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Wastewater-based epidemiology in coping with COVID-19 in Brazil: implications for Primary Health Care actions as an alternative for community monitoring and diagnosis

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Abstract: The wastewater-based epidemiology could subsidize regional actions to contain the SARS-CoV-2 in Primary Health Care (PHC), allowing anticipating the mobilization of services in areas of potential risk. With the information from the sewers, PHC services could organize interventions considering local specificities, in order to enhance their attributes. Sewage Epidemiology would allow being able to monitor spatial and temporal trends, produce results in near-real time (through biosensors), generate information on a population scale, and determine the status of COVID-19 within and among communities. In addition, it would require less public spending compared to clinical testing. Even with the limitations on the optimal coverage of sanitation services in all cities, Sewage emerges as another point to be considered at this pandemic time, presenting itself as a tool that can provide a collective diagnosis in the communities, adding to the strengthening of health, epidemiological and environmental surveillance systems in the country.

Keywords: *COVID-19; SARS-CoV-2; Wastewater-Based Epidemiological Monitoring; Primary Health Care.*

I. INTRODUCTION

The COVID-19, caused by the new coronavirus SARS-CoV-2, is already considered one of the greatest challenges of the century for public health worldwide. It is estimated that one in six infected people develops more severe symptoms, requiring hospital care. Therefore, most of them have mild symptoms, with the possibility that some of them are still asymptomatic.[1-2] Therefore, it must be recognized that Primary Health Care (PHC) plays a fundamental role in this scenario, since most of the suspected and confirmed cases will be attended by it. However, in order to provide safe, quality care at this level of care, data based planning, reorganization of services based on the characteristics of the epidemic, and actions and resources to address the ongoing pandemic are needed.[3-5]

With the release of studies reporting the presence of genetic materials of SARS-CoV-2 in the feces of infected individuals (symptomatic and asymptomatic)[6-8] and in sanitary sewage samples[6,9-10], new challenges emerged in the discussions on COVID-19, with Wastewater-based epidemiology gaining prominence in this context.[9-12] Thus, considering the role that PHC plays in reducing the incidence of infection in the ascribed population, with direct impact on the reduction of morbidity and mortality,[3-5] and taking into account the challenges arising from new sewage monitoring surveys,[6-12] it becomes important to discuss how Sewage Based Epidemiology can contribute to Primary Health Care services. Thus, this article discusses the potential of sewage monitoring for PHC services in times of pandemic by COVID-19, especially in the Brazilian context.

II. DEVELOPMENT

Based on the results of some international studies[6-8] and Brazilian research[9-10] reporting the presence of SARS-CoV-2 in feces and wastewater, Sewage Based Epidemiology emerges as a promising alternative, as it allows for the detection of the virus in the sewage system, i.e. on community scales. The Sewage Epidemiology approach has been used successfully to track and provide early warnings of virus outbreaks such as hepatitis A, poliovirus and norovirus.[13] The technique has been greatly developed in the last two decades, mainly in Europe, aiming at monitoring the use of illegal drugs.[14]

In the context of COVID-19, to make a quantitative correlation of ribonucleic acid (RNA) samples of the virus found in sewage with the scale of the disease at population level, it is necessary to determine the amount of RNA present in people's excreta and, from the concentration found in the samples, it is possible to make an extrapolation to the population, using mathematical projections and trend curves.[9,15] North American Researchers[16] from Tempe, Arizona evaluated the opportunities and challenges of using this tool to list active SARS-CoV-2 infections at the local and global level. A mathematical modeling associated with computer analysis was performed to estimate the number of infected based on RNA concentration data of the virus in sewage. Some of the parameters included in the modeling were: range of expected RNA concentration in the feces of infected people; per capita effluent generation values; data on decay kinetics for the new coronavirus, based on biomarkers; effect of mean sewage temperature on decay kinetics; detection limit in sewage samples. The authors[16] estimated that, depending on local conditions, a case of infection (symptomatic or not) could be detected for the range of 100 to 2 million uninfected people. Thus, in view of the existence of about 105,600 sewage treatment plants in operation in the study city, the authors predicted that about 2.1 billion people could be monitored using this approach.[16]

Some sewage monitoring studies were initiated in Minas Gerais[9], Rio de Janeiro[10], Rio Grande do Sul[17], and Santa Catarina[18].

Highlighting the findings of the latest research bulletin in Minas Gerais, the researchers collected sewage samples at different points in the sewage system of the cities of Belo Horizonte and Contagem, inserted in the river basins of the Arrudas and Onça riverines, between April 13 and August 14, 2020. The data showed that 100% of the sewage samples tested positive over the last 10 consecutive weeks of monitoring in the Arrudas basin; and in the Onça basin, all samples tested positive in the last 12 weeks of monitoring. Through mathematical estimates, the authors highlighted that 170,000 residents could be contaminated - 20% less than data collected between July 20 and 24. At the time, it was estimated that 850,000 people could have the virus. The estimates of the infected populations were made from the viral loads quantified in the affluent sewage to the Arrudas and Onça Sewage Treatment Plants, considering a per capita viral load equivalent to $2x10^7$ number of copies of viral RNA (genetic material) per person per day (equivalent to 10^5 copies of viral RNA per gram of feces per day). For per capita viral load, an average value was adopted, obtained from international references (for feces samples) and from own studies (for hospital sewage samples). A fecal contribution of 200 grams per person per day was adopted.[9]

Thus, in the Brazilian context, sewage monitoring can predict, for example, the speed of spread of the disease in certain communities. The use of environmental modelling of sewers is appropriate to simulate and know the contamination of the population, but it is worth reinforcing that mathematical models should be used in a complementary way and with great caution (as the models demand), so that there is no over or underestimation.[16]

In the context of PHC, Sewage Based Epidemiology could provide elements for regionalized actions to contain the virus, allowing the mobilization of services in areas of potential risk to be

anticipated — where the circulation of the virus is detected in advance by sewage surveillance. In addition, due to the unique characteristic of having the territory as a nucleus of analysis and action, with the information coming from the monitoring of sewage, the PHC services could organize educational practices in each community or in specific micro areas (through awareness campaigns and testing strategies, when possible), considering local specificities, in order to enhance the coordination of care at this level of attention - and its other attributes[3] (first contact access, longitudinality, completeness, cultural competence, and family and community orientation).

In Brazil, considering that it is one of the countries with the highest number of infected (3,846,153 cases and 120,462 deaths by August 30, 2020)[19], in addition to the restriction of mass testing and the existence of asymptomatic cases, sewage monitoring can be an additional tool in strengthening health, epidemiological and environmental surveillance systems,[11-12] especially in PHC, as it receives 80% of mild cases and part of medium severity cases.[3,5]

Thus, Sewage Epidemiology would bring unique contributions to PHC services, being able to monitor spatial and temporal trends, produce results in almost real time (through biosensors)[20], generate information on a population scale and determine the status of COVID-19 within and between communities.

It should be noted that in the monitoring of SARS-CoV-2 in sewers, the studies carried out so far have been based on representative samples, with the aim of monitoring contagion curves that may extend over weeks, months or years. Thus, authors have debated which samples conducted each week would be better, as it would allow the optimization of important financial and logistic resources in the analyses.[20]

It is essential that the companies providing sanitation services align their actions, obtaining control over the sanitary sewage systems, so that quality data is provided and able to guide the preventive measures of contagion, risk mitigation and care. Thus, a database and a sentinel system could be created, so that information about the presence of SARS-CoV-2 in the sewerage system could be fed by regions, so that all the services of the Health Care Networks (HCN) are aware, seeking integration between them.

The care of people in relation to COVID-19 needs to be present in the different phases of infection and in the whole spectrum of severity, in lines of care that involve from the prevention of new infections, monitoring of mild cases in home isolation, early identification of signs of deterioration, admission to intensive care units (ICU), until the post-discharge phase for rehabilitation.[4] It has been common to observe greater concern on the part of state and municipal managers regarding prompt care services, the creation of campaign beds and hospitals. However, without strengthening Primary Health Care, it is not always possible to ensure that the user has access to the beds or campaign hospitals. Therefore, it is essential to value the services of PHC, which are sometimes forgotten by health authorities and the hegemonic media in the current context of a pandemic. Authors[5] discuss that while strong epidemiology and surveillance systems are indispensable tools for outbreak detection and monitoring and public health emergencies, strengthened Primary Health Care services form the basis of any emergency response.

Furthermore, in economic and practical terms, Sewage Based Epidemiology presents in cheaper and faster orders of magnitude when compared to clinical screening.[11-12,20] Authors stress that clinical diagnostic tests are financially inadequate for rapid monitoring of the incidence of COVID-19 in certain populations, and it is not feasible to perform repeated individual tests on a large scale.[18,20,21]

The estimated presence of SARS-CoV-2 in sewers is relevant to underpin the decisions of the authorities, especially with regard to the knowledge of the need to advance or reduce social distancing efforts or other stricter measures, such as lockdown.[12] And PHC has this function of expanding the

local response capacity not only by reducing infection, but also by mitigating the social and economic effects of social distancing measures.[4] Such an observation reinforces a further potential of Sewage Based Epidemiology in PHC services in the Brazilian context.

In addition, such a tool can support secondary and tertiary care services' decisions, especially in the allocation of resources for the creation of emergency care units (ECUs) for cases of medium complexity and the opening of new hospital beds for intensive care.[12]

With the information of areas with greater virus circulation through sewage surveillance and environmental modelling, Primary Health Care managers will be able to direct actions that may prevent the occurrence of new cases, while accompanying those already installed and with mild symptoms, in addition to early identification of serious cases that need to be managed for the specialized services. In a complementary and coordinated way by PHC, secondary attention can follow if the virus circulation reaches very high peaks, staying alert for possible cases that will increase demand, creating rear beds, for example. Thus, tertiary attention can also be organized regarding the opening of intensive treatment beds and the allocation of human resources. To this end, it is essential to strengthen coordination between all levels of assistance, with well-defined flows and agreements.

With support from Sewage Based Epidemiology, PHC services and those of other levels of care can draw up contagion maps, infected community curves and asymptomatic curves, subsidizing the allocation of resources and professionals to priority regions quickly and effectively.

Despite the limitations as to the ideal coverage of sanitary sewerage in all Brazilian cities, sewers appear as another point to be considered at this time of pandemics, presenting itself as a tool that can provide a collective diagnosis, especially in the largest cities that already have a sewage system with collection that serves a percentage above 50% of the population. It is recognized that mass clinical trials for the diagnosis of COVID-19 are preferred; however, in the current context of financial and operational limitations for this measure in Brazil, Sewage Based Epidemiology represents a complement, adding to the strengthening of health, epidemiological and environmental surveillance systems in the country.

Sewage Based Epidemiology is a tool that needs to be incorporated into the surveillance services of COVID-19 in Brazil, especially in the context of Primary Health Care, as it would be able to contribute in a unique way with the services, monitoring spatial and temporal trends, generating information on a population scale and determining the situation of COVID-19 within and between communities, that is, making a collective diagnosis. In addition, it would be a less costly strategy, as it would require less public spending compared to clinical testing. As Brazil already has financial and operational limitations for mass testing, it is important to broaden the discussion of this issue in health system actions to address the pandemic.

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