

Effective Containment of a COVID-19 Subregional Outbreak in Italy Through Strict Quarantine and Rearrangement of Local Health Care Services

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Background. Since the beginning of the pandemic, the epidemiology of coronavirus disease 2019 (COVID-19) in Italy has been characterized by the occurrence of subnational outbreaks. The World Health Organization recommended building the capacity to rapidly control COVID-19 clusters of cases in order to avoid the spread of the disease. This study describes a subregional outbreak of COVID-19 that occurred in the Emilia Romagna region, Italy, and the intervention undertaken to successfully control it.

Methods. Cases of COVID-19 were defined by a positive reverse transcriptase polymerase chain reaction (RT-PCR) for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on nasopharyngeal swab. The outbreak involved the residential area of a small town, with ~10 500 inhabitants in an area of 9 km². After the recognition of the outbreak, local health care authorities implemented strict quarantine and a rearrangement of health care services, consisting of closure of general practitioner outpatient clinics, telephone contact with all residents, activation of health care units to visit at-home patients with symptoms consistent with COVID-19, and a dedicated Infectious Diseases ambulatory unit at the nearest hospital.

Results. The outbreak lasted from February 24 to April 6, 2020, involving at least 170 people with a cumulative incidence of 160 cases/10 000 inhabitants; overall, 448 inhabitants of the municipality underwent at least 1 nasopharyngeal swab to detect SARS-CoV-2 (positivity rate, 38%). Ninety-three people presented symptoms before March 11 (pre-intervention period), and 77 presented symptoms during the postintervention period (March 11–April 6).

Conclusions. It was possible to control this COVID-19 outbreak by prompt recognition and implementation of a targeted local intervention.

Keywords. coronavirus; Italy; outbreak; quarantine.

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-associated coronavirus disease 2019 (COVID-19) has spread worldwide since December 2019 and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. Italy has been heavily affected by the disease; following the first Italian case diagnosed on February 21, 2020, widespread community transmission occurred, and during the so-called first epidemic wave (February–April 2020), nearly 200 000 microbiologically confirmed cases were identified, with

~27 000 deaths and an overall crude mortality of 13.5% [2–4]. Trying to slow the spread of the infection, national and regional authorities progressively implemented containment measures based on social distancing, closure of nonessential activities, and movement restrictions, which were initially applied to the most affected areas and then extended to the entire national territory [5].

During this first phase, the Italian epidemiology of COVID-19 was characterized by the occurrence of subnational outbreaks, involving mainly the Northern Italy [6], with Lombardy being the most affected region, with 73 479 confirmed cases at the end of April 2020 [4,7] and an overall incidence of 73 cases/10 000 inhabitants. The Emilia Romagna region has had an overall incidence of 55 cases/10 000 inhabitants (24 662 cases), but with important differences between areas. The province of the regional county seat, Bologna, has had an overall incidence of 40 cases/10 000 inhabitants [8], but at the beginning of March 2020, a local COVID-19 outbreak was recognized in a small town called Medicina, where the cumulative incidence subsequently reached 160 cases/10 000 inhabitants.

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In this paper, we describe the characteristics of the outbreak and the local intervention undertaken to contain it.

METHODS

Setting

The outbreak lasted from February 24 to April 6, 2020, and developed in a small town called Medicina, a municipality of ~16 900 inhabitants in Emilia Romagna, Italy, located 25 km from the regional county seat, Bologna. The residential area of the town and the hamlet Ganzanigo, which were involved in the outbreak, have ~10 500 inhabitants in an area of 9 km². In this area, the primary and hospital care is provided by the Local Health Unit Azienda Unità Sanitaria Locale di Imola (AUSL Imola), which serves 10 municipalities, with an overall population of 133 480 inhabitants.

Patients

Cases of COVID-19 were defined by a positive reverse transcriptase polymerase chain reaction (RT-PCR) for SARS-CoV-2 on nasopharyngeal swab. All the assays were performed by the same Microbiology Laboratory with no changes in the techniques during the study period; total genomic DNA/RNA was extracted from 280 µL of the clinical swab sample by Nuclisens EasyMag (BioMerieux, Marcy l'Etoile, France) following the manufacturer's instructions. Detection of SARS-CoV-2 virus was performed by real-time RT-PCR following the WHO and/or Centers for Disease Control and Prevention protocol in a QuantStudio S5 Real-time PCR system (ThermoFisher, Waltham, MA, USA).

Demographic, clinical, and outcome data of the patients involved were prospectively collected; all patients were followed up for 30 days after diagnosis. The registry of the COVID-19 cases reported to the Regional Public Health Department, the database of the local reference Microbiology Laboratory, and patients' medical records were used as data sources.

Patients were defined as asymptomatic if they had a positive RT-PCR in the absence of signs/symptoms of disease. They were classified as having mild disease in the presence of systemic symptoms with normal (or not performed) chest imaging, moderate/severe disease in the presence of radiographic signs of pneumonia, and critical disease if they developed 1 of the following conditions: respiratory failure needing invasive ventilation, septic shock, multiple organ failure [9].

Patient Consent Statement

This study was conducted according to the principles of the Helsinki Declaration; it conforms to the standards currently applied in Italy and does not include factors necessitating patient consent.

Intervention

After the identification of the outbreak, a tailored intervention was implemented beginning March 11, 2020, based on

rearrangement of health care services with intensive case and contact tracing and strict quarantine of the involved area.

On March 11, 2020, local health care authorities formally requested that the Emilia Romagna region enhance surveillance and containment measures. From March 15 to April 5, 2020, a "red zone" was established, including the residential area of Medicina and the hamlet Ganzanigo. In this controlled area, public services, commercial activities, and workplaces were closed (with the exception of grocery stores, pharmacies, and nursing homes), public transport was interrupted, and population movement to and from the area was suspended with a decree from the Emilia Romagna region.

With respect to health care services, beginning March 11 the following measures were implemented:

1. closure of general practitioner outpatient clinics and telephone contact with all residents to investigate the presence of signs/symptoms consistent with COVID-19;
2. activation of a home care service with a general practitioner and a nurse, dedicated to COVID-19 patients with mild disease in isolation at home and to medical monitoring of contacts of confirmed cases in quarantine;
3. activation of social services to assist people in isolation at home with primary assets (ie, food, medicines).

Between March 11 and 18, 2020, personnel of the Public Health Department contacted all residents by telephone to inform them about the containment intervention and to explain how to access health care services during the period. Following a pre-established questionnaire, people were asked about their possible contacts with suspected or confirmed COVID-19 cases and about the presence of symptoms consistent with COVID-19. All residents were contacted at least once; people who had been in contact with confirmed cases were contacted periodically (every 48–72 hours) over a 14-day period after the contact occurred to assess the presence of symptoms.

Subsequently, on March 27, dedicated COVID-19 health care units (USCA, Unità Speciali di Continuità Assistenziale) were activated. Each USCA consisted of a specially trained physician and nurse; they were provided with personal protective equipment (gloves, masks, glasses, and suits), a portable electrocardiograph, an oxymeter, and a contactless thermometer. Their activity consisted of visiting all patients with symptoms consistent with COVID-19 and their contacts, identified through the telephone contact described above, according to a pre-established checklist. In case of clinical suspicion of COVID-19, they decided the site of care (hospitalization or home-based isolation). In case of clinical conditions allowing home care but insufficient logistic or overcrowding, quarantine in a single room of dedicated hotels was offered.

If home isolation was possible, they performed a nasopharyngeal swab to detect SARS-CoV-2 RNA (results available

within 48 hours), and in the absence of contraindications, they prescribed a hydroxycloquine-based therapeutic regimen potentially able to modify the course of disease and scheduled an ambulatory visit with an Infectious Disease specialist within the next 48 hours.

A similar approach was applied to those patients presenting to the emergency department of the nearest hospital (Santa Maria della Scaletta Hospital, Imola) with mild symptoms consistent with COVID-19. If home isolation was possible, the individuals underwent nasopharyngeal swab to detect SARS-CoV-2 RNA (results available within 48 hours) and returned home with a prescription for the abovementioned hydroxycloquine-based therapeutic regimen and an appointment for ID evaluation.

ID evaluation took place in a dedicated area of the abovementioned hospital (Santa Maria della Scaletta Hospital, Imola), where patients were accompanied by a dedicated transport. During the visit, patients could undergo arterial blood gas analysis, chest ultrasound and/or x-ray and/or computed tomography scan, blood tests, and electrocardiogram. In case of a negative nasopharyngeal swab result, the ID specialist would assess whether to stop or continue therapy according to signs/symptoms and level of clinical suspicion; in case of a positive result, therapy was continued through day 5 and subsequent follow-up was planned according to clinical severity.

RESULTS

Incidence and Clinical Characteristics of Patients

From February 24 to April 6, 2020, at least 170 cases of COVID-19 were identified among the inhabitants of the residential area of the town Medicina and the hamlet Ganzanigo, with a cumulative incidence of 160 cases/10 000 inhabitants.

The outbreak started at the end of February 2020 (index case presented symptoms on February 24) and involved 6 people who had had been present in the same senior center between February 15 and 17, 2020. The first case was microbiologically confirmed on March 3, 2020, and the peak incidence was observed on March 7, with 16 people presenting symptoms consistent with COVID-19. By March 10, 2020, 32 microbiologically confirmed cases of COVID-19 had been diagnosed among the inhabitants of the town, with a cumulative incidence of 30 cases/10 000 inhabitants, while there were 1533 microbiologically confirmed cases of COVID-19 in Emilia Romagna and 86 in the Bologna Province, with an incidence of 3.4 and 1 cases/10 000 inhabitants, respectively. Subsequently, following the implementation of the tailored containment intervention, initiated on March 11, 2020, incidence progressively decreased (Figure 1). Overall, 93 patients presented symptoms before March 11, 2020) and 77 during the postintervention period (March 11–April 6, 2020), with a cumulative incidence of 160 cases/10 000 inhabitants. The last 2 cases were identified on April 6. No new cases have occurred since April 7, 2020.

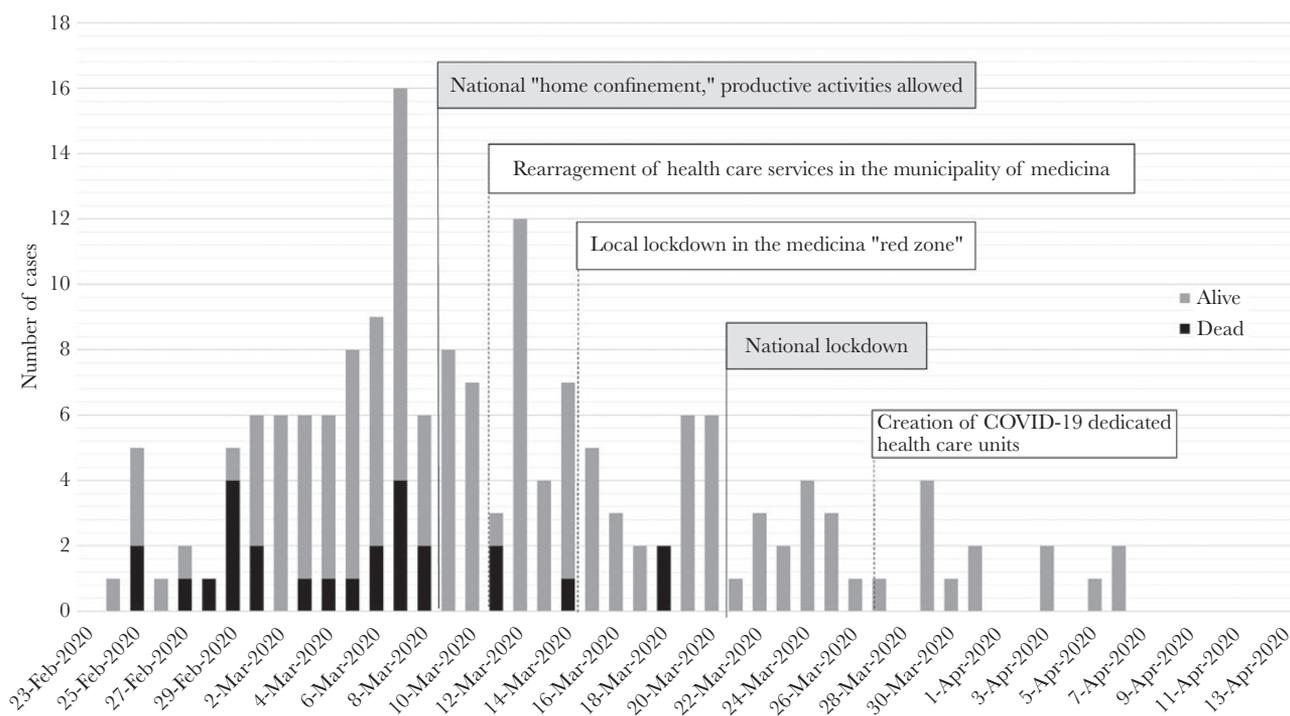


Figure 1. Epidemic curve of microbiologically confirmed cases of coronavirus disease 2019 by symptom onset diagnosed in the context of the outbreak involving the town Medicina, Emilia Romagna, Italy, from February 24 to April 6, 2020, and main national and local containment measures.

Twenty-nine cases of transmission within household contacts were identified, and no cases were diagnosed among residents of the local nursing homes.

Demographics and clinical characteristics of patients are summarized in Table 1. Briefly, half of the patients were older than 70 years; the majority were males, with moderate/severe disease. Overall, 94 patients required hospitalization, while 76 were managed at home; 30/170 cases were critical (18%). The overall mortality rate was 15% (26/170); crude mortality reached 27.5% in hospitalized patients (26/94). The case fatality rate was higher in men and in older patients (Table 1); it was also higher among those who presented symptoms before the implementation of the intervention.

Activities of Health Care Services During the Outbreak Period

This outbreak of COVID-19 had a significant impact on the local health care service (Table 2). Overall, 448 inhabitants of the municipality of Medicina underwent at least 1 nasopharyngeal swab to detect SARS-CoV-2, and 170 of them tested positive, for a positivity rate of 38%; 217 people were screened because they were identified as close contacts of confirmed cases, and 29 tested positive while being only mildly symptomatic or asymptomatic. The overall number of nasopharyngeal swabs reached 888, including those performed to assess virological clearance in patients whose clinical symptoms had resolved.

The activity of USCA in the municipality of Medicina lasted from March 27 to April 7. USCA performed 102 visits, which allowed the diagnosis of 23 cases of microbiologically confirmed

COVID-19, and identified 56 more patients who tested negative by nasopharyngeal swab but received a clinical diagnosis of COVID-19 according to symptoms and laboratory and radiological findings. These subjects were managed as COVID-19 patients, although they are not included in the total number of confirmed cases, as there was no microbiological diagnosis.

DISCUSSION

In this study, we describe the successful containment of an outbreak of COVID-19 that occurred during the first wave of the epidemic in a small area in the Emilia Romagna region through a targeted local intervention consisting of the combination of a promptly implemented strict quarantine and rearrangement of health care services.

In February 2020, Italy became the epicenter of the COVID-19 pandemic in Europe, with widespread community transmission, particularly in the Northern area of the country [10, 11].

In such a context, the combination of an early implemented quarantine with other public health measures (eg, closure of schools, social distancing, and travel restrictions) has shown efficacy in reducing incidence and mortality during the COVID-19 pandemic [12].

Indeed, as a public health response, Italian national and regional authorities launched mitigation strategies trying to slow the spread of the epidemic. Briefly, on February 22, 2020, a strict lockdown was imposed to the more affected areas of Lombardy and Veneto (11 municipalities), including a ban on

Table 1. Demographics and Clinical Characteristics of Patients Diagnosed With COVID-19 in the Context of the Outbreak Involving the Town Medicina, Emilia Romagna, Italy, From February 24 to April 6, 2020

	Cases, No. (%)	Case Fatality Rate, ^a No. (%)
Age classes, y		
0–9	1 (1)	0/1 (0)
10–19	0	-
20–29	1 (1)	0/1 (0)
30–39	11 (6)	0/11 (0)
40–49	20 (12)	0/12 (0)
50–59	25 (15)	1/25 (4)
60–69	29 (17)	3/29 (10)
70–79	45 (26)	10/45 (22)
80–89	35 (21)	11/35 (31)
≥90	3 (2)	1/3 (33)
Gender		
Male	107 (63)	22/107 (20.5)
Female	63 (37)	4/63 (6)
Site of care		
Home-based	76 (45)	0/76 (0)
Hospitalization	94 (55)	26/94 (27.5)
Symptom onset		
February 24–March 10	93 (55)	21/93 (22.5)
March 11–April 6	77 (45)	5/77 (6.5)

Abbreviation: COVID-19, coronavirus disease 2019.

^aCase fatality rate: number of deaths/number of cases.

Table 2. Summary of the Activities of the Local Health Care Services From February 24 to April 27, 2020, in the Area Affected by the COVID-19 Outbreak Involving the Town Medicina, Emilia Romagna, Italy

	AUSL Imola	Inhabitants of Medicina
People undergoing nasopharyngeal swab, No.	2043	448
Positive, No. (%)	366 (18%)	170 (38%)
Activity of emergency department, No. (%)		
Accesses	4405	368
Positive nasopharyngeal swabs	133/369 (36%)	60/92 (65%)
Hospitalizations among people with a positive NPS	107/133 (80%)	57/60 (95%)
ICU admissions	16/107 (15%)	10/57 (17%)
ID ambulatory visits	295	84
Activity of USCA (March 27–April 7, 2020), No.		
Telephone contacts	525	233
Home visits	220	102
Nasopharyngeal swabs	154	68
Hospitalizations following evaluation	10	5
Hydroxychloroquine-based empirical therapies	133	59

Abbreviations: AUSL, Azienda Unità Sanitaria Locale; COVID-19, coronavirus disease 2019; ICU, intensive care unit; ID, infectious diseases; NPS, nasopharyngeal swab; USCA, Unità Speciali di Continuità Assistenziale (special health care units).

population movements, shutdown of businesses, schools, and public places, and physical distancing. During the first week of March, the lockdown was extended to the entire Lombardy region and 14 more provinces of Northern and Central Italy. Subsequently, mandatory home confinement was applied to the entire country (only productive activities allowed), and finally, on March 22, even nonessential productive activities (eg, those related to food and health) requiring physical presence were suspended nationwide [5, 13–15].

These measures were effective in confining the outbreak of the disease mainly to the Northern Italy, with Southern regions involved to a lesser extent during the first phase of the pandemic [16].

However, these measures cannot be maintained for a long time on a national scale, as they have a profoundly negative impact on individuals, communities, and societies by bringing social and economic life to a near stop.

A successful experience of containment of COVID-19 spread without strict lockdown has been reported in Singapore; it was based on enhanced surveillance and aggressive contact tracing, as well as health care and border control measures, while a community-level approach was focused on social responsibility, with life continuing as usual with precautions. Nevertheless, this model is resource-intensive, may not be maintained easily for a long time, especially in larger countries, and would require the application of adjunctive measures in case of sustained community transmission of the infection [17].

According to WHO recommendations, the goal should be to maintain a sustainable steady state of low-level or no transmission and to have the capacity to rapidly control clusters of cases. If community transmission occurs, exceptional measures will need to be taken to suppress it as quickly as possible; this approach needs to be applied at the lowest administrative level

possible in each country to ensure a tailored and appropriate response depending on the situation and capacity to respond [18].

Our experience of the management of a subregional outbreak may be regarded as an example of the application of this strategy.

The first COVID-19 epidemic wave in Italy was characterized by subnational outbreaks; Lombardy was the most affected region, with 73 479 cases diagnosed at the end of April 2020, followed followed by Piedmont (25 098 cases) [4]. Emilia Romagna has been the second most affected region for a long time; at the end of April, 24 662 cases were identified, but important differences between areas have been found. The province of Piacenza, the nearest to the area of the first outbreak in Lombardy, was the most heavily affected, with an overall incidence of 126 cases/10 000 inhabitants, while a lower incidence rate was found in the province of Ravenna (24 cases/10 000 inhabitants). The province of the county seat, Bologna, has had an intermediate incidence (40 cases/10 000 inhabitants) [8], and the intervention we described has probably been effective in containing the local spread of the infection. The incidence in the municipality of Medicina has been significantly higher, 160 cases/10 000 inhabitants, despite an effective containment intervention. When compared with regional data, the Medicina outbreak shows a higher prevalence of elderly people (49% in the Medicina cohort vs 39% in Emilia Romagna overall were aged ≥ 70 years) and a lower prevalence of health care workers (5% in the Medicina cohort, 13% in Emilia Romagna overall). These findings are consistent with the characteristics of the outbreak, involving mainly healthy elderly people attending a senior center and their contacts. Overall mortality and case fatality rates in different age classes, instead, were comparable [8].

In our cohort, the case fatality rate was much lower among women and during the second phase of the outbreak, with no

deaths among people diagnosed after March 18. This finding is probably related to the fact that, before the intervention, only people with moderate or more severe disease received the diagnosis of COVID-19; these patients were mainly elderly men who got the infection at the senior center and had been symptomatic for quite a long period before seeking care. After the implementation of the intervention, instead, when active case finding was pursued, we were able to identify several cases of mildly symptomatic and asymptomatic infection, with a lower risk of death; moreover, during this second phase of the outbreak, severe cases were diagnosed earlier after symptom onset, and these individuals had faster access to appropriate care. With respect to the gender difference in case fatality rates, our findings confirm previous observation of a lower risk of death among women [19, 20]. However, the particularly marked difference observed in our cohort was probably related to its specific demographic characteristics; indeed, the majority of patients at higher risk of death (elderly with moderate/severe disease diagnosed before the implementation of the intervention) were men.

The outbreak has some peculiarity that may have favored its effective management. First, it occurred in a very small area with a limited number of inhabitants and an efficient health care system; therefore, a limited amount of human and economic resources was sufficient to face the emergency. Second, the first cases that occurred at the end of February 2020 were clearly epidemiologically linked (people who were present at the same senior center ~10–14 days before), a circumstance that may have facilitated recognition of the outbreak. Nevertheless, when the cluster of cases was identified, local health care authorities acted promptly, starting to monitor the situation closely, and on March 11 they decided to adopt exceptional measures, different from those in place at a national level at that moment. Indeed, unlike what happened in other areas of Northern Italy, we formally requested of the regional authorities the creation of a “controlled zone,” a measure that became effective on March 15, essentially anticipating the national lockdown by 1 week. On March 11, when the intervention began, the whole of Italy was placed on “home confinement,” but productive activities were allowed and people continued to meet at their workplaces and to use public transport; moreover, the modality of access to health care services had not been uniformly changed. Home confinement has been an important measure to reduce contact between people, but we deem that our additional interventions, in particular the closure of general practitioner clinics and the early lockdown, were crucial to confining the spread of the infection and therefore to controlling the outbreak.

The support of the municipal administration, social services, and civil protection was crucial in ensuring essential services to the population during quarantine. In addition, the health care system demonstrated itself capable of adapting to emergency very quickly. Indeed, it was completely rearranged,

with the closure of General Practitioners outpatient clinics and creation of special units to visit people at home, in order to minimize the risk to health care workers, especially general practitioners, of unprotected contact with COVID-19 patients and to reduce population movement to a minimum, avoiding at the same time delays in access to medical assistance for infected people.

To conclude, our experience demonstrates that it was possible to control a subregional COVID-19 outbreak by prompt recognition and implementation of a tailored local strategy based on strict quarantine, providing social support to the population, and rearrangement of health care services with active case finding. This kind of approach was very challenging and required great efforts; nevertheless, it complied with WHO recommendations and may serve as a model to control further COVID-19 local outbreaks during the second epidemic wave, which is affecting Europe.

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Ethical approval. The study was conducted according to the principles of the Helsinki Declaration. No specific ethical committee approval was required, as individual patients' data were not collected.

Author contributions. **Design of the containment intervention:** P.V., A.R., A.M., G.P. Data collection/analysis: **Members of the COVID-19 Fighting Team, R.F., F.B., S.G., L.B., S.C., A.R., S.T., M.G.** Drafting the manuscript: S.T., M.G. Manuscript revision for important intellectual contents and approval of the final version: all authors.

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