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## Response of forensic scientific community to Covid-19 pandemic: A Review Article

استجابة المجتمع العلمي لعلوم الأدلة الجنائية لجائحة فيروس كورونا المستجد Covid-19: مراجعة

علمية

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### Abstract

The purpose of this review was to show the impact of the Covid-19 pandemic on forensic science as reflected in the publications, which appeared in 2020. The review covered following topics: response of legal medical experts on the increased daily workload in forensic practice and enhanced risk issues arising in forensic practice, particularly regarding autopsy, drugs used in Covid-19 therapy and their toxicological significance, and influence of the Covid-19 pandemic on the profile and extent of substance abuse.

### المستخلص

تهدف هذه المراجعة العلمية إلى بيان تأثير جائحة كوفيد-19 على علوم الأدلة الجنائية تبعًا لما عكسته المقالات العلمية التي نشرت خلال عام 2020م. حيث غطى هذا المقال الموضوعات التالية: تصدي الخبراء الطبيين القانونيين لعبء العمل اليومي الزائد المتعلق بالقضايا ذات الصلة بالممارسات الجنائية، والمخاطر المتفاقمة الناشئة في الممارسات الجنائية، لا سيما ما يتعلق بتشريح الجثث، والعقاقير المستخدمة في علاج كوفيد-19 ودلالاتها السمية، وتأثير جائحة كوفيد-19 على منظور ومدى تعاطي مواد الإدمان.

**Keywords:** Forensic Science, COVID-19 Pandemic, Forensic Medicine in Pandemic, Substance Abuse in Pandemic.

**الكلمات المفتاحية:** علوم الأدلة الجنائية، جائحة كوفيد-19، الطب الشرعي، تعاطي مواد الإدمان.



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## 1. Introduction

The Covid-19 pandemic, which until December 2020 had affected over 59 million people in the whole world and caused the death of 1.4 million inhabitants of our planet, exerted influence on all aspects of human activity and life. Forensic medicine, forensic toxicology, and related areas were very much involved in this dramatic issue and the scientific and practical activities of these disciplines were affected by the pandemic.

The impact of the Covid-19 pandemic on forensic disciplines was reflected in reviewed publications, which appeared in 2020 (until December). The authors of statistical reports generally covered the period from January to June 2020, whereas the publications on future aspects, sequelae of the pandemic and warnings concerned the population of COVID-19 survivors and the future impact on its physical and mental health.

The review is divided into following sections:

- Section 1: Response of medicolegal experts on the increased daily workload in forensic practice and enhanced risk issues arising in forensic practice, particularly regarding autopsy.
- Section 2: Drugs used in Covid-19 therapy and their toxicological significance.
- Section 3: Influence of Covid-19 pandemic on the profile and extent of substance abuse.

For each section, following types of publications were reviewed: Experimental data, regional, national, and international statistics, reviews, position papers of international and national forensic organizations, as well as personal views and recommendations.

## 2. Response of medicolegal experts on the increased daily workload in forensic practice and enhanced risk issues in forensic practice, particularly regarding autopsy

### 2.1. Statistical considerations and presumptions

Violent death cases, particularly homicides, cause the most serious burden to forensic medical work. American authors [1] analyzed monthly homicide rates in 64 cities, as reported from January-June 2020, with the corresponding data from three previous years. The total population involved was 53.2 million, i.e. 16% of the US population. Homicide rates increased from January to March, but decreased in the next months, when the social restrictions were eased. The authors predicted that in future months the homicide rates might increase, due to relaxation of social distancing, exhausting of social and preventing resources, as well as cessation of support for unemployed.

The other group of American authors [2] investigated the impact of social distancing on the volume and distribution of crime in two big cities: Los Angeles and Indianapolis. As an indicator of crime rate the daily counts of calls for service (CFS) was chosen, and the data were collected from January to April 2020. A distinct increase in domestic violence cases was noted, and significantly less cases of burglary, vandalism, and traffic stops. This report did not mention homicides and suicides.

Peruvian authors [3] investigated the influence of the lockdown strategy on violent death cases, including homicide, suicide, and fatal traffic accidents. The data from the Peruvian National Death Information System were analyzed, as collected from January 1 until June 28, 2020. The introduction of lockdown was associated with a sharp decrease in all kinds of death cases, particularly of traffic accidents. Homicides and suicides showed similar decrease in women, while the homicide number dropped more distinctly in male population. The impact on road traffic accidents was easy



to interpret since people are not exposed to this risk during lockdown measures. However, the reason for decrease in suicide and homicide cases was less obvious.

In an Australian study, [4] violent crime rates (common assault, serious assault, sexual offence, and domestic violence) were recorded for the month of March 2020, as reported for the state of Queensland, Australia. Queensland was chosen because it was the first state or territory in Australia to declare a public health emergency, and serious restrictions in commercial and educational activities were introduced by law and followed by the local population. The rates were compared with the forecasts for this area and significantly different results were not observed. The results should be treated with caution since the results presented were based on recorded crime data, while a significant proportion of violent crime goes unreported to police.

Several authors presented their view – mainly from forensic psychiatric or psychological perspectives - on the future development of crime profiles and intensity during the pandemic as well as influence on pandemic survivors. From the New Zealand perspective, Standish [5] presumed that suicides may increase after a pandemic due to the intensity of lockdown. Male population might be particularly at risk, since it already comprises 75% of completed suicides and may respond to rising rates of substance use, unemployment, anxiety, and isolation with intentional killing. Also, the survivors of the pandemic might be at higher risk of suicidal or suicidal-homicidal violence. A similar problem was discussed by other authors from the US point of view. Sher [6] analyzed the possible impact of the COVID-19 pandemic of suicide rates from the psychological and psychiatric

perspective. Profound psychological and social effects of the COVID-19 pandemic will probably persist for an exceedingly long time. This concerns such disturbances as distress, anxiety, fear of infection, depression, and insomnia, and may affect both the general population and healthcare professionals. This may also lead to the development of drug misuse and abuse. Suicide risk among COVID-19 survivors may be elevated. The author postulated active psychiatric countermeasures for potentially affected people. Similarly, Joiner et al., [7] stressed that the pandemic raised concerns about an increased risk for psychological distress and suicide mortality. Researchers, clinicians as well as politicians should be warned about possible increases in violent crime as sequelae of the COVID-19 pandemic. The onset of the pandemic was associated with the reports of increased gun and alcohol sales, domestic partner violence and child abuse.

## **2.2. Safety and logistics issues in forensic medical experts' work in COVID-19 environment**

The group of experts from India, France, Norway, Sweden, and Finland published a “roadmap to the safe practice of forensic medicine in the COVID-19 pandemic” [8]. Since the potential for contracting the virus from working in close contact with patients is known, the risk of infection from the deceased requires full recognition. This article presents the guidelines for forensic pathologists involved in COVID-19 pandemic cases. These guidelines concern following points: Case definitions, risk reduction during autopsy in COVID-19 suspected cases, associated clinical syndromes and pathological features, safe approach to the autopsy in suspected cases, infection prevention control of mortuary workers as well as the gen-



eral society. The need for systematic autopsies during the pandemic was underlined. Lack of detailed knowledge of the postmortem transmission of the SARS-CoV-virus caused the forensic and clinical pathology staff members reluctance to perform post-mortem examinations of possibly infected corpses. The appropriate protective equipment and dedicated autopsy facilities should be available for the safe postmortem examinations, including tissue sampling. Systematic tissue sampling offers unique material for detailed study of the pathogenesis of COVID-19 using state-of-the-art laboratory technologies. The guidelines of the proposed roadmap comprise following points: Case definition (suspected or confirmed), removal of the body and transportation, safe autopsy requirements, safe sample collection for laboratory examinations, and biomedical waste disposal.

Italian authors [9] presented a review (89 references), which aims to analyze the diagnostic techniques (including autopsy) used to diagnose the COVID-19 infection postmortem. Virus nucleic acid RT-PCR is the standard method used to prove the COVID-19 infection both in living subjects and corpses. The staff should be trained in safety protocols, and able to handle high workloads. The problems with new serological tests is that the WHO recommends their use only in research settings, and nothing has yet been published regarding the applicability for postmortem samples. The authors proposed a flow chart for the pathologist performing postmortem examination of a subject with antemortem findings of COVID-19 status or without any previous information.

Forensic scientists from the Madrid's Institute of Legal Medicine and Forensic Sciences [10] described the measures adopted to fulfill three tasks: To avoid the collapse of the Pathology Department

due to overwhelming amount of work, to prevent the risk of virus exposure to the personnel, and to meet the recommendations of the authorities in the emergency and lockdown phase. Procedure for processing corpses during COVID-19 was developed, and a crisis group was organized, which composed of the leadership of the Institute, local medical, infrastructure, justice, and civil defense authority representatives. All agreements, communications, recommendations, and instructions for the forensic personnel were described. The paper shows that the number of death cases for the period from 9 March to 20 April 2020, compared with the same period in 2019, raised dramatically, with the peak at the end of March, whereas the number of violent death cases for the same period decreased. Another Spanish group [11] reviewed the aspects of the pathophysiology of the disease having an impact on the postmortem infectivity of the body's tissues and fluids. The people who had died from violent or unknown causes should be considered as antemortem infected by the virus SARS-CoV-2. Postmortem diagnosis of the infection has legal implications, which requires appropriate protective measures and sampling. The practice of autopsies on people who have died from COVID-19 has been limited by the mandatory preventive measures and by the need for facilities with an adequate level of protection against biological risk. Therefore, cases published to date are scarce and partial, with limited approaches (minimally invasive autopsy or needle biopsy).

According to Chinese authors [12] autopsy is of primary importance for recording the pathological changes and elucidating the cause of death of COVID-19 and can provide a theoretical basis for the prevention and control of pandemic outbreak. On the base of laws and regulations, clinical man-



ifestations and epidemiological characteristics of COVID-19 and guidelines on the prevention and control of this epidemic, combined with the practical work of forensic pathology examinations, the Guide to Forensic Pathology Practice for Death Cases Related to Coronavirus Disease 2019 (COVID-19) was developed (Trial Draft). This guide systematically describes the background investigation of the death cases, autopsy room requirements, personal prevention and protections, external examinations, autopsy practices and auxiliary examinations, and thus offers a reference for forensic and pathological examination of institutions and staff.

Indian authors [13] discussed the necessity of “needless autopsies” in the time of COVID-19 pandemic. The “needless autopsies” are those, which are performed in cases where cause of death can be easily diagnosed without autopsy. It concerns such cases as death cases occurring in hospital after fatal injuries caused by accidents, homicide, or suicide attempts. To prevent the medical care workers from possible infection, the authors propose in such cases to apply non-invasive or minimally invasive autopsy techniques or performing partial autopsy or even no autopsy at all.

The potential use of virtual autopsy, as a safer alternative to classic one in the case of COVID-19 infected subjects has been discussed. Virtual autopsy has unique advantages in the forensic examination of patients who died of infectious diseases. Accumulated virtual autopsy imaging data are of great value to the study of the pathological mechanism and diagnosis of COVID-19. Virtual autopsy has been suggested as an effective alternative to high-risk traditional autopsy procedure. It can be employed independently in forensic examination of the dead or as an addition to conventional autop-

sy, over which it has numerous advantages. Chinese authors [14] examined the imaging changes in postmortem material in relation to pathology of the COVID-19. They provided reference data for performing virtual autopsy in the outbreak of COVID-19. Kanchan et al., [15] stressed that medico-legal autopsy in COVID-19 deaths is a high-risk procedure and should be avoided whenever possible. In the absence of virtual autopsy facilities for post-mortem examination, portable X-ray and ultrasonography machines can be used. It may be possible to arrange for the use of CT and MRI facilities that are available in the hospital.

### **3. Drugs used in Covid-19 therapy and their toxicological significance**

#### **3.1. Drugs used in COVID-19 therapy and their efficacy.**

The group of Romanian scientists [16] presented an in-depth review of repurposed drug admitted for use in the treatment of COVID-19. The drugs were selected on the base of their chemical structure and biological activity, highlighting the absorption, distribution, metabolism, and excretion properties and the biologically active groups linked to potential adverse effects. A detailed pharmacological description of the novel potential anti-COVID-19 therapeutics was included. Following groups of drugs used in treatment were reviewed: broad-spectrum antivirals (Remdesivir, Lopinavir/Ritonavir, Oseltamivir, and others), antimalarial drugs (Chloroquine and Hydroxychloroquine), anti-inflammatory compounds (Baricitinib, Bedratinib, Ruxolitinib, Sunitinib), anti-coagulants (low molecular weight Heparin, unfractionated Heparin), convalescent plasma, and novel potential antivirals (vaccines, anti-SARS-CoV-2 antibodies, and natural compounds). At the time of review (June 2020), Remdesivir was considered the



most promising therapy for SARS-CoV-2 infection being already included in the interim guidelines for COVID-19 treatment. Chloroquine and hydroxychloroquine were recommended for compassionate use in mild-to-moderate (as single treatment option) and in severely and critically ill forms of COVID-19. The authors stressed that the clinical effectiveness of above-mentioned drugs as anti-COVID-19 agents was debatable at this point (June 2020).

This reservation in the final assessment of the efficacy of remdesivir and chloroquine turned out to be true. In the international study coordinated by WHO, the results of treatment with remdesivir, hydroxychloroquine, lopinavir, and litonavir, were assessed [17]. These observations were performed in 405 hospitals in 30 countries. 11,266 adults were randomized, with 2750 allocated remdesivir, 954 hydroxychloroquine, 1411 lopinavir, 651 interferon plus lopinavir, 1412 only interferon, and 4088 no study drug. No studied drug definitely reduced mortality, initiation of ventilation or duration of hospital stay. It was concluded that remdesivir, hydroxychloroquine, lopinavir and interferon regimens appeared to have little or no effect on hospitalized COVID-19 cases. This represents some of the strongest evidence yet that remdesivir is unlikely to be the life-saving drug for the masses that many have hoped for.

Hsu [18] recently scrutinized the results of studies on the use of remdesivir in COVID-19 therapy. None of the published randomized controlled trials have shown that remdesivir saves significantly more lives than standard medical care. The World Health Organization's Solidarity trial [17] has published interim results showing that the drug has no significant impact on mortality, length of hospital stays, or need for ventilation among hospitalized patients. Hsu advocated the use of the well-known, cheap, and widely available corticosteroid dexamethasone,

which has been proved to reduce mortality among severely ill COVID-19 patients who were either on ventilators or receiving oxygen. Given the apparent benefit of dexamethasone to reducing mortality in some cases, the studies testing remdesivir effectiveness given in conjunction with corticosteroids are required. Gilead (company which developed remdesivir) published a statement that attempted to cast doubt on the Solidarity trial because of its open label design that allows physicians and patients to know who is taking remdesivir.

Abd-Elsalam [19] evaluated the safety and efficacy of hydroxychloroquine added to standard care in patients with COVID-19. This was a multicenter, randomized controlled trial conducted at three major university hospitals in Egypt. One hundred ninety-four patients with confirmed diagnosis of COVID-19 were included in the study. It was concluded that hydroxychloroquine treatment did not decrease the need for ventilation and did not significantly decrease mortality among COVID-19 patients.

Apart of above-mentioned compounds, other drugs were proposed as potentially useful in the therapy of COVID-19 patients. Dominguez-Rodriguez et al., [20] and Hardeland et al., [21] recommended the study on the use of melatonin as protective agent because of its anti-inflammatory and antioxidant properties. The body of knowledge on melatonin's efficacy in respiratory diseases is encouraging for the use of this powerful agent in COVID-19. Iranian authors proposed a rather unusual treatment; they opted for the study on the use of opioids and cannabinoids in treatment of COVID-19 patients, but without any experimental or clinical evidence [22].

### 3.2. Adverse, toxicologically relevant effects of



### drugs used in COVID-19 therapy.

Several groups of authors reported important influence of antiviral therapy on the pharmacokinetics of immunosuppressive drugs used in transplant medicine. Ziip et al., [23] observed that transplant recipients receiving cyclosporine and tacrolimus developed severe illness when infected with the new coronavirus disease (COVID-19). Two of the proposed drug regimens for the treatment of this disease, lopinavir/ritonavir and chloroquine, could seriously affect the efficacy and safety of immunosuppressive therapy. Ritonavir is an inhibitor of cytochrome P450 isoform 3A (CYP3A). This enzyme limits the uptake of numerous drugs in the intestine and accelerates hepatic drug clearance. The clinical consequence of CYP3A inhibition by ritonavir is a strong increase in the biological availability and half-life of tacrolimus and cyclosporine. A study in healthy subjects showed a 57-fold higher tacrolimus exposure, whereas cyclosporine exposure showed a 6-fold increase. Sirolimus and everolimus concentrations are also expected to increase when used in combination with ritonavir. To prevent serious clinical toxicity, drug monitoring and dose adjustment for tacrolimus and cyclosporine is essential. Also, Tacrolimus exposure might be affected by Chloroquine in the same manner. Bartiromo et al., [24] reported the case of a 36-year-old kidney-transplanted woman diagnosed with COVID-19 pneumonia without need for oxygen supplementation. Hydroxychloroquine and lopinavir/ritonavir treatment was started, and the antiviral drug was replaced with Darunavir/Cobicistat after 2 days for diarrhea. Immunosuppressant level-monitoring showed extremely high tacrolimus trough level. The patient was left with steroid therapy alone. The authors stressed the need for guidelines in transplant recipients with COVID-19 infection. Also, Meziyerh et al., [25] reported highly elevated everolimus concentrations

in a renal transplant recipient, after treatment of COVID-19 pneumonia with chloroquine and lopinavir/ritonavir. All these case reports raise awareness for pharmacokinetic interactions between experimental COVID-19 therapy and maintenance of immunosuppression in the particularly vulnerable population of transplant patients.

A patient with COVID-19 was treated at first with chloroquine and later with remdesivir and amiodarone. He developed acute hepatotoxicity, caused probably by the interaction of Remdesivir with P-glycoprotein (P-gp) inhibitors chloroquine and amiodarone. The combination of these agents probably increased the intrahepatocellular concentration above the toxicity threshold, causing the hepatocellular toxicity. No studies investigating the influence of P-gp inhibition on remdesivir-mediated hepatotoxicity have been performed yet. However, the physicians prescribing P-gp inhibitors in patients receiving remdesivir therapy should be cautious.

Russo et al., [27] reviewed the literature on the pharmacological interactions between cardiovascular drugs more commonly used in atrial fibrillation management and experimental COVID-19 therapies, based on EU and US summaries of product characteristics. A review [28] assessed the risk of drug–drug interactions in the severely ill COVID-19 patients. Experimental therapies were identified by searching ClinicalTrials.gov. As of 30 June 2020, a total of 2378 clinical trials were retrieved from ClinicalTrials.gov. 249 drugs from ClinicalTrials.gov met the inclusion criteria. The drugs listed included 27 antivirals, 48 immunotherapy drugs, 5 antimalarial drugs, 6 glucocorticoids and 163 miscellaneous compounds with different modes of action. The following 13 drugs were taken forward for analysis of drug–drug interactions: anakinra, baricitinib, chloroquine, favipiravir hydroxychloroquine, interferon  $\beta$ , lopinavir/ritonavir, nitazoxanide, remdesivir, ribavi-



rin, ruxolitinib, sarilumab and tocilizumab.

Acc. to Kostoff et al (29), COVID-19 and previous pandemics have been viewed almost exclusively as virology problems, with toxicology problems mostly being ignored. However, in the real-life situation, the exposure to SARS-CoV-2 virus is combined with the exposition to multiple toxic stressors affecting the immune system. This mixed exposure may increase the possibility of complications, and mortality associated with COVID-19. For the short-term, virology-focused treatments are of higher priority than proactive toxicology-focused treatments. For long-term pandemic prevention, a toxicology-based approach should be given higher priority than a virology-based one.

The omnipresence of the SARS-CoV-2 virus in the environment as well as massive therapeutic measures are reflected in the pollution of the aquatic compartments. Race et al., [30] provided an overview of possible implications on the quality of aquatic compartments due to the recent SARS-CoV-2 outbreak. The methodologies for detection of coronaviruses persistence in wastewater were reviewed, as well as potential harmful impact of antiviral drugs on aquatic living organisms. The environmental impacts are mainly related to the virus persistence in sewage and wastewaters, and possible contamination of aquatic compartments with drugs used in treatment of SARS-CoV-2 infected patients. This report provides an up-to-date knowledge on the topic of the influence of COVID-19 pandemic on the aquatic environment and may be useful for environmental toxicologists.

#### **4. Influence of Covid-19 pandemic on the profile and extent of substance abuse.**

Implementation and enforcement of extraordinary changes in everyone's life is not something "obvious" and "automatic". Such an enforcement

cannot be taken for granted but requires a strong effort of adaptation and the active participation of all people, including drug users. Social distancing and quarantine can be particularly challenging for addicts, especially for illegal substance addicts. Forced isolation and difficulties in moving around and obtaining illegal substances can impact the behavior of drug abusers, and the profile of substances used as well. Pandemic conditions are pushing more people toward illicit substance use, and it may create a welcome opportunity for drug dealers to attract potentially new customers. On the other hand, global limitations in travel and goods transportation due to pandemic are not favoring the usual, "classic" trade business. This may have impact on the profile of abused substances and may reduce drug trafficking on the streets, pushing consumers toward illegal markets on obscure internet pages. This problem was reflected in several studies at the international and national level as well as recommendations from international organizations.

Two organizations: The European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) in Europe, and the National Institute on Drug Abuse (NIDA) in USA, first raised concerns about the enhanced vulnerability of people with substance use disorders to COVID-19, especially because of the effects of such drugs as opiates, synthetic opioids, and methamphetamine on the respiratory system and lung function [31]. Drug users are at particular risk of respiratory distress and consecutive fatal complications if infected with COVID-19 due to the high prevalence of chronic diseases of respiratory tract. Smoking heroin or crack cocaine may cause asthma and chronic obstructive pulmonary disease. Moreover, people using prescription opioids in high doses may experience additional challenges for their respiratory function. Respiratory-depressant effects on action of opioids on the central nervous



system is well known, and high doses may cause severe hypoxemia, and in consequence may lead to irreversible brain damage. The incidence of cardiovascular diseases among opiates, opioids, and cocaine users is high, which aggravates the risk. EMCDDA and NIDA recommended that awareness action should be developed, and response activities on national and international level should be coordinated, related to the impact of pandemic on drug abuse, its profiles, and trends.

International Society of Addiction Medicine (SAM), represented by the group of experts (from 10 countries) on addiction medicine, infectious diseases, and disaster psychiatry, published recommendations concerning the dangers and prevention of substance use disorders during COVID-19 (32). The problem of the comorbidity of pandemic and substance use was analyzed. Drug users are at increased risk due to stigmatization and marginalization. They usually live in crowded places, are more vulnerable to mental health problems. Their medical conditions such as respiratory illness, renal insufficiency, chronic pain, and cardiovascular disorders have influence of the morbidity and should be addressed.

Dos Santos et al., [33] presented Brazilian perspective on the changes in the profiles of acute poisoning associated with the outbreak of COVID-19 in Brazil. The data were collected from Toxicological Information Center of Rio Grande do Sul, from March to July 2019 and from March to July 2020. The frequencies of intoxications with anticonvulsants, antidepressants, antipsychotics, benzodiazepines, and recreational drugs were compared for the two observation periods mentioned. Generally, the highest rise was observed for alcohol intoxication, from 94 to 137 cases (+45.7%) and for cocaine, from 62 to 91 cases (+46.8%). A substantial increase was also found for other substances such as marijuana which

rose from 17 to 27 cases (+58.8%) and ecstasy/MDMA, from 5 to 9 cases (+80.0%). Unlike for recreational drugs, intoxication with prescription drugs used for psychiatric treatment, particularly with antidepressants, showed a decrease during pandemic. The number of suicide attempts decreased by 10%. These data are in contrast with opinions of psychiatrists from other countries, who warned about enhanced risk of suicides with antidepressants.

Rodda et al., [34] analyzed the frequency of fatal overdose cases in San Francisco during the first four months of pandemic. The Office of the Chief Medical Examiner dealt with 459 death cases in the first 109 days of the 2020; 121 cases were opioid-related accidental overdoses; 95 were related to fentanyl, 13 to heroin, and 13 cases concerned fentanyl and heroin in combination. Majority (82%) of the victims were males in median age of 45 years. 1.47 deaths per day were registered from March 16 to April 18, and before this period, only 0.95 death cases per day were noted. The authors concluded that the number of deaths related to opioid overdose may increase during an isolation period caused by the pandemic.

A large US retrospective case-control study of electronic health records (EHRs) was performed [35]. Data from 50 states, collected on 15 July 2020, comprised 73,099,850 patients, and 12,030 had a diagnosis of COVID-19. Patients with a recent diagnosis of substance use disorder (within past year) were at significantly increased risk for COVID-19. This effect was strongest for opiate abusers, followed by individuals addicted to tobacco. Generally, patients abusing substances had significantly higher prevalence of chronic kidney, liver, lung diseases, cardiovascular diseases, type 2 diabetes, obesity, and cancer. Concerning patients abusing substances, African Americans had significantly higher risk of COVID-19 than Caucasians, with strongest ef-



fect observed for opiate abusers. The study findings indicate that individuals with substance abuse disorder, particularly with opiate abuse, and African Americans, have increased risk for COVID-19 and its severe outcomes, like hospitalization and death. In similar but more local study [36] the change in drug overdoses during the COVID-19 pandemic was described. The data from one urban emergency medical services (EMS) system, located in Marion County, Indiana (Indianapolis) were analyzed. The data included calls for service (CFS) for suspected overdose, CFS in which Naloxone was administered, and fatal overdose data from the County Coroner's Office. The daily frequency of all calls and the rate of fatal overdose cases increased when the Indiana stay-at-home order was introduced in Indiana and continued to increase after the stay-at-home order was terminated. The authors postulated implementation of special strategies to be applied during social isolation period and its suspension. Another published study based on the analysis of EMS data concerned Kentucky [37]. The changes in the average daily EMS interventions for opioid overdose between January 14, 2020 and April 26, 2020 were analyzed. A 17% increase in the number of EMS opioid overdose runs with transportation to an emergency department was noted, runs with refused transportation increased by 71%, and a 50% increase in suspected fatal opioid overdoses was observed. This study, although locally specific, gives further evidence that COVID-19 pandemic is associated with opioid overdoses.

Australian authors [38] studied whether social distancing and social isolation policies triggered by COVID-19 have an influence on alcohol consumption. This was analytically investigated through the measuring of ethyl sulfate (ethanol metabolite) in wastewater samples in Adelaide, South Australia, using high-pressure chromatography-mass spec-

trometry. Wastewater catchment area was representative of 1.1 million inhabitants, and wastewater samples were collected from four plants for 7 consecutive days every 2 months from April 2016–April 2020. Weekly consumption and weekend to mid-week consumption ratios were analyzed. The introduction of social distancing in April 2020 was associated with significant reduction of the estimated weekend alcohol consumption (698 standard drinks/day/1000 people) as compared with data for February 2020 (1047 standard drinks/day/1000 people). Moreover, weekend to midweek consumption ratio during social distancing period was 12% lower than the average ratio for all previous sampling periods. The authors concluded that enforcement of social isolation policies caused a decrease in population-level weekend alcohol consumption, and the analysis of wastewater provides important epidemiological information in the case of substance abuse study. Wang et al., [39] examined drugs presence in municipal wastewater in central New York during 12 weeks of pandemic (from April 19, to June 2020). The samples were collected from six wastewater treatment plants and analyzed with an automated high-throughput liquid chromatography-high-resolution mass spectrometry. Twenty-six substances were identified and quantified over a 12-week sampling period. Six major substance groups (i.e., antidepressants, antiepileptics, antihistamines, antihypertensives, synthetic opioids, and central nervous system stimulants) were found. The calculated consumption rate of these compounds correlated with disparities in household income, marital status, and age of the contributing populations as well as the detection frequency of SARS-CoV-2 RNA in wastewater and the COVID-19 test positivity in the studied sewers catchment area.

Many authors, mainly from psychiatric and social sciences area, formulated warnings and prognoses



concerning the mental health of the population exposed to COVID-19 pandemic.

Tyndall [40] postulated the controlled distribution of safer opioids for addicts during pandemic. Additionally, he proposed the use of technology that can assure safe dispense and monitoring the therapy with drug substitutes. Such technology has been already introduced in Vancouver, Canada since December 2019. Acc.to Wakeman et al., [41], social distancing enforced to limit the spread of SARS-CoV-2 may enhance the feeling of social isolation and despair. These feelings are recognized as risk factors for the development and exacerbation of addiction. On the other hand, poor access to illegal opioids may drive the opioid addicts to seek treatment with substitutes, like Methadone or Buprenorphine. Chiappini et al., [42] stressed that the disruption of the classic street drug market, reduced supply and access to illicit drugs may enhance drug-seeking activities online. It was observed that the prices of some legal pharmaceutical products with abuse potential, such as benzodiazepines, remarkably increased. The author warned that such substances might be considered by addicts as substitutes. This may also concern over the counter medications, such as Codeine, ephedrine, pseudoephedrine, and Loperamide (“poor man’s Methadone”), among others.

Healthcare providers, pharmacists, and public health policies should develop and implement preventive measures against transmission of COVID-19 among drug users. Close social contact, overcrowding, or sharing drug-using equipment should be prevented. The group of Italian and American psychiatrists aimed to raise awareness concerning patients with alcohol and substance use disorders during the pandemic. The combinations of these disorders with the social situation during pandemic may cause dramatic global health crisis,

which the authors call “the perfect storm” [43]. Similar view was expressed by Vasylyeva et al., [44], who stated that COVID-19 is likely to disproportionately affect people who inject drugs due to a high prevalence of comorbidities that make the disease more severe, unsanitary and overcrowded living conditions, stigmatization, common incarceration, homelessness and difficulties in adhering to quarantine, social distancing or self-isolation mandates. While relationships between drug use, blood-borne and sexually transmitted infections are well studied, less attention has been paid to other infectious disease outbreaks among addicts.

## 5. Closing Remarks

COVID-19 pandemic created challenges and exerted multilateral impact on the forensic community worldwide. Institutes of forensic medicine and other organizations dealing with postmortem examinations were confronted with rapid increase of autopsy cases, demanding special safety measures. Specific recommendations concerning logistics, case treatment, and personnel protection were formulated on national and international levels.

The pandemic influenced the profile of criminal activities, including domestic violence, homicides, suicides, as well as profile of abused substances. All these factors have an impact on the activity of forensic institutions and were reflected in the current literature.

Forensic aspects of mental health of the society were exacerbated by the COVID-19. However, the published reports show different experiences in particular countries, which indicates the need of appropriately developed preventive measures.

Unfortunately, the promised and expected hopes concerning development of an effective antiviral therapy against SARS-CoV-2 infection were not fulfilled. All tested repurposed drugs were of limited



or questionable efficacy and caused dangerous adverse effects. Specifically developed and effective drugs against the SARS-CoV-2 virus are not known.

The experience gained by the forensic community during the CoVID-19 pandemic may be helpful for possible future outbreaks similar in nature.

### Conflict of Interest

The author disclosed that no conflict of interest exists, and no funding were received in preparation of the manuscript.

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