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Cordon sanitaire, a necessary evil? Evaluation of non-pharmacological interventions against COVID-19 in Ovar, Portugal

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Abstract. *Background and aim*: From March 17 to April 17, 2020, the Portuguese municipality of Ovar was submitted to a cordon sanitaire due to a COVID-19 outbreak. During this period a whole Public Health structure had to be built up to respond to the healthcare needs of the population. The aim of this work is to contribute to the evidence on the efficacy of cordon sanitaire as an epidemic control strategy. *Methods:* All the major institutions in Ovar, both health and socially related, were called from the first day to form a Crisis Cabinet. Case tracking was assured by the creation of an online database. A major telephone network oversaw contact tracing, isolation mandates and surveillance. A massive testing structure was built up, and clinical assistance was assured by the local hospital and the Primary Care units. Patient referral to testing and clinical visits were made through online forms that allowed an efficient response and data for epidemiologic research. *Results:* A decline in the daily number of cases was seen after an incubation period (14 days), confirming lockdown was effective in blocking transmission chains. Besides, neighboring municipalities were not significantly affected in relation to others. Lethality was bigger in Ovar than in whole Portugal. *Conclusions*: The decrease in the incidence, in the reproductive number and the non-affection of neighboring municipalities appear to prove the cordon sanitaire as an effective Public Health measure to contain epidemics. However, an appropriate mitigation strategy must be adopted to conceal the challenge.

Key words: COVID-19, Portugal, Public Health, Disease Outbreaks, Delivery of Health Care

Introduction

On March 17, 2020, a state of calamity and cordon sanitaire was decreed for the municipality of Ovar (1). On the day before, Ovar registered 29 cases, being the first Portuguese locality to present community transmission of COVID-19 and requiring extraordinary containment and mitigation measures. Since that day, and until April 17, the entire municipality kept all outside accesses blocked, besides a general closure of all non-essential industry and commerce, anticipating the lockdown rules of the declaration of national emergency on March 18 (2). The cordon sanitaire represents, by its exceptional, new, and sudden character, a challenge both to the physical and psychological endurance of those involved, as well as to their capacity for creativity and adaptation.

The history of the cordon sanitaire, a term coined in France in the 19th century, dates to the Middle Ages and has since been successively applied to contain outbreaks of yellow fever, bubonic plague, and cholera, among others (3). In the 20th century, the hygienic-sanitary and medical-scientific evolution, associated with greater efficiency in communication and global

politics, led to its frank decline. The present century recorded cordon sanitaires during the SARS crisis in 2003 (4) and Ebola in 2014 (5). In Portugal, there had been no cordon sanitaires since 1899, when the bubonic plague epidemic affected the city of Oporto (6). Implying a strong security apparatus, social reorganization, household readjustments and commercial breaks, the cordon sanitaire is a costly action at all levels, and highly demanding for the population. The efficiency of its application is not always consensual and raises ethical questions about individual freedom (7,8). Isolation can lead to a shortage of resources, implies drops in employment and income, and the limitation of mobility can, on the other hand, accelerate contagion within the enclosed community (9). For example, in the cordon established in Monrovia, Liberia, during the Ebola outbreak, the ensuing humanitarian crisis led to an increase in the basic reproduction number within that community (10). An adequate support structure is thus essential to the effectiveness and *raison d'être* of a cordon.

The COVID-19 pandemic, beginning in China in November 2019 and spread worldwide in early 2020, has again replicated the cordon sanitaire strategy. The city of Wuhan, Hubei province, whose livestock market was presumed to be the source of the virus, was cordoned off from January 23 to April 7, 2020. Non-pharmacological interventions in this context were seen as central in the Chinese fight against COVID-19 (11), namely: 1) Tracing and adequate isolation of contacts; 2) Expanded testing strategy; 3) Use of innovative technologies for information and control (12).

The Portuguese municipality of Ovar has a population of approximately 55,000 inhabitants (13), divided into five parishes. At the healthcare level, there are five primary care units (USF), all belonging to the Baixo Vouga Primary Care Cluster (ACES BV). At the time of the cordon sanitaire, one of them was closed due to an outbreak among healthcare professionals. In addition, this area counts with the Francisco Zagalo Hospital (HFZ), a facility without an emergency service, and for which the reference hospital is in another municipality, outside the cordon. It also has five Retirement Homes (ERPI).

This report is intended to describe the non-pharmacological strategies to tackle the COVID-19 epidemic situation inside the cordon sanitaire, the Public Health services articulation with other entities, and to assess the efficacy of the cordon sanitaire in what was its largest example in contemporary Portugal.

Methods

Crisis cabinet

On March 16, 2020, preceding the cordon, a structure henceforth known as the Crisis Cabinet was created. Under the tutelage of the Mayor, as the municipal responsible for the Civil Protection of Ovar, the cabinet reunited the following institutions: Ovar City Council (CMO), five Parish Councils, Portuguese Army, Health Authority and Public Health Unit (USP) of the ACES BV, HFZ, Ovar Primary Care Centre of the ACES BV, National Republican Guard (GNR), Public Security Police (PSP), Fire Departments, Portuguese Red Cross, National Emergency Service (INEM), Social Security Administration, and Economic and Food Security Authority (ASAE). During the cordon sanitaire, the cabinet kept at least one daily meeting to assess the situation. It was permanently based in the City Hall, with 24 hours a day attendance ensured by the fire department.

Epidemiological investigation and contact tracing

An online database was created in Excel®, shared and updated between public health professionals, and linked to a focal point with the Regional Public Health Department. In this database all positive cases of COVID-19 were aggregated: those notified through the national notification system (SINAVE), direct emails from hospitals, laboratories, and the Regional Department of Public Health, and, later, those of the national COVID-19 patient's monitoring and contact tracing tool (Trace COVID-19®). Information on positive cases included: sociodemographic characteristics (e.g., age, sex, postcode), status (active, recovered, hospitalised, death), clinical presentation, previous medical conditions, and putative source of

infection. For each case, the respective contacts were indexed, along with their surveillance data (i.e., daily clinical and isolation assessment).

Isolation and quarantine

For the imposition, monitoring and management of the isolation of confirmed cases, as well as quarantine of high-risk contacts, it was necessary to create a wide telephone network that relied on dozens of professionals. Using the ACES BV headquarters, the work was coordinated by two Public Health medical residents and integrated multiple professionals exceptionally assigned to this activity, including junior doctors. Hundreds of phone calls were made every day, ensuring the correct isolation and clinical assessment of the patients, as well as their referral to other levels of care, if necessary. To ensure they maintained domiciliary isolation, *in situ* verification was attributed to the police force (GNR and PSP), which established daily visits to patients and high-risk contacts.

In the case of isolation or quarantine of individuals without proper living conditions, a support centre was created at the Youth Hostel in Ovar, specially adapted for this purpose. This structure had two separate areas, one for infected patients and one for high-risk contacts. After a sanitary audit by the USP's environmental health technicians, nurses and physicians, the facility opened with newly hired healthcare workers and volunteers. Medical support was guaranteed by the local hospital (HFZ). Opening on March 26, 2020, the hostel received a total of 11 users.

Psychological and social support was also provided to confirmed cases in isolation and individuals in quarantine, by a psychologist and a social worker. This service was provided through phone calls and the two professionals were in constant contact with the health authorities (USP), family medicine teams (USF) and municipal social care services in case referral was needed.

Massive testing

At the time, Ovar did not have a laboratory, public or private, to ensure SARS-CoV-2 Polymerase Chain Reaction (PCR) tests. An autonomous testing structure was thus set up with the collaboration of ACES BV/ Regional Health Administration of Central Portugal (ARSC), HFZ and CMO. Operating daily, with the possibility of domiciliary collection, the samples were then sent for a lab network that included hospitals, private laboratories, and the National Health Institute (INSA). Patients for testing were either referred by the public health physicians, family medicine physicians, or physicians from the local hospital (HFZ). Since Ovar was in the context of active community transmission, we assumed a mitigation strategy. Criteria for testing included the presence of symptoms or high-risk contact with an infected individual, at a time where national norms asked for both.

Clinical assistance

Due to the difficulty in adapting the national phone line (SNS 24) to the Ovar context, a new line was created on April 2, 2020, by the CMO and ACES BV, with a 12-hour daily attendance carried out by the USF physicians. The circuit (Figure 1) also included the COVID-19 Dedicated Area (ADC), which worked as a Primary Care assistance point for confirmed or suspected patients, operating 8 hours a day. The physical space included a reception, an attendance room, two observation rooms and an X-ray room. Physicians, nurses and one radiology technician, from the various USF, ensured this service. The referral of patients was made by physicians of the USF, USP and SNS24 line, and was managed by the USP. This ADC was in direct contact with the local hospital (HFZ) and the emergency services of the other reference hospitals.

An online form was created by the USP for referral of patients for testing and consultation, allowing all information to be aggregated, classified by priority, and directly monitor the activity of primary health care. This form also allowed the creation of a database for epidemiological study of clinical presentations, previous medical conditions, and context of contagion. The appointments were made by professionals from the Management Support Unit (UAG) of the ACES BV.

In turn, the local hospital (HFZ) kept consultations open for suspected or confirmed cases of COVID-19 and adapted its facilities to create a dedicated ward, with physical conditions for hospitalization

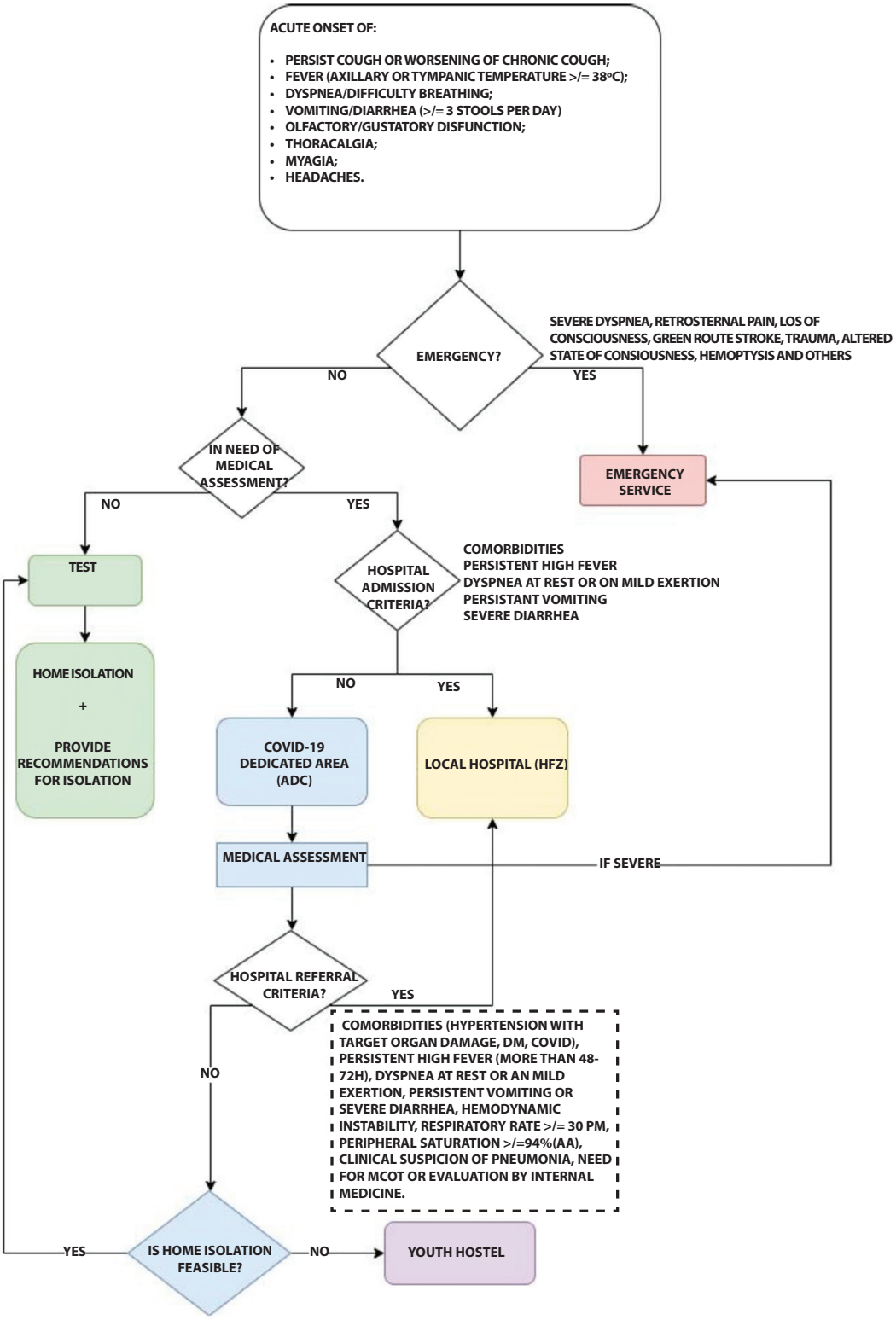

Figure 1. Flowchart representing the referral circuit implemented in Ovar during the cordon sanitaire. Source: USP from ACES BV

of patients who did not require intermediate/intensive care. On April 12, the opening of a field hospital - the *Anjo d'Ovar* - with the support from CMO, HFZ and ARSC, also played an essential role in providing care. The setting up of the hospital was monitored by the Program for Primary Prevention and Control of Infection and Antibiotic Resistance (PPCIRA) from ACES BV and counted on the clinical direction of the HFZ, physicians from the USF and other professionals hired or volunteering for this purpose.

Retirement homes (ERPI)

The outbreaks in ERPI were also a motif of concern and needed intervention during the cordon sanitaire. After the first positive result in a retirement home was known, all employees and residents were tested. In the 24 hours following the publication of these results, the nursing and PPCIRA team from ACES BV visited the institution, cooperating in the restructuring and reallocation of spaces, with the creation of infected and non-infected areas, and clean and dirty circuits. The ACES BV also provided material, medical and nursing support to the residents, with support from the HFZ for laboratory needs and subsequent hospitalizations. All the tested users with initial negative results were tested twice in the three following weeks. After this first event, all remaining four ERPI received similar interventions, with full testing of users and staff and PPCIRA counselling on infection prevention and control strategies. In total, there were three ERPI with positive users and two with all negative results.

Results

As seen in Figure 2, from the first COVID-19 case diagnosed in Ovar (on March 9, 2020) to the end of the cordon sanitaire, the daily number of cases (epidemic curve) registers its peak between the 7th and the 14th day after the implementation of the cordon sanitaire. Since the incubation period of SARS-CoV-2 is from 2 to 14 days (14), this roughly equates to an incubation period. When we observe the increase in the number of cases in the first few days, it should be assumed that this increase does not necessarily represent an increase in transmission, given the length of the incubation period and the radical containment to which this population was subjected from day one. This increase must be understood along with a progressive increase in testing, as is clear in Figure 3. During the first 14 days of cordon sanitaire, the positivity rate was 35 positive tests per 100 tests performed. Besides, the massive testing structure allowed Ovar

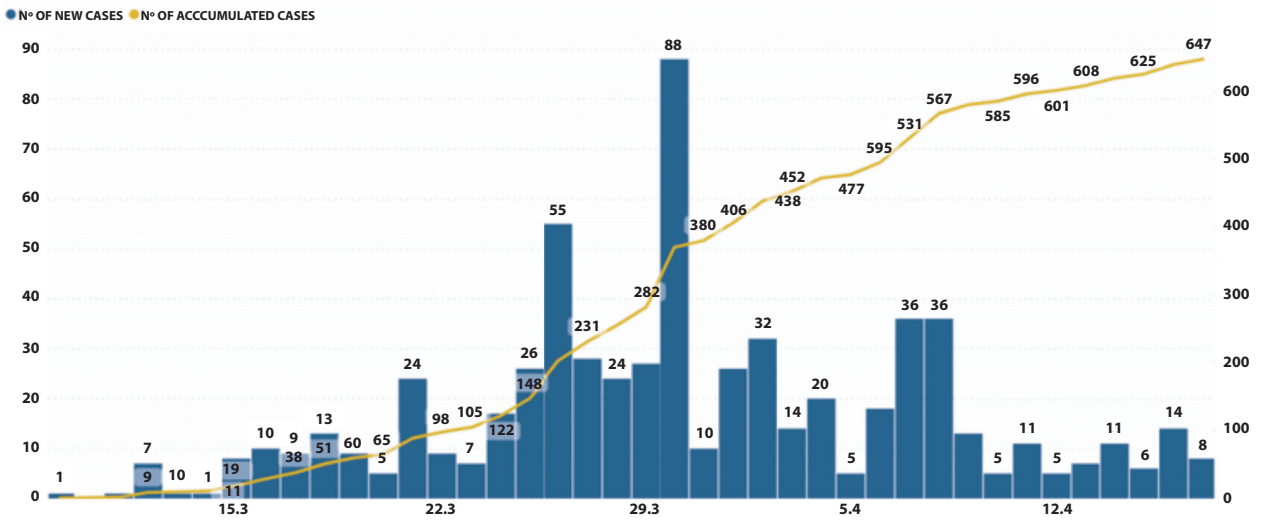

Figure 2. Daily and accumulated incidence of COVID-19 in Ovar from the first case to the end of the cordon sanitaire. Source: USP from ACES BV

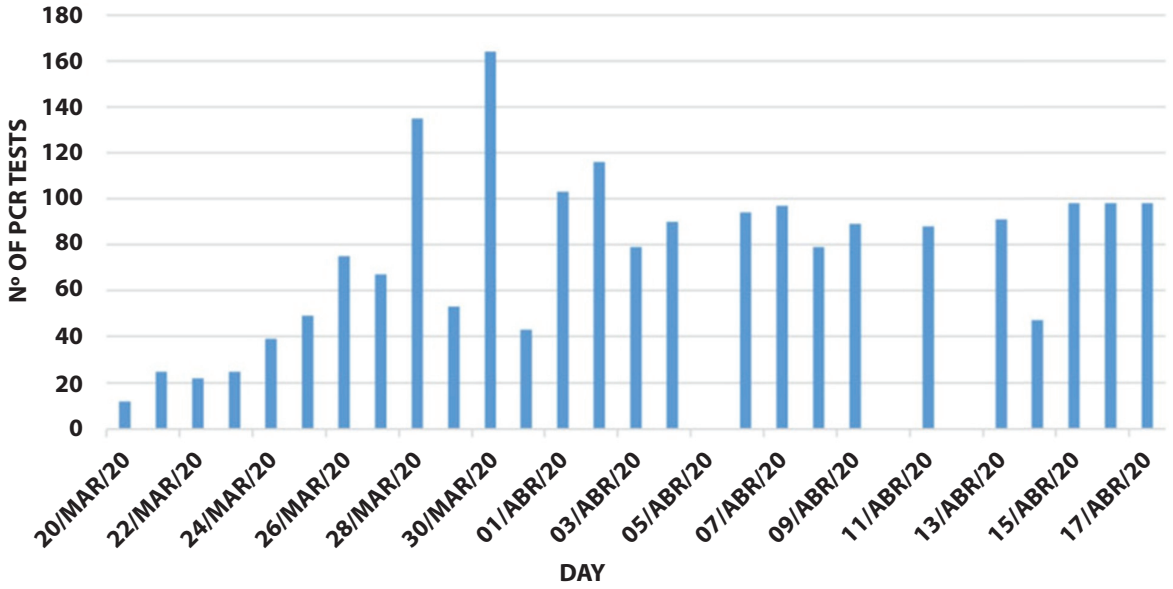

Figure 3. Number of PCR tests for COVID-19 diagnosis realized per day in Ovar during the cordon sanitaire. Source: USP from ACES BV

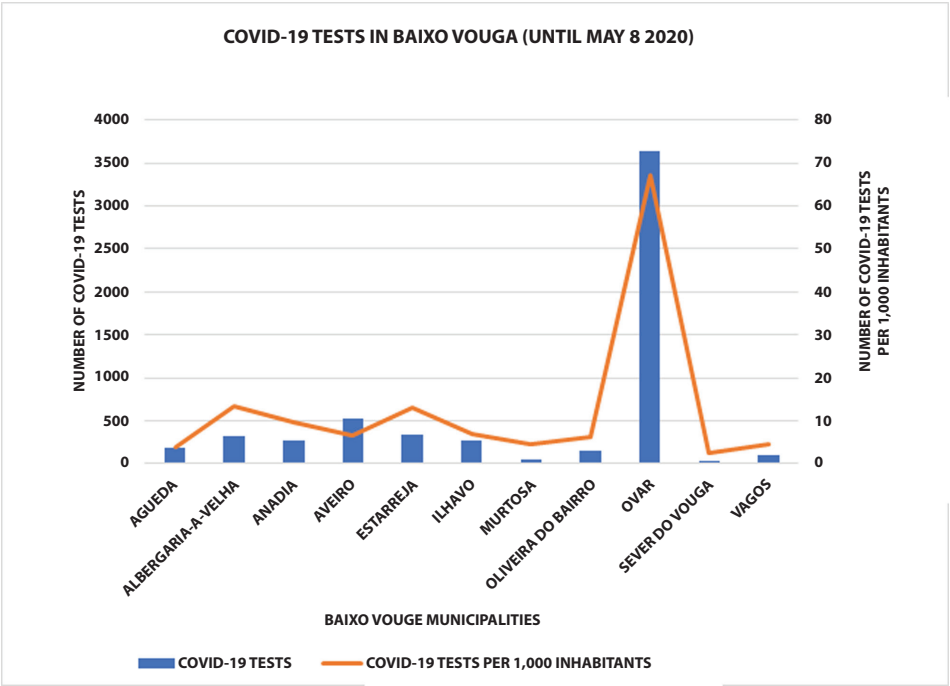

Figure 4. Number of PCR tests for SARS-CoV-2 performed in ACES BV until May 8, 2020. Only tests performed in Primary Health Care were considered. Source: USP from ACES BV.

to test more than other municipalities of ACES BV, reaching a total of 67 tests per 1000 inhabitants, compared to ratios lower than 15 in all other municipalities (Figure 4). The basic reproduction number R(t) was already below 1 by the time the cordon sanitaire was lifted (Figure 5)

Transmission chains originating in Ovar, initially identified in other municipalities of ACES BV

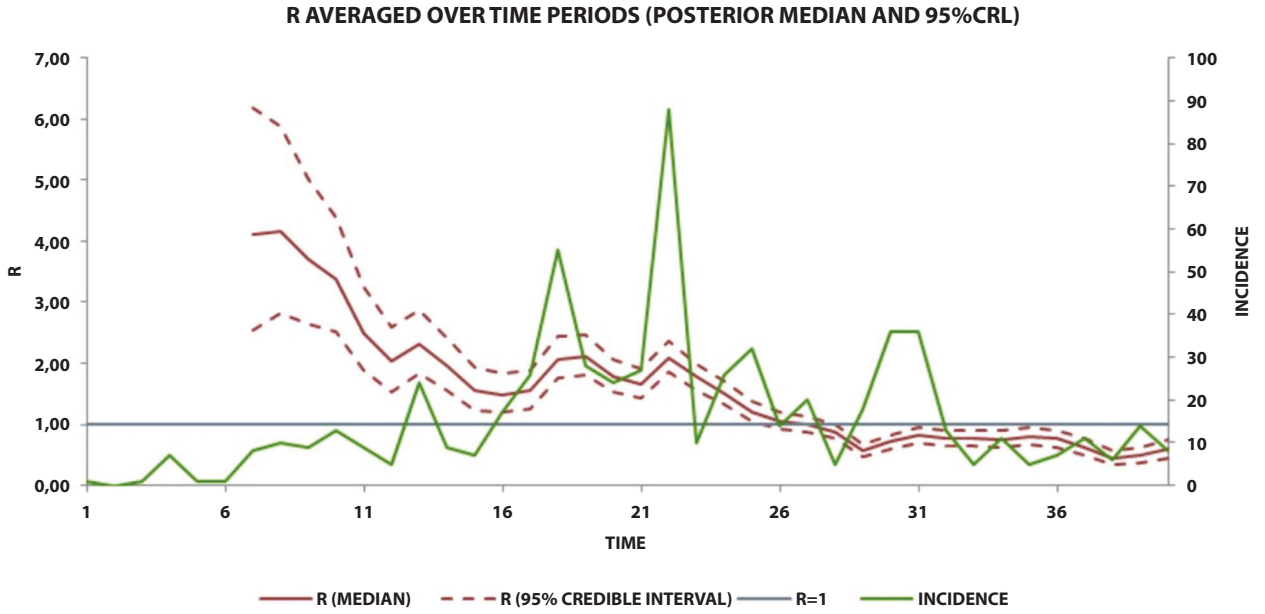

Figure 5. R averaged during time periods (posterior median and 95% Cr) in Ovar from the first case to the end of the cordon sanitaire. Source: USP from ACES BV

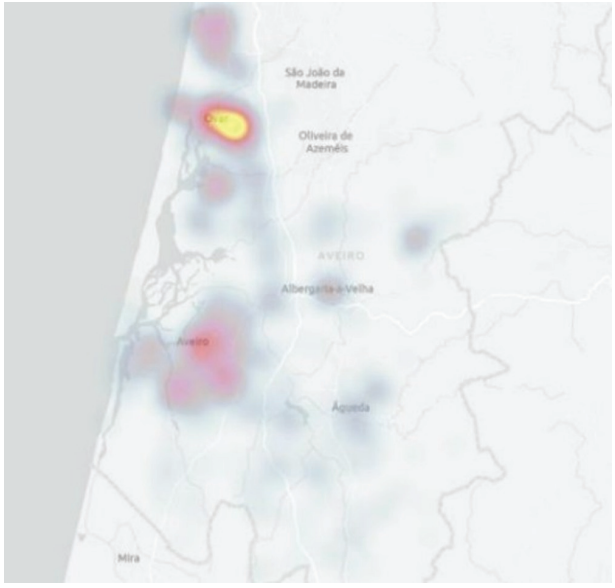

Figure 6. Heat map of accumulated cases of COVID-19 in the region of ACES BV on May 5, 2020. Source: USP from ACES BV

and contiguous geographical areas (e.g., ACES Dão Lafões), stopped being reported after 7 days of cordon sanitaire. In Figure 6, the georeferencing of cases and comparison of incidences also supports that hypothesis. Indeed, in the ACES BV, Ovar neighbouring municipalities were not significantly affected in relation to others. Two months after the first case was diagnosed, the epidemiological curve in Ovar assumed a residual presence, similar or even lower than in the other municipalities in ACES BV (Figure 7).

During the period of the cordon sanitaire, Ovar registered a total of 28 deaths attributed to COVID-19. The average age of death was 82 years, with 28.57% of them happening among ERPI residents. During this period, the global Case Fatality Rate (CFR) for COVID-19 was 3.44% in Portugal, compared to a CFR of 4.33% in Ovar. Among age groups above 70 years old, Age-Specific Case Fatality Rate was also consistently higher in Ovar when compared to national numbers (Figure 8). Most of the deaths by COVID-19 in the Ovar municipality during the first epidemic wave were concentrated in the period from March 26 to April 20, 2020 (n= 34), stabilizing then until October, considered to be the start of the Portuguese second epidemic wave. The same indicator (CFR), when applied to the second and third epidemic waves (data estimated between October 1, 2020, and February 28, 2021) was 1.36% to Ovar and 1.97% to Portugal.

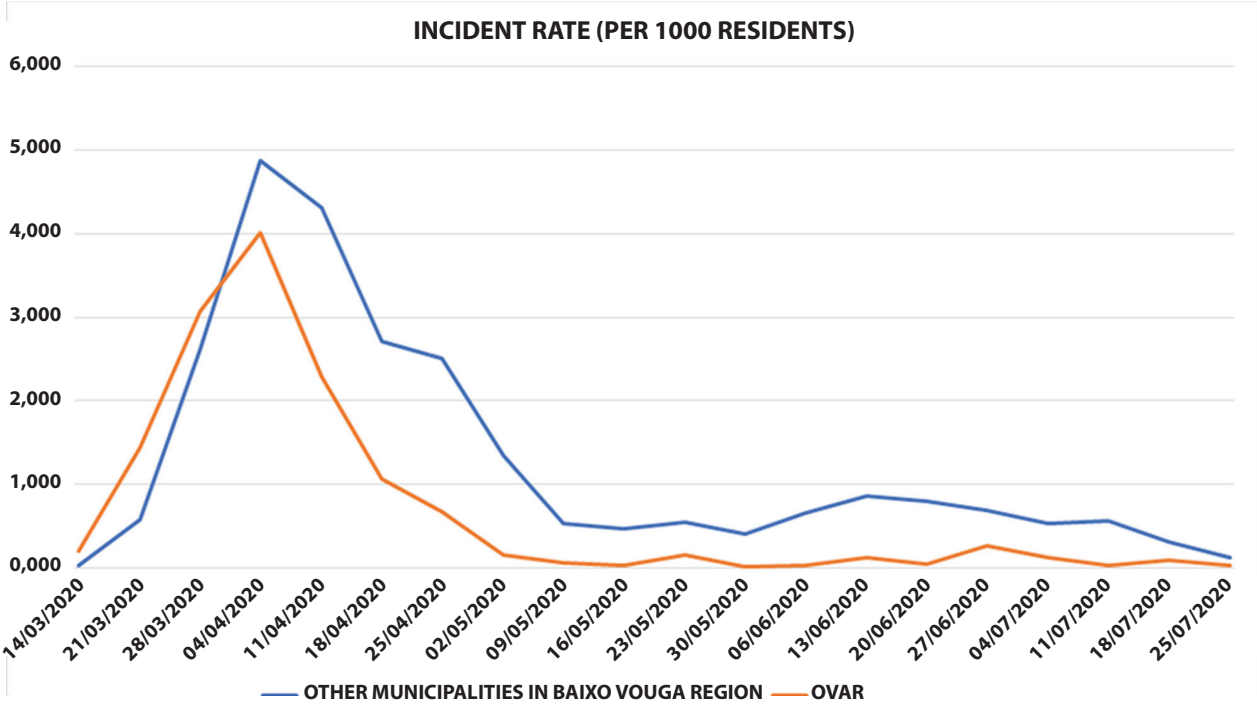

Figure 7. 7-day incidence rate (per 1000 residents) in Ovar and all other municipalities in ACES BV combined. Source: USP from ACES BV.

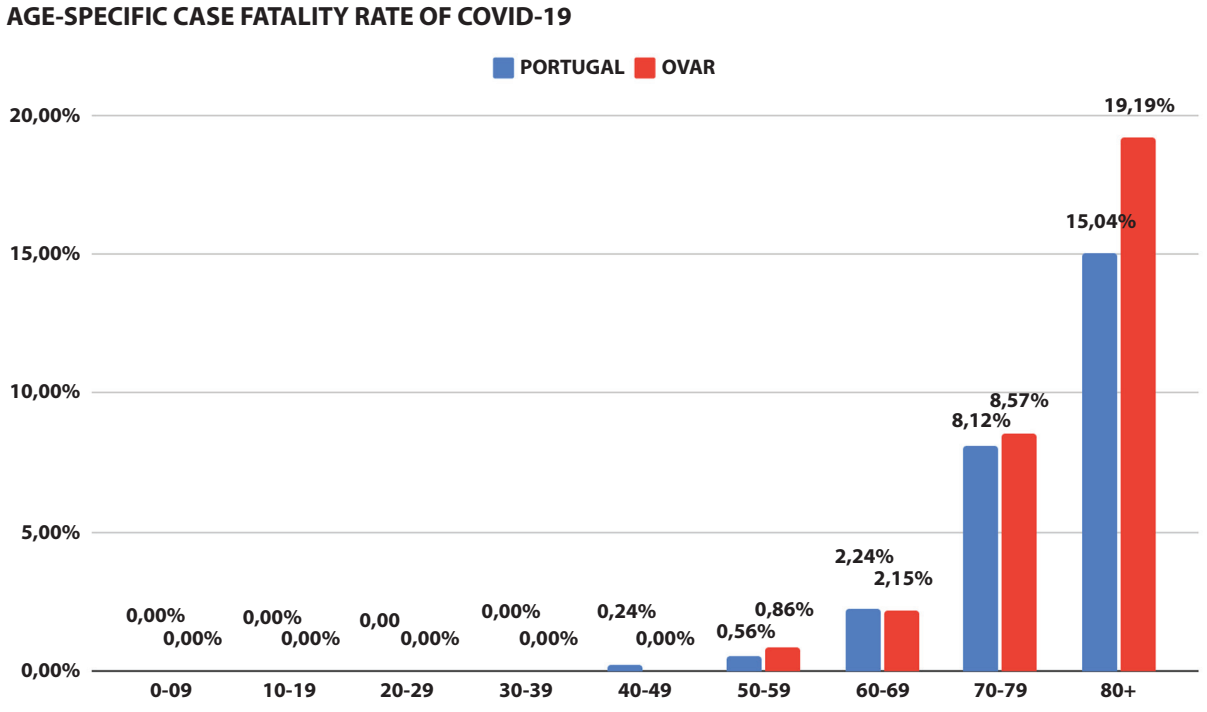

Figure 8. Case fatality rate of COVID-19 per age group between March 17 and April 17, 2020, in whole Portugal and in Ovar municipality. Source: Direção-Geral de Saúde, USP from ACES BV

Conclusions

The cordon sanitaire in Ovar was an experience of a significant dimension, with results that support the effectiveness of the strategy in the face of an epidemic crisis such as the one experienced with COVID-19. Without the pre-existence of support structures and contingency plans, given the novelty of the pathogen, the cordon sanitaire demonstrates to be a viable solution for the rapid containment of a disease with these characteristics, whenever rapid and solid social and health support is ensured.

The positivity rate during the first 14 days of cordon sanitaire (35 positive tests per 100 tests) allows the enforcement of the initial hypothesis that there was already active community transmission within the community. This was furtherly sustained by research combining field epidemiology and genomics data (15). Besides, the departure from the official norm on the national mitigation strategy at the time (16) widened testing criteria for suspect cases in Ovar. This allowed a rate of testing (67 tests per 1000 inhabitants) higher than the mean of the ACES BV (16 per 1000 inhabitants), leading to rapid tracking of positive cases and increased case detection. This strategy was then supported by research conducted on the same population that found clinical presentations (such as anosmia), not considered in the national criteria, to be positively associated with the odds of presenting the infection (17).

The progressive and sustained decrease of infections (seen both in the incidence rates and their respective growth rate) and transmissibility (seen in the decrease of the R(t)) indicates that the containment strategy, along with screening and isolation of cases and contacts, was effective to break most transmission chains within the municipality.

The analysis of the georeferencing of cases and the comparison between incidences showed that Ovar neighbouring municipalities were not significantly affected in relation to further others. Additionally, the transmission chains originating in Ovar, initially identified in other municipalities, stopped being reported to the USP after 7 days of cordon sanitaire. The cordon sanitaire results must also be interpreted along with a heavy package of non-pharmaceutical interventions applied in all the Portuguese territory. It is worth noting that other limitations on the circulation of people around municipalities also took place nationwide during the 2020 Easter weekend (9-13 April). Time-series analysis for intervention evaluation was attempted but data was not robust enough to present reliable results. Despite the limitations, our findings point to the effectiveness of this cordon sanitaire.

It is not possible, from the data presented, to establish an association between the strategy of the delivery of care - with the establishment of the ADC and increased accessibility - and a decrease in the CFR of the disease. This, however, was the wide subjective impression of the team on the various front lines, with close clinical control and surveillance of those with moderate disease, and an effective early referral of rapidly decompensating patients. Besides the inherent differences between the Portuguese and Ovar subpopulations (e.g., age, comorbidities), and the different virulence between circulating variants at the time, the lower CFR in Ovar reported between the period considered to embark the second and third epidemic waves in Portugal suggests that the cordon sanitaire was an important factor for the initial discrepancy. Further investigation is needed to understand whether the sole implementation of the cordon sanitaire was the cause for the high CFR recorded. In all cases, these results highlight the need to ensure, in situations of cordon sanitaire, strong healthcare support. Clear referral, clinical support systems, and supplementary infrastructure must be planned and rapidly implemented from the first moment to tackle the vulnerability imposed by the cordon. It is hoped that this article can contribute with future knowledge on how to manage a situation of cordon sanitaire and implement circuits and structures that respond to populations' healthcare needs. This is a situation that could benefit from timely strategies, provided in simulation schemes, in a similar way to disaster medicine, as previously shown (18).

In a world where infectious diseases are returning as an emerging challenge, in the face of increased resistance to antibiotics, increased migratory flows, and climate change, the preparation and training of professionals for completely new threats will be indispensable. Finally, of important value for the future, it is worth highlighting the relationship between professionals from the various institutions, of different

categories and specialities. For the development of the circuits, this was fundamental and of considerable professional richness. Through the whole process there was constant sharing of information, clinical and operational fluidity, and mutual understanding between the Public Health professionals, the personnel of the USF and the Internists of the HFZ. Networking and working in unison were key to the success of this investment and will always be so in the projection and sustainability of a robust National Health Service.

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Ethics and Study Oversight. The descriptive analysis of incidence and case fatality rate (CFR) was reported using secondary data from public data sources. No collection of primary data took place. Data on testing and healthcare usage was obtained from the Public Health authorities in an aggregated way. All authors vouch for the integrity of the data.

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