymptomatic" person (not sick although viral replication occurs) and a "pre-symptomatic" person (the virus is detected, clinical symptoms appear later). Some individuals with minimal symptoms may remain unrecognized patients and thus allow the virus to spread to vulnerable "at risk" populations (e.g. nursing home residents). The mild form of the disease is characterized by uncomplicated symptoms of the upper respiratory tract infection – fever, general weakness, cough, sore throat, headache and muscle aches (Rodriguez-Morales et al., 2020). However, the clinical data show that only 43.8 percent of patients have fever in the early stages of the SARS-CoV-2 infection (Rodriguez-Morales et al., 2020), and some patients have atypical symptoms of the upper respiratory tract infection – olfactory and taste loss, nausea, vomiting, diarrhoea (Hoffmann et al., 2020). The moderate disease is characterised by pneumonia at normal saturation without the need for oxygen therapy (Elias et al., 2021). The disease progresses to severe forms in 7 to 32 percent of patients (33, 34, 35, 36, 37). SARS-CoV-2 can also cause serious illnesses with as yet unknown long-term consequences in people of all ages. Some cases of the disease can be fatal. Severe pneumonia with decreased oxygen saturation is diagnosed in the cases of the severe disease (Rothe et al., 2020). A critical form of the disease severity

is diagnosed with the onset of respiratory failure, septic shock and the development of hypercytokinemia. Hypercytokinemia causes increased vascular permeability, multiple organ failure and death (Rothe et al., 2020). The available data suggest that clinical deterioration is usually sudden and difficult to predict. Acute respiratory failure, especially acute respiratory distress syndrome (ARDS) in very common in patients with severe COVID-19. Many patients are in a stable condition for more than a week and even a month before acute respiratory failure or ARDS which develop suddenly within 2–3 days. Other possible complications include thromboembolic events, acute cardiac injury, renal impairment and inflammatory complications (World Health Organization, 2020). Laboratory signs of the severe COVID-19 disease include lymphopenia, elevated D-dimers, and increased inflammatory markers. Risk factors for the severe disease include older age (the highest risk for those over 80) and chronic diseases such as cardiovascular disease, diabetes, chronic lung disease, chronic kidney disease, oncological disease, obesity, immunodeficiency (Su et al., 2016). The symptomatic duration of the COVID-19 disease depends on its severity. The symptoms can last up to 4 to 12 weeks after the onset of the disease. In some cases, the recovery period can be longer than 12 weeks or even some new symptoms, unexplained by an alternative diagnosis, and thus attributed to the COVID-19 disease and referred to as post-COVID-19 syndrome can occur (Hoffmann et al., 2020).

Various drugs available and prescribed for other diseases have been tried to treat COVID-19. Some of them were discontinued due to low efficacy or side effects. At present, pending antiviral drug search and clinical trials, it is recommended that patients with COVID-19 be treated with an antiviral drug belonging to the nucleotide analogue group, remdesivir (Amin et al., 2011), the interleukin-6 receptor antagonist tocilizumab (Van Doremalen et al., 2020), corticosteroids (51, 62–65), anticoagulants (66), oxygen therapy (depending on the severity of the disease, supplemental oxygen therapy, adaptive lung ventilation (ALV) or extracorporeal membrane oxygenation (ECMO)), antipyretics or non-steroidal anti-inflammatory drugs (NSAIDs) (49, 67), prophylaxis of stress ulcers and gastrointestinal bleeding with histamine 2 receptor blockers or proton pump inhibitors. In the presence of signs of bacterial infection, antibacterial therapy is recommended (33, 34, 68, 69). Nevertheless, effective and safe vaccines against COVID-19 are needed to protect public health, especially for healthcare professionals and vulnerable groups, such as the elderly or the chronically ill. Vaccine development requires time – many years of the laboratory research, including animal testing and tests with volunteers, before the new vaccines reach a consumer (70). Considering the significant negative impact of the COVID-19 pandemic on human health, social and economic life as well the public health emergency, in 2020 teams of scientists began to work intensively to produce safe and effective SARS-CoV-2 vaccines in record time. The development and approval of the first COVID-19 vaccines took less than a year. Currently, 82 vaccines are still under clinical trials; 22 of them have reached the final stages of research (71). 182 vaccines are actively being investigated in the preclinical phase (71). COVID-19 vaccines are developed and tested in accordance with the same legal requirements for quality, efficacy and safety as other vaccines. Based on the recommendations of the European Medicines Agency (EMA), in March 2021 the European Union approved and now allows vaccination of the EU population with four COVID-19 vaccines: Comirnaty – COVID-19 mRNR vaccine BNT162b2, produced by Pfizer-BioNTech (since December 21, 2020), mRNA 1273 COVID-19 Vaccine Moderna (since January 6, 2021), COVID-19 Vaccine AstraZeneca, a vector adenovirus vaccine (since January 29, 2021), and Johnson & Johnson vector adenovirus vaccine COVID-19 Vaccine Janssen (since March 11, 2021) (72–75). Pfizer/BioNTech and Moderna COVID-19 vaccines were produced by using the latest RNA (iRNA and mRNA) vaccine production technologies (72, 73, 76). According to the data provided by the manufacturers, both vaccines are highly effective in adults of all ages (a 95 and 94.5 percent efficacy), safe, and require two intramuscular doses (72, 73). The vaccines developed by the researchers at AstraZeneca and Johnson&Johnson are adenovirus vector vaccines (74, 75). AstraZeneca requires two doses, with an average effectiveness of 70.4 percent, according to the manufacturer (74). Based on the clinical trial data, the efficacy of Vaccine Janssen is 66.4 percent, and a single dose of the vaccine, which protects against the severe disease, hospitalization and death with 85 percent efficacy, is sufficient to induce protective immunity (Kampf et al., 2020). The exact duration of immunity after vaccination as well as the need for revaccination are not yet known.

1.1. Comparison of functionality features of competitive products

The review of competitive products and their manufacturers in the market allowed to distinguish the functionality of competitive products and compare them with analogues offered on the market. A summary of competing products in terms of functionality is provided in (World Health Organization, 2021).

The vast majority of competing products reviewed are based on the use properties of UV-C shortwave ultraviolet radiation for surface and air disinfection with >99%. efficiency of pathogen eradication. Only a few products are based on other disinfection methods, e.g. the use of hydrogen peroxide vapor (Bioquell Q-10 hydrogen peroxide vapor (HPV) biological decontamination system). The duration and area of pathogen eradication of the reviewed products varies depending on the power and number of UVC lamps used. Devices are usually designed to perform a specific disinfection function and are presented as finished products without the possibility of

integration with other devices (World Health Organization, 2021).

As an additional important advantage of competitive products available in the market is the time spent by the user in using the developed products and another issue is the ease of use of the developed products.

In this case, the market segmentation process involves identifying the characteristics of market segmentation, identifying target segments, and determining a positioning strategy. Market segmentation research allows to identify the demographic profile of the product user, the selection priorities, the problems faced by the target group, how the product is evaluated, the supply channels, how to attract the target group's attention, how important the brand is to the consumer, etc. (Wu et al., 2020). Market segmentation is the division of the market into separate groups of buyers according to their needs, characteristics and behavioural characteristics. The attractiveness of a market segment is assessed based on the following criteria: segment size, segment growth rate, intensity of competition, stability, and economies of scale. It is usually planned that the user of the device under development will be a business enterprise.

1.2. Methodology

A worker who will take a patient's sample to confirm the diagnosis of the COVID-19 infection must wear PPE (personal protective equipment) level 5. Samples are taken with 2–3 sterile swabs into a liquid viral transport medium with a screw cap. Below we present the procedure for taking material for examination approved by Lithuanian University of Health Sciences Hospital Kaunas Clinics and Lithuanian legal acts. The sampling site must have: tools and measures for taking a sample from a patient's nasopharynx and pharynx (2–3 sterile swabs per patient, special equipment with viral transport medium, a tube with transport medium); sealed plastic bags with absorbent material (secondary sample packaging); a cardboard box for sample tubes (tertiary packaging), a non-washable pen; disinfectants for hand and surface disinfection, reusable gloves for cleaning and disinfection, a box of disposable gloves (at least 100 pairs); a small easily disinfected table; a sealable container with a waterproof bag for contaminated medical waste; two cooler bags or refrigerators (one for tubes with clean media, and the other for tubes with samples); at least 1 spare set of personal protective equipment for each team of employees and at least 1 set of personal protective equipment per shift; a box with disposable napkins to remove the nasal secretion; tongue clamps; a place for a team of professionals to sit (Rothe et al., 2020). A swab is taken with a dominant hand, and a tongue is pressed down with a spatula in the other hand. The most protuberant area of the tongue is pressed with a spatula to avoid causing a nausea reflex. The first dry sterile cotton swab is used for rubbing over the tonsils and then the soft palate, and returned through the posterior wall of the pharynx. Care should be taken not to touch the tongue and gums. The swab is immersed into the transport medium. If the swab shaft is hard to break, then it is bent without breaking. If a patient has a runny nose, he/she must be asked to blow one side and then the other side of the nose into a disposable napkin. A patient's head is reclined at an angle of 70 degrees. The second sterile swab is inserted into the nose and gently pushed along the bottom of the nose to the nasopharynx at a 90-degree angle (until it rests on the back of the pharynx). The swab is rotated for 2–3 seconds, and then the same is done in the other nostril. The distance from the nostril to the nasopharynx is on average about 6–7 cm (roughly corresponds to the distance from the nostril to the ear). If a patient complains of persistent difficulty in one-side breathing through the nose, no force should be used to take a sample from this side. The swab is immersed into the transport medium. If the swab shaft is hard to break, then it is bent without breaking. The samples are packed in a category B double packaging consisting of: the primary packaging (tubes with viral transport medium for collecting samples), and the secondary packaging (an impermeable, sealed plastic bag for packing primary packagings). The primary packaging is individually packed into the secondary packaging with a sufficient quantity of sorbent to help maintain the vertical position of a tube and to absorb the leaked sample in the event of damage. The barcode generated during registration of a sample is affixed to the bag of the secondary packaging. It is necessary to make sure that the transport medium cover is screwed on properly. The patient's name and surname are written on the tube (primary packaging) with a non-washable pen. The hands and the tube (primary packaging) with the sample are cleaned with an alcohol wipe. The tube (primary packaging) with the sample is placed into a sealed plastic bag (secondary packaging), and the latter is cleaned with an alcohol wipe. The sample is placed onto the prepared tray. The container with the secondary packaging is transferred to a room where the sample is stored until it is taken to the laboratory. The secondary packaging is placed into the tertiary packaging (a cardboard box). The tubes with samples are delivered to the laboratory. Prior to delivery, the samples are stored with a lid facing up (perpendicular position) to ensure that the swabs with the samples are immersed in the medium, at the temperature of 4 °C (in a refrigerator) at the point of collection. The samples at room temperature must be delivered to the laboratory within 1 hour. The samples can be stored in the refrigerator for up to 3 days. Sending samples by air transport is strictly prohibited (Han et al., 2020).

Recently, the polymerase chain reaction (PCR) method of nasal sampling has been introduced. This method differs from the traditional one in that the anterior nasal cavity rather than nasopharynx is sampled. This procedure is much simpler and practically does not cause any discomfort to the subject. The samples are tested in the laboratory five at a time, which saves time and reduces costs. By employing a pooled testing method, swabs with 5 personal nasal samples are placed in a single tube with the medium in

which the virus remains viable for several days (Rodriguez-Morales et al., 2020). Sampling from the anterior nasal cavity can also be employed for the rapid Ag test. For rapid antigen testing, sampling is minimally invasive, with swabs inserted 1.5 to 2 centimetres into the anterior nasal cavity and rotated several times (79). The samples for detecting COVID-19 can also be taken from bronchoalveolar lavage and saliva, and from blood for antibodies.

Results. At present, three types of methods are proposed in Lithuania: real-time PCR, antigen test and antibody test. The first two are intended for detecting the virus fragments and are used to diagnose the COVID-19 disease. The antibody test is intended for detecting the response of the human immune system to the viral infection. It is best suited to determine whether a person has already had Covid-19, and thus has developed the immunity specific to this virus (Onder et al., 2020). No test is 100 percent accurate. Virus particles are invisible even under a simple microscope. They are detected indirectly through biochemical reactions. The final product of these reactions is the resulting colour which is visible to the eyes or devices. Test developers and manufacturers make every effort to develop by far the most sensitive and accurate tests, but we need to understand that errors may occur at each stage of the test, samples can get contaminated, virus particles can be lost (e.g. adhere to the tube wall), and the amount of the virus taken up in a smear may be just too small (Onder et al., 2020).

Test results are evaluated based on particular quality parameters. Sensitivity indicates which proportion of people with the infection are correctly tested "positive". Specificity indicates which proportion of people without the infection under consideration are correctly tested "negative". Finally, the detection limit indicates the minimum number of virus particles that must be present in the sample to obtain the result "positive" (Table 1) (Onder et al., 2020).

The COVID-19 agent – SARS-CoV-2 – is transmitted via air (through droplets or particles) or by close contact. In an aerosol, the virus remains stable and viable for up to three hours (Van Doremalen et al., 2020). SARS-CoV-2 has also been found to be distributed by asymptomatic carriers (Perlman, 2020). Recently, faster-spreading strains of this pathogen have been identified. Given the rapid spread of the virus, timely and adequately implemented preventive measures are of great importance. These measures cover protection of medical facilities (including dental ones), personal and premises protection, protection of the society and public places (quarantine, travel restrictions, mass testing, vaccination, etc.).

Table 1. Comparison of the major SARS-CoV-2 virus test indicators

Test	SARS-CoV-2 PCR	SARS-CoV-2 rapid PCR	Ag test	Ab test	Pooled PCR	Rapid Ag test when sampling the anterior nasal cavity
Test sample	Nasopharyngeal smear, saliva	Nasopharynx	Nasopharynx, saliva	Blood	Nasopharynx and pharynx or anterior nasal cavity sample	Anterior nasal cavity sample
Sensitivity	About 73 percent	About 73 percent	70–98 percent within 7 days of the onset of symptoms	Varies depending on the method	96 percent (comparing individual and pooled samples)	
Specificity	>98 percent	About 98 percent	Close to 100 percent			
Detection limit	Detection limit is only 4 particles/ml		100–1000 times more virus particles than for PCR	Not the virus, but the response of the human immune system is sought		
Intended for	Asymptomatic and symptomatic individuals	Symptomatic individuals	Symptomatic individuals within 7 days of the onset of the symptoms	Recovered or vaccinated individuals for evaluation of immunity. A positive test indicates emerging or already established immunity. The test alone is not relevant for diagnosing the COVID-19 disease	Preventive examination	Preventive examination, detection of the disease in its early stage

End of Table 1

Test	SARS-CoV-2 PCR	SARS-CoV-2 rapid PCR	Ag test	Ab test	Pooled PCR	Rapid Ag test when sampling the anterior nasal cavity
Test duration	Reaction itself takes about 3 hours; preparatory work is required, i.e. isolating the viral genetic material (RNA) from the sample medium, transporting it to a specialized laboratory and processing the results	Up to an hour (15–45 minutes)	15 minutes	15 minutes	Several hours	30 minutes
Special equipment	Relatively expensive reagents, equipment, trained staff are required	Test can be performed on site – in a medical institution; there is no need to transport samples to a special lab; there is no need for special staff. Testing requires special equipment	There is no need for expensive reagents, equipment. The test itself looks like a small plastic plate on which the sample is applied	Simple and fast, a plastic plate is used; but in this case, an individual's blood rather than a smear is taken, and the response of the human immune system (not the virus) is sought		
Price	EUR 20–30	EUR 40	EUR 7–20	EUR 10		

To reduce the spread of COVID-19, healthcare establishments, including nursing and supportive care institutions, must implement several types of measures. The basis for the control of this infectious disease is undertaking administrative measures, adherence to physical distancing, hand hygiene and the correct use of personal protective equipment (Galbadage et al., 2020). The administrative measures slow the spread of the virus and at the same time reduce the likelihood of outbreaks in healthcare establishments. In the common areas of these institutions, visitors and patients must maintain a safe distance, observe hand hygiene and wear masks when it is impossible to maintain a distance. Medical institutions must ensure that adequate personal protective equipment is available and that it is used correctly. Responsible persons or teams must be appointed to ensure (Table 2): a) infection control, supply of personal protective equipment, accounting for it and training on how this equipment is used; b) monitoring the COVID-19 situation; c) SARS-CoV-2 testing, outbreak detection and control; d) medical and psychosocial assistance; e) visitor supervision.

Due to their ability to cause chemical reactions and fluorescence of substances, ultraviolet rays are widely used not only in the area of medicine. The use of these rays for destruction of viruses, bacteria and fungi as well as for disinfection has been known for a very long time already. In dentistry, ultraviolet rays are used for tooth florescence with low irradiance of small areas at a dose not exceeding 5 J/cm^2 (Hoehl et al., 2020). Ultraviolet rays have a direct antimicrobial effect (Holshue et al., 2020). They have been proved effective in killing a variety of airborne viruses (103). There are several types of ultraviolet rays. These are ultraviolet A rays (UVA, 400–315 nm), ultraviolet B rays (UVB, 315–280 nm) and ultraviolet C rays (UVC, 280–100 nm). The highest energy UVC rays are used for killing the SARS-CoV-2 virus. The DNA molecule absorbs 260 nm wavelengths best. When irradiated with ultraviolet light, the DNA sequence of microorganisms can form pyrimidine dimers, which can affect DNA duplication. This, in its turn, causes destruction of nucleic acids and the viruses become harmless.

Market segmentation

Most of the products that are already available in the market received maximum or average ratings in terms of their applicability to dental services, integration of UV-C radiation, protection against pathogens of various origin, eradication duration and efficiency. Nevertheless, the products under consideration generally provide only one protection barrier in terms of COVID-19 virus prevention, i.e. they disinfect the air exhaled by a patient or dental water (e.g. "Sterisil Ac+"). In addition, none of the products uses HINS rays. All of this justifies the uniqueness and innovativeness of a newly developed product

Table 2. Disinfectants and their description

Product's name and composition	Concentration	Exposition	Notes
Bacticid (the product contains 72% ethanol, two quaternary ammonium compounds, surfactants)	–	3 minutes	For quick disinfection of surfaces not contaminated with blood or other biological fluids
Alcohol wipes *Top Off* (impregnated with alcoholic propanol, ethanol solution, disinfectant)	–	1 minute	For quick disinfection of surfaces not contaminated with blood or other biological fluids
Betaguard (didecyldimethylammonium chloride)	3%	15 minutes	For all surfaces
Incidin Plus (glucoprotamine)	2%	15 minutes	For medical surfaces
Anios Oxy'Floor (mixture of sodium carbonate and hydrogen peroxide (2:3), N,N-ethylenebis [N-acetylacetamide], Benzyl-C12-C14-alkyldimethyl chloride, benzalkonium chloride)	0.5%	15 minutes	For medical surfaces
Chlor-clean	1 tablet per 1 litter of water	15 minutes	For medical surfaces
Klorsept 87 (troclosene sodium)	1 tablet per 5 litters of water	60 minutes	For non-medical surfaces

which is going to integrate multi-level protection functions and innovative technologies (HINS rays) in terms of COVID-19 virus prevention (Meselson, 2020).

The market segmentation process involves identifying the relevant segmentation characteristics and target segments, and establishing a positioning strategy. Marketing segmentation studies allow to identify the demographic profile of a product user, choice priorities and the problems faced by the target group. It also shows how users evaluate the product, what channels they use to purchase the product, how to attract attention of the target group, how important the brand is to a user, and so forth.

Market segmentation is division of the market into separate groups of users according to their needs, features and behavioural characteristics.

Attractiveness of a market segment is assessed on the basis of the following criteria: a segment size, a segment growth rate, intensity of competition, stability and economies of scale (Kotler et al., 2003). Market segmentation for the product under development is provided in Table 3. The product is expected to be used by business companies.

Table 3. Market segmentation for the product under development

Activity area	Geographical area	Consumption intensity	Company size	Product application
Dentistry	EU	Used in service provision on a continuous basis	SMEs	Specific application in dental service provision
Cosmetology	EU	Used in service provision on a continuous basis	SMEs	Specific application in cosmetology service provision

Conclusions

COVID-19 is highly contagious and spreads rapidly in society. The epidemiological situation in Lithuania and worldwide remains complicated. SARS-CoV-2 can cause serious illnesses with as yet unknown long-term consequences in people of all ages. A part of patients die. At present, pending antiviral drug search and clinical trials, it is recommended that patients with COVID-19 be treated with an antiviral drug belonging to the nucleotide analogue group, remdesivir, the interleukin-6 receptor antagonist tocilizumab, corticosteroids, anticoagulants, oxygen therapy, etc., depending on the severity of the disease. To protect public health, especially healthcare professionals and vulnerable groups such as the elderly or the chronically ill, effective and safe vaccines against COVID-19 are used. The exact duration of immunity after vaccination as well as the need for revaccination are not yet known. Dental procedures are directly related to the close contact between a patient and a dentist, and formation of an aerosol. The greatest risk of aerosol infection in dentistry is caused by particles with a diameter of less than 50 mkm due to their ability to remain in the air and enter the respiratory tract. Viruses in the aerosol can be destroyed by using chemical gas and other air sterilization methods such as: using ozone, ionized air, photocatalytic oxidation, hydrogen peroxide vapours, HEPA filters, etc. Ultraviolet rays are suitable for disinfecting surfaces, air and liquids. They destroy viruses, damaging not only nucleic acids, but also proteins. The effectiveness depends on the radiation intensity, duration and relative humidity. For viruses in the air, the lethal dose of ultraviolet light is lower than for those on surfaces. Most sources of ultraviolet rays emit UVC waves with a length of approximately 254 nm. These rays are harmful to the skin and eyes. SARS-CoV-2 can be detected not only in sick individuals or carriers, but also in the environment. Air samples are usually taken in patients' treatment rooms (wards). The major source of

aerosol is a human. There is no single device that could serve as a "golden standard for collecting viral aerosols". A very convenient portable *Sartorius MD8* aerosol sampler with gelatine filters has been used in a number of studies recently. After dissolution of the gelatine filter, 1 mL of virus transport medium is collected and used for nucleic acid extraction and real-time PCR. Sampling from surfaces is conducted by using two or three sterile disposable swabs.

In the event of a global pandemic, all products developed for pandemic management are automatically entering or accelerating their entry into the global market.

The market segment of the newly developed product covers the range of services provided by dentists, cosmetologists and ENT physicians. It will focus on small and medium-sized enterprises and specialized units of large enterprises.

References

Amin, S. H., Razmi, J., & Zhang, G. (2011). Supplier selection and order allocation based on fuzzy SWOT analysis and fuzzy linear programming. *Expert Systems with Applications*, *38*(1), 334–342. https://doi.org/10.1016/j.eswa.2010.06.071

Deng, W., Bao, L., Gao, H., Xiang, Z., Qu, Y., Song, Z., Gong, S., Liu, J., Liu, J., Yu, P., Qi, F., Xu, Y., Li, F., Xiao, C., Lv, Q., Xue, J., Wei, Q., Liu, M., Wang, G., Wang, S., Yu, H., Liu, X., Zhao, W., Han, Y., & Qin, C. (2020). Rhesus macaques can be effectively infected with SARS-CoV-2 via ocular conjunctival route. *bioRxiv*. https://doi.org/10.1101/2020.03.13.990036

Elias, C., Sekri, A., Leblanc, P., Cucherat, M., & Vanhems, P. (2021). The incubation period of COVID-19: A meta-analysis**.** *International Journal of Infectious Diseases*, *104*, 708–710. https://doi.org/10.1016/j.ijid.2021.01.069

Galbadage, T., Peterson, B. M., & Gunasekera, R. S. (2020). Does COVID-19 spread through droplets alone? *Frontiers in Public Health*, *8*, 163. https://doi.org/10.3389/fpubh.2020.00163

Han, Q., Lin, Q., Jin, S., & You, L. (2020). Recent insights into 2019-nCoV: A brief perspective from the front line. *Journal of Infection*, *80*(4), 373–377. https://doi.org/10.1016/j.jinf.2020.02.010

Hoehl, S., Rabenau, H., Berger, A., Kortenbusch, M., Cinatl, J., Bojkova, D., et al. (2020). Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. *New England Journal of Medicine*, *382*, 1278–1280. https://doi.org/10.1056/NEJMc2001899

Hoffmann, M., Kleine-Weber, H., Schroede, S., Krüger, N., Herrler, T., Erichsen, S., Schiergens, T. S., Herrler, G., Wu, N.-H., Nitsche, A., Müller, M. A., Drosten, C., & Pöhlmann, S. (2020). SARS-CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor. *Cell*, *181*(2), 271–280. https://doi.org/10.1016/j.cell.2020.02.052

Holshue, M. L., DeBolt, C., Lindquist, S., Lofy, K. H., Wiesman, J., Bruce, H., Spitters, C., Ericson, K., Wilkerson, S., Tural, A., Diaz, G., & Cohn, A. (2020). First case of 2019 novel Coronavirus in the United States. *New England Journal of Medicine*, *382*, 929–936. https://doi.org/10.1056/NEJMoa2001191

Kampf, G., Todt, D., Phaender, S., & Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of Hospital Infection*, *104*(3), 246–251. https://doi.org/10.1016/j.jhin.2020.01.022

Khalili, M., Karamouzian, M., Nasiri, N., Javadi, S., Mirzazadeh, A., & Sharifi, H. (2020). Epidemiological characteristics of COVID-19: A systematic review and meta-analysis. *Epidemiology and Infection*, *148*, e130. https://doi.org/10.1017/S0950268820001430

Kotler, P., Armstrong, G., Saunders, J., & Wong, W. (2003). *Rinkodaros principai* [Marketing principles]. Poligrafija ir informatika.

Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., Ren, R., Leung, K. S. M., Lau, E. H. Y., Wong, J. Y., Xing, X., & Xiang, N. (2020). Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *New England Journal of Medicine*, *382*, 1199–1207. https://doi.org/10.1056/NEJMoa2001316

Lu, C. W., Liu, X. F., & Jia, Z. F. (2020a). 2019-nCoV transmission through the ocular surface must not be ignored. *Lancet*, *395*(10224), e39. https://doi.org/10.1016/S0140-6736(20)30313-5

Lu, R., Zhao, X., Li, J., Niu, P., Yang, B., Wu, H. et al. (2020b). Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet*, *395*(10224), 565–574. https://doi.org/10.1016/S0140-6736(20)30251-8

Meselson, M. (2020). Droplets and aerosols in the transmission of SARS-CoV-2. *New England Journal of Medicine*, *382*, 2063. https://doi.org/10.1056/NEJMc2009324

Onder, G., Rezza, G., & Brusaferro, S. (2020). Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. *JAMA*, *323*(18), 1775–1776. https://doi.org/10.1001/jama.2020.4683

Perlman, S. (2020). Another Decade, another coronavirus. *New England Journal of Medicine*, *382*, 760–762. https://doi.org/10.1056/NEJMe2001126

Rodriguez-Morales, A. J., Cardona-Ospina, J. A., Gutiérrez-Ocampo, E., Villamizar-Peña, R., Holguin-Rivera, Y., Escalera-Antezana, J. P., et al. (2020). Clinical, laboratory and imaging features of COVID-19: A systematic review and meta-analysis. *Travel Medicine and Infectious Disease*, *34*, 101623. https://doi.org/10.1016/j.tmaid.2020.101623

Rothe, C., Schunk, M., Sothmann, P., Bretzel, G., Froeschl, G., Wallrauch, C., et al. (2020). Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *New England Journal of Medicine*, *382*, 970–971. https://doi.org/10.1056/NEJMc2001468

Su, S., Wong, G., Shi, W., Liu, J., Lai, A. C. K., Zhou, J., et al. (2016). Epidemiology, genetic recombination, and pathogenesis of Coronaviruses. *Trends in Microbiology*, *24*(6), 490–502. https://doi.org/10.1016/j.tim.2016.03.003

Van Doremalen, N., Bushmaker, T, Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., et al. (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New England Journal of Medicine*, *382*, 1564–1567. https://doi.org/10.1056/NEJMc2004973

Wax, R. S., & Christian, M. D. (2020). Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients. *Canadian Journal of Anesthesia*, *67*, 565–578. https://doi.org/10.1007/s12630-020-01591-x

Weiss, S. R., & Leibowitz, J. L. (2011). Coronavirus pathogenesis. In K. Maramorosch, A. J. Shatkin, & F. A. Murphy

(Eds.), *Advances in virus researc*h (pp. 85–164). Academic Press. https://doi.org/10.1016/B978-0-12-385885-6.00009-2

Woo, P. C., Huang, Y., Lau, S. K., & Yuen, K. Y. (2010). Coronavirus genomics and bioinformatics analysis. *Viruses*, *2*(8), 1804–1820. https://doi.org/10.3390/v2081803

World Health Organization. (2020). *Director-General's remarks at the media briefing on 2019-nCoV on 11 February 2020*. http://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-february-2020

World Health Organization. (2021). *WHO Coronavirus Disease (COVID-19) Dashboard*. Retrieved March 18, 2021 from https://covid19.who.int/

Wu, F., Zhao, S., Yu, B., Chen, Y., Wang, W., Song, Z. G., Hu, Y., Tao, Z.-W., Tian, J.-H., Pei, Y.-Y., Yuan, M.-L., Zhang, Y.-L., Dai, F.-H., Liu, Y., Wang, Q.-M., Zheng, J.-J., Xu, L., Holmes, E. C., & Zhang, Y.-Z. (2020). A new coronavirus associated with human respiratory disease in China. *Nature*, *579*, 265–269. https://doi.org/10.1038/s41586-020-2008-3

Yu, J., Chai, P., Ge, S., & Fan, X. (2020). Recent understandings toward Coronavirus disease 2019 (COVID-19): From Bench to Bedside. *Frontier in Cell and Development Biology*, *8*, 476. https://doi.org/10.3389/fcell.2020.00476

Zhai, S. L., Wei, W. K., Lv, D. H., Xu, Z. H., Chen, Q. L., Sun, M. F., et al. (2020). Where did SARS-CoV-2 come from? *Vet Rec*ord, *186*(8), 254. https://doi.org/10.1136/vr.m740

Zhao, Y., Cui, C., Zhang, K., Liu, J., Xu, J., Nisenbaum, E., et al. (2020). COVID19: A systematic approach to early identification and healthcare worker protection. *Frontier in Public Health*, *8*, 205. https://doi.org/10.3389/fpubh.2020.00205

Zhou, P., Yang, X. L., Wang, X. G., Hu, B., Zhang, L., Zhang, W., et al. (2020). A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*, *579*, 270–273. https://doi.org/10.1038/s41586-020-2012-7

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., Zhao, X., Huang, B., Shi, W., Lu, R., Niu, P., Zhan, F., et al. (2020). A novel coronavirus from patients with pneumonia in China, 2019. *New England Journal of Medicine*, *382*, 727–733. https://doi.org/10.1056/NEJMoa2001017

Zou, L., Ruan, F., Huang, M., Liang, L., Huang, H., Hong, Z., et al. (2020). SARS-CoV-2 viral load in upper respiratory specimens of infected patients *New England Journal of Medicine*, *382*, 1177–1179. https://doi.org/10.1056/NEJMc2001737