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Research article

Is limiting COVID-19 outside hospitals cost-effective? Cost-effectiveness analysis of the Italian special care continuity units (USCA)

Arianna Lippi[1], Darryl Jason Price[2], Rodolfo Benelli[3] and Giuseppe Lippi[4,*]

[1] Resident doctor ST2 Infectious Disease, University of Florence, Florence, Italy
[2] Management consultant, Spinelli & associati, Florence, Italy
[3] General Practitioner and USCA Figline, Azienda Sanitaria Toscana Centro, Florence, Italy
[4] USCA Figline Representative, Azienda Sanitaria Toscana Centro, Florence, Italy

*** Correspondence:** Email: lippi.giuseppe@alice.it.

Abstract: Italian USCAs are composed of a team of specialists that visit COVID-19 patients at their homes so as to hospitalize promptly only the most serious cases. This paper was carried out on an USCA located in the surroundings of Florence, which operates on a vast hilly area of almost 60,000 inhabitants. The mean specific cost for each USCA patient is about 470€ and personnel cost alone is close to 90% of total direct specific costs. The Cost-Effectiveness Analysis developed in this article demonstrates that avoiding hospitalization of only 3% of USCA patients would be enough to offset the full cost of the USCA.

Keywords: COVID-19; costs; CEA; cost effectiveness analysis; USCA; territory

JEL Codes: I180

1. Introduction

Although epidemics have always had a significant impact on our social history, and in particular among the poorest populations of equatorial Africa, up until the advent of COVID-19 this phenomenon was of little interest to the scientific community. Before COVID-19 the international reference text on epidemics was by Rosenberg (1992). Using historical examples, Rosenberg explains how to prevent

epidemics, which in the author's mind are still geographically limited, from causing health disasters which also impact those not directly affected by the disease.

Rosenberg had three suggestions for preventing such disasters:

1. avoiding the spread of panic in the population,
2. defending healthcare workers from infection, and
3. preventing health facilities (especially hospitals) from being overwhelmed by patient demand.

We do not know if the Italian government had these indications in mind when, on March 9, 2020, established the USCAs (Unità Speciali di Continuità Assistenziale or Special Continuity Care Units) as a territorial "barrier" against the COVID-19 epidemic (Decreto Legge, 2020).

Although timely, the decree did not dictate specific rules for USCA activity; consequently, in compliance with a well-known biblical precept: "In those days Israel had no king; everyone did as they saw fit" (Judges17:6), each Italian Region, and within them each ASL, adopted different USCA operating regulations. In compliance with the same precept, every single USCA organized itself "as it saw fit".

In this article we will describe the story of USCA Figline, one of the 86 USCAs in Tuscany. In deference to Popper (1987), this story should not be extrapolated from its context, but, since the rules can be broken if everyone knows they are broken, we will likewise use this narrative to generalize some conclusions.

The purpose of this work is to be able to understand whether USCAs have been cost-effective in managing the COVID-19 epidemic outside of hospitals by using USCA Figline as a prototype. To succeed in our aim, we will: in section 2 describe what USCA Figline is and how it works, at section 3 illustrate its activity, at section 4 develop a cost analysis as comprehensive as possible and (section 5) carry out cost-effectiveness analysis. Finally, at section 6, we draw some conclusion.

2. What is USCA Figline

USCA Figline is one of the 34 USCAs of USL Toscana Centro (Regione Toscana, 2020), the ASL which includes the provinces of Florence, Prato and Pistoia. The Figline Valdarno district is one of the three districts of the south-east Florence area (over 160,000 inhabitants). The territory on which this USCA operates is the upper Florentine Valdarno and it includes three municipalities (Rignano sull'Arno, Reggello and Figline - Incisa Valdarno, for a total of 58,472 inhabitants) spread over a very vast, hilly and mountainous area (273.8 sq km) (Figure 1).

Figure 1. Where USCA Figline operates.

USCA Figline's rules of engagement resemble those of all other USCAs of USL Toscana Centro and foresee that only General Practitioners (GPs) can activate USCA services for COVID-19 positive (or suspected positive) patients who show symptoms that require medical attention (Figure 2).

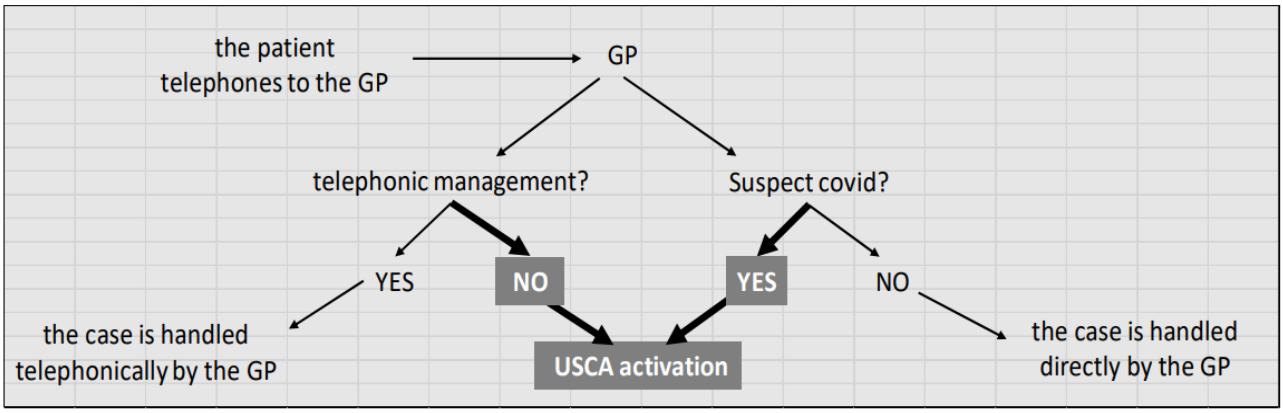

Figure 2. The "rules of engagement" of USL Toscana Centro USCAs, including USCA Figline. GP: general practitioner.

Once activated, the USCA team takes care of the patient, carries out the necessary home visits (including arterial blood gas analysis and portable ultrasound, if required) and all the appropriate follow-ups, until the patient is discharged. Hospital admissions considered indispensable (usually due to serious respiratory failure) are agreed with the emergency services (112) or with the emergency room (ER, in Italy usually called Emergency and Acceptance Department, or DEA) of the reference hospital (Santa Maria Annunziata Hospital, OSMA). (Figure 3)

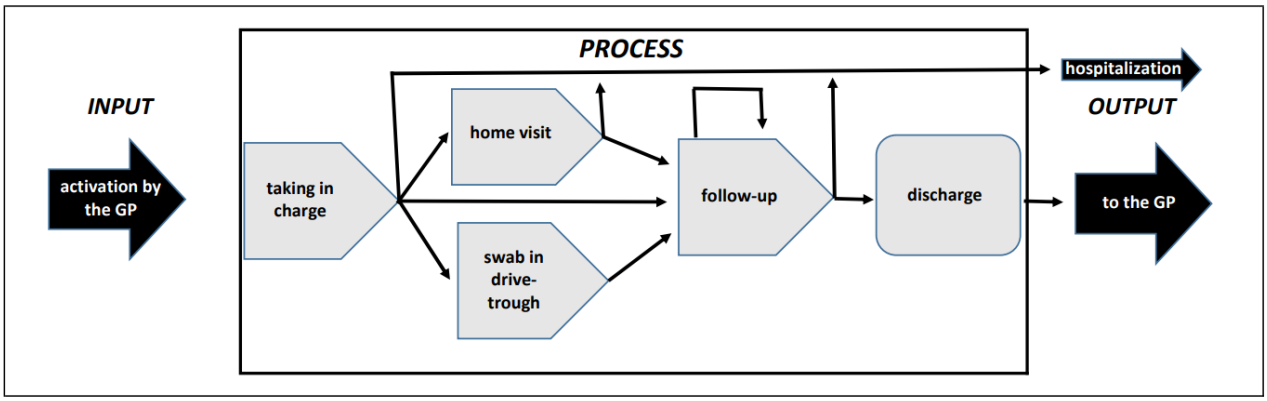

Figure 3. USCA Figline patient management process.

By far the most prevalent path is the one in which the home visit follows the taking in charge. Direct hospitalizations without home visits are exceptional, as are follow-ups without a preliminary visit. In less than 5% of cases, USCA is activated only to perform swabs in drive-through mode.

Peculiarities of USCA Figline are: (1) the composition of the team (a doctor and a nurse, instead of the usual two doctors), (2) having an "open" phone number, i.e. visible from the number called, so that patients can contact the USCA team in case of need, without intermediation from their general practitioner (GP) (with the aim of reassuring people) and (3) triple data recording: on digital support and on double paper cards: a real medical record and, in addition, a daily summary sheet of activity, which allows both the keeping of an accurate daily survey and to make up for any information gaps.

3. USCA Figline activity

USCA Figline began its activity on April 2, 2020 and is still operative[1].

For this paper we have only considered the period 1 July 2020 to 30 June 2022, as there was no good data collection available prior to 1 July 2020.

3.1. Materials and methods

The database from which the information was extracted consists of the electronic daily activity reports; missing data was manually extracted from one of the other reporting systems; those that were completely missing (only antigenic swabs prior to 2021) were not included.

[1]Although with a different name. Starting from July 1, 2022 the name was changed to "Unit of continuity care" (Unità di Continuità Assistenziale, UCA), no more "special".

Patients followed in communities (residences for the elderly, religious associations, centers for physical or mental disabled, etc.) were excluded, for a total of 303 patients. This decision is due to the temporary establishment (year 2021) of a dedicated USCA (USCA RSA); including these patients would have introduced a confounding element due to the type of cases differing in terms of severity risk against the general population and furthermore the unit costs would have been very underestimated[2]. Consequently, the activity considered is only the "institutional" one of USL Toscana Centro USCAs: to support GPs for the assistance of their COVID-19 patients or suspected positive patients (Figure 2) who need home medical controls.

3.2. Results

Activity data are shown in Table 1 for a total of 1535 cases, of which only 1090 are positive. 303 patients in communities were excluded.

Activity data was detected by discharged records and therefore is slightly offset in the reporting month. The USCA days-in-charge are to be understood as the number of days -1, similarly to what happens for DRGs (Diagnosis Related Groups)[3]. Almost all patients were visited at least once, always at home, and home visits were always carried out on the same day if requested before 3 pm. Occasionally more than one visit was made within the same family unit during the same access. The maximum number of visits on the same day was 12; the maximum number of follow-ups on the same day was 45. In less than 5% of cases, swabs (antigenic or molecular) were performed during single drive-through accesses at USCA headquarters (Figure 3). The accesses to ER are net of patients sent for the administration of monoclonal antibodies and of 13 cases, excluded because they were sent to ER for pathologies not directly related to COVID-19 (injuries, myocardial infarctions, arrhythmias, diabetes, strokes...). About 90% of the cases sent to ER were hospitalized[4] (Lippi et al, 2021, including unpublished data and updates). 31 patients died, all sent to ER by USCA within 24 hours of being admitted; there were no deaths at home.

Table 1. USCA Figline activity data. Description in the text.

PERIOD		ACTIVITY § *									*patients in communities^^*
YEAR	MONTH	total patients	positive patients	days in charge USCA	home visits #	follow-up	molecular swabs	antigenic swabs	patients sent in ER **	patients death §§	
2020	July	66	21	*979*	75	144	75	0	1	0	
	August	69	50	*1023*	77	143	77	0	1	0	
	September	46	39	*682*	31	81	31	0	1	1	*18*

Continued on next page

[2]For example, to visit patients in a community of 40 people: (1) a single set of Personal Protective Equipment (PPE) is used, as to a single home access, (2) a single go and return trip is made, (3) in the facility usually there are already nurses that can support medical activity, (4) patient visits are in series and not personalized.

[3]To minimize errors: if the taking in charge takes place no earlier than 8.00 am and the discharge takes place not after 8.00 pm, then considering the first and last day as two whole days leads to a minimum error of 25%: (8 + 4) / 48= 0,25. If we consider them as a single day, 25% is the maximum error.

[4]102 hospitalized out of 115 sent to ER, equal to 88.70%.

PERIOD		ACTIVITY § *									*patients in communities^^*
YEAR	MONTH	total patients	positive patients	days in charge USCA	home visits #	follow-up	molecular swabs	antigenic swabs	patients sent in ER **	patients death §§	
	October	102	32	*1513*	92	177	102	0	5	1	*33*
	November	140	48	*2076*	129	334	129	0	14	9	*82*
	Dicember	109	98	*1616*	117	368	109	0	15	3	*43*
2021	January	70	42	914	102	386	56	9	5	1	
	February	64	33	1207	172	533	79	32	12	2	
	March	137	114	2338	183	787	66	21	34	4	
	April	109	89	1889	153	634	59	14	6	2	
	May	88	71	1121	91	449	30	6	5	1	
	June	24	16	217	24	118	10	7	5	0	
	July	17	10	113	22	84	20	3	3	0	
	August	19	16	226	33	144	14	4	4	0	
	September	22	16	172	18	112	12	6	1	0	
	October	19	17	220	20	123	6	5	0	0	
	November	24	16	255	22	117	18	11	4	0	
	Dicember	31	24	658	74	286	98	35	6	0	
2022	January	121	106	2123	119	781	26	52	10	3	*25*
	February	70	66	1144	45	328	5	21	7	3	*38*
	March	53	49	1114	82	430	4	31	8	0	*36*
	April	73	63	836	31	313	3	14	6	1	*16*
	May	44	37	252	23	137	0	9	6	0	*12*
	June	18	17	87	13	65	0	3	0	0	
TOTAL		1535	1090	22776	1748	7074	1029	283	159	31	*303*

Note: § patients dischargerd in the month; * without patients in communities (residence for elderlies, religious communities, centers for mental or physical disabled…); # all carried out within the day if requested before 3 pm; ** net of hospital sents for monoclonal antibodies and patients hospitalized for non-covid related diseases; §§ all hospitalized within 24 hours of taking charge; ^^ not accounted for in the article.

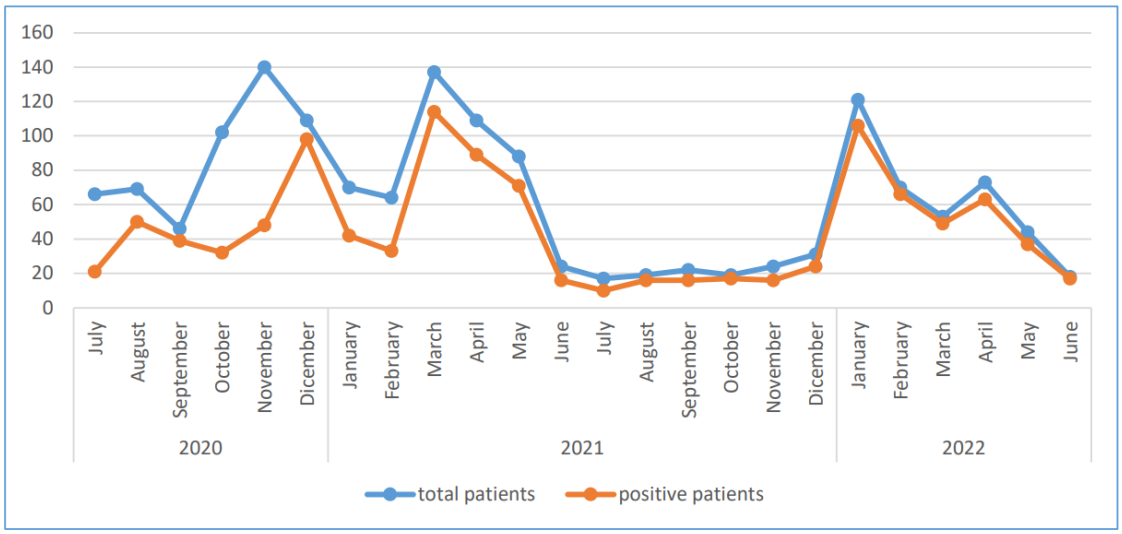

Figure 4. Positive cases followed by USCA Figline vs cases reported by GPs. Description in the text.

The operating hours of the USCA service are usually from 8.00 am to 8.00 pm every day, including Sundays and holidays; in the summer operating hours were sometimes reduced to 6 hours and on some days the USCA was even closed. Conversely, in some periods it was necessary to double the team due to the high number of patients.

In Figure 4 the trend of positive cases vs total cases is shown. The three distinct COVID-19 waves are clearly visible in the figure, as well as the progressive improvement in the ability of GPs to correctly identify patients to be sent to USCA (the gap between total and positive cases).

4. Cost analysis

To perform a correct cost analysis, first of all we analyzed the costs for personnel, for supplies, for equipment and for intermediate services; second, to apply the full cost principle, we estimated overhead costs. Third, we summarized costs according to various cost objects (Cokins, 2001; Moisello, 2000). All costs are in euro.

4.1. Personnel costs: methods and results

Using the monthly reports of time schedules for USCA activity only (net of time dedicated to vaccinations and to patients in communities) and the mean hourly costs of the two professionals, we constructed Table 2. On rare occasions it has not been possible to exclude the hours worked for patients in communities or those dedicated to vaccinations, so the values are slightly overestimated.

Table 2. Personnel costs. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

PERIOD		SERVICE COSTS				
		DOCTORS		NURSES		TOTAL COST
YEAR	MONTH	month hrs	COST	month hrs	COST	
2020	July	252	10.080	312	7.800	17.880
	August	252	10.080	288	7.200	17.280
	September	240	9.600	312	7.800	17.400
	October	405	16.200	324	8.100	24.300
	November	438	17.520	300	7.500	25.020
	Dicember	384	15.360	288	7.200	22.560
2021	January	476	19.040	288	7.200	26.240
	February	509	20.360	288	7.200	27.560
	March	558	22.320	324	8.100	30.420
	April	559	22.360	300	7.500	29.860
	May	537	21.480	300	7.500	28.980
	June	360	14.400	300	7.500	21.900
	July	271	10.840	324	8.100	18.940
	August	274	10.960	300	7.500	18.460
	September	252	10.080	288	7.200	17.280
	October	372	14.880	312	7.800	22.680
	November	505	20.200	300	7.500	27.700
	Dicember	372	14.880	288	7.200	22.080

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PERIOD		SERVICE COSTS				
		DOCTORS		NURSES		TOTAL COST
YEAR	MONTH	month hrs	COST	month hrs	COST	
2022	January	464	18.560	288	7.200	25.760
	February	349	13.960	288	7.200	21.160
	March	372	14.880	324	8.100	22.980
	April	180	7.200	138	3.450	10.650
	May	156	6.240	150	3.750	9.990
	June	168	6.720	150	3.750	10.470
TOTAL		8.705	348.200	6.774	169.350	517.550

4.2. Supplies costs: methods and results

Supplies (consumables or materials) data were taken from the USCA Figline cost center reports. The cost center has been activate only since October 2020 and we did not carry out an inventory of goods in July 2022, so there may be small errors, both positive and negative, which should balance out.

Looking at the cost center report, we allocated all supplies into one of three categories:

- materials used for home visits: personal protective equipment (PPE, including gloves and disinfectants), arterial blood gas analysis cards and syringes, materials for swabs (antigenic and molecular), materials for portable ultrasound and other more. All these materials have also been used much less frequently to perform drive-through swabs;
- supplies for USCA on-site activities: stationery, printer paper, labels, classifiers, toners, and so on.
- We considered some cost center reports (rents, condominium expenses, logistics and reverse logistics) as to be attributable more properly to overhead costs, so these costs have been accounted separately.

Table 3 Materials costs. The table is divided into two sections. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

COST OF MATERIALS				
ACTIVITY	TOTAL COST	*incidence*	*Units of Product (UoP) number*	€/UoP *
home visits	40.514	*96.25%*	*1748*	23.18
USCA on-site activities	1.577	*3.75%*	*22776*	0.07
TOTAL	42.091			
COST TO OVERHEAD				
WHAT IS PAYED FOR	YEAR	COST §	n° months	€/ month
rent USCA headquarter	2020	732.000	4	183
rent USCA headquarter	2021	8.740	12	728
rent USCA headquarter	2022	2.180	3	727
condominium fees	2021	1.868	12	156
ESTIMATED COST 24 MONTHS	2020–2022	21.217	24	884
logistic and reverse-logistic	2021	7.372	12	614
ESTIMATED COST 24 MONTHS	2020–2022	14.744	24	614

Note: * for home visits: cost of each home visit; cost of on-site activities: cost of each day-in-charge USCA, § costs attributed directly to USCA Figline, but interpreted by us as overhead.

Table 3 summarizes total and Unit-of-Product (UoP) costs for each of these three groups of supplies costs. As you can see, almost all the supplies costs (outside of those interpreted by us as overhead) are attributable only to home visits (96%) and each home visit used materials costing 23.18 euros on average. Supplies costs for activities in the USCA headquarters are almost irrelevant: only 7 cents per patient per day-of-stay. In the table we show also our estimation for costs attributed by us to overhead: 884€/month for rent and condominium costs and €614 for logistics.

4.3. Equipment costs (more properly: COT, costs of technology): methods and results

Costs for the most important portable equipment (blood gas analyzer and portable ultrasound system) were inferred from the company files used for depreciation. The two computers and printer were charged a presumed cost. Zebra, the printer used for labels for molecular swabs, has not been valued, neither were USCA's two mobile phones (Table 4). It was not necessary to calculate depreciation because it is orthodox to depreciate hardware completely over two years and our investigation covers exactly two years. It should be noted, however, that the blood gas analyzer and the portable ultrasound system have only been available since October 2020; moreover, as far as VAT is concerned, it is difficult to understand if the Italian Government included this equipment in the COVID-19 tax exemption. Where we are in doubt we attribute them a regular VAT (22%). For these two reasons, equipment costs may be slightly overestimated.

Home visits include almost the entirety of equipment costs (87%, 3.61€ each); the equipment cost for activities in USCA is residual (4 cents per USCA day-in-charge).

Table 4. Costs of technology. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

EQUIPMENT	unit cost 1	VAT	unit cost 2	*n° of equipm*	TOTAL	*Units of Product (UoP) number*	€/UoP * §	
portable ultrasound	3.280	722	4.002	*1*	4.002	*1748*	2.29	3.61
blood gas analyzer	1.886	415	2.300	*1*	2.300	*1748*	1.32	
PC	300	66	366	*2*	732	*22776*	0.03	0.04
laser printer	150	33	183	*1*	183	*22776*	0.01	
zebra printer	n.v.			*1*	n.v.		n.v.	
mobile phones	n.v.			*2*	n.v.		n.v.	
TOTAL	5.616	1.235	6.851	*8*	7.217			

4.4. Intermediate services costs: methods and results

"Intermediate services costs" are defined as those incurred in acquiring goods (or services) from cost centers other than the one under investigation.

USCA Figline bears only three types of intermediate costs: costs for molecular swabs, costs for the car dedicated to home visits and costs for laboratory tests (Table 5).

Table 5. Intermediate services costs. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

WHAT USCA FIGLINE PAYED FOR	number	unit cost	TOTAL COST
molecular swabs	1.029	80.00	82.320
antigenic swabs	*cost included in consumables*		0
car for home visits	1.748	7.01	12.248
blood samplings	*not valued*		
TOTAL			94.568

Molecular swabs have been valued according to NTR of the Tuscany region (NTR, 2022)[5]. It should be noted that these costs are not USCA specific costs since, even if USCA did not exist, they would still have been carried out[6]. In the cost summary we will develop this issue.

To evaluate the costs of the car used for home visits, we estimated the car cost for each visit and then multiplied it by the number of home visits[7]. This value is slightly underestimated as sometimes more than one patient per household was visited during the same access.

Laboratory tests have not been valued because they were required only in exceptional circumstances.

4.5. Cost summary: methods and results

Costs are summarized in Table 6.

In the Table we show:

1. two totals: direct cost and full cost, the latter obtained by adding 25% of direct costs as an overhead estimate, as is usually done by the Tuscany regional administration;
2. cost incidences: direct costs refer to the total of direct costs, overhead costs refer to the overhead total only;
3. mean costs:

- mean cost per patient: cost for each case followed by USCA Figline,
- mean cost per positive: imputing the entire cost of negative cases to the positive ones;
- mean cost per USCA day-in-charge: day-patient cost, or how much each patient costs for each day in which they have been admitted to USCA Figline.

[5]The NT (Nomenclatore Tariffario, Tariff Nomenclator) is a document issued by the Ministry of Health that establishes the type and methods of supply of prostheses and aids to be paid by the National Health Service. "R" stands for regional updating.

[6]Specific costs are usually identified with that costs that disappear when the cost object no longer exists.

[7]First of all, we calculated the distance to make 200 visits (2832 km, from 28 January to 29 June 2022), for a mean per visit of 14.16 km in a "milk run" route (in logistics "milk Run" stands for a mode of transport that follows that of the milkman who makes deliveries from house to house in the morning). Then we valued the general car mileage cost (Lancia Y elefantino blu) using ACI rates (0.3918 / km) [Gazzetta Ufficiale n. 307, 2021]. Finally, MISE (Ministry of Economic Development) tables allowed us to calculate the mean cost of gasoline until March 2022 [Ministero dello Sviluppo Economico, 2022] (therefore slightly underestimated) in 1.60788 €/l, and the on-board computer calculates mean consumption (15.60 Km/l). The total mean car cost is 14.16 x 0.3918 + 14.16 x 1.60788 / 15.6 = 7.01€ for each home visit x 1,748 home visits = 12,249€.

4. Specific costs. These are the real USCA costs and they are highlighted in grey in Table 6. To obtain specific USCA costs, we must remove the costs that would still be incurred by the ASL even if USCA would not be there, that is molecular swabs costs. It is important to note that the mean specific cost for patient is about 470€ and personnel cost alone is close to 90% of total direct costs.

With the summary Table of costs we concluded our evaluation of the expenditure that the ASL incurred for USCA Figline activities. The time has now come to ask ourselves whether this expenditure is justified.

Table 6 Summary of costs. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

PRODUCTION FACTORS	TOTAL	*Incidence direct costs & overhead*	MEAN COSTS		SPECIFIC COSTS	
			for patient	for positive	for day in charge USCA	
number of unit			*1535*	*1090*	*22776*	
PERSONNEL	517.550	*78%*	337.17	474.82	22.72	517.550
of which for nurses	169.350	*26%*	110.33	155.37	7.44	169.350
of which for doctors	348.200	*53%*	226.84	319.45	15.29	348.200
MATERIALS	42.091	*6%*	27.42	38.62	1.85	42.091
of which for home visits	40.514	*6%*	26.39	37.17	1.78	40.514
of which for activities in USCA headquarters	1.577	*0%*	1.03	1.45	0.07	1.577
COST OF TECHNOLOGY	7.217	*1%*	4.70	6.62	0.32	7.217
of which for home visits	6.302	*1%*	4.11	5.78	0.28	6.302
of which for activities in USCA headquarters	915	*0%*	0.60	0.84	0.04	915
INTERMEDIATE SERVICES * §	94.569	*14%*	61.61	86.76	4.15	12.249
of which for cars for home visits	12.249	*2%*	7.98	11.24	0.54	12.249
of which for molecular swabs	82.320	*12%*	53.63	75.52	3.61	not specific cost
TOTAL DIRECT COST	661.427	*100%*	430.90	606.81	29.04	579.107
OVERHEAD ESTIMATION	165.357	*25%*	107.72	151.70	7.26	144.777
of which for rent and condominium	21.217	*13%*	13.82	19.46	0.93	21.217
of which for logistic and reverse-logistic	14.744	*9%*	9.61	13.53	0.65	14.744
FULL COST ESTIMATION	826.784		538.62	758.52	36.30	723.884

Note: * antigenic swabs included in the cost of home visit materials; § blood tests not evaluated because of a residual number.

5. Cost-Effectiveness Analysis (CEA)

Cost-effectiveness analysis is "*a mode of economically comprehensive evaluation in which both costs and consequences of health programs are examined*"[8] (Drummond et al, 2000).

[8]Translated from page 115 of the Italian edition.

Once the costs have been measured, to proceed with the Cost-Effectiveness Analyses (CEA), the objectives, the "E" for effectiveness, must be defined.

5.1. How to choose effectiveness

Generally speaking, USCAs' effectiveness can be defined by Rosenberg's three suggestions.

Estimating the impact of USCAs presence on the "panic of the population" would require sociological analysis, beyond our possibilities.

Also, assessing how many General Practitioners (GPs) would have got ill in the absence of USCAs is not measurable, although we have the important evidence that none of the 34 GPs working in the Figline district contracted COVID-19 in the most critical period before vaccinations, something that did not occur in territorial contexts without USCAs.

More reliable data can be discussed on the effect that the presence of USCA Figline had on the reference hospital, even if a rigorous statistical analysis, that would require using a control group (territory without USCA), is not possible. We recall that safeguarding hospitals was the main reason why Tuscany established the USCAs.

5.2. Methodology for USCA Figline effectiveness evaluation

Considering that the primary function for which USCAs were established was to limit hospital access by identifying serious cases early on the territory and to hospitalize quickly only them, it is important to estimate how many accesses in ER and how many hospitalizations have been avoided by the activity of USCA Figline. To do this, a GP with extensive experience identified among the USCA Figline staff, was uniquely assigned (to avoid bias related to differences of judgment) the task of examining the clinical documentation and evaluating whether, in the absence of USCA, the GPs would or would not have sent the patient to hospital, assigning each patient examined a "severity class" (Figure 5).

METHODOLOGY:
A. for each month: to separate the positive folders from the negative ones;
B. only from the positive folders: to draw at least 15% of the folders by lot;
C. to examine each folder extracted and to assign the class to each case:
class 0 = not to hospitalize
class 1 = probably not hospitalized
class 2 = probably hospitalization
class 3 = definitely hospitalization

Figure 5. Methodology used to identify the severity classes of cases sent to USCA. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

To avoid bias related to the variability of positives/negatives between months (Figure 4), we have chosen to consider only positive patients. This leads to an error of underestimation because sometimes the patients that USCA visited who then proved negative would have been considered by their GP, who only spoke to them by telephone, worthy of sending to ER. However, as we will see in the results, being prudent increases the validity of our analysis.

Table 7 shows the results, monthly and overall, of this estimation, with: the number of positives, the number of folders to be extracted, the number of those evaluated, the classes of belonging and the estimate of the cases considered as "probably to be hospitalized" (class 2) and "definitely to be hospitalized" (class 3) in absence of USCA. In the last column of Table 7 we report the cases actually sent to ER by USCA Figline, including deceased cases.

Table 7. Estimation of the severity of cases sent by GPs to USCA Figline from 1st July 2020 to 30th June 2022. Description in the text.

Year	MONTH	positive patients	n° of cases to draw by lot	draw by lot (only positives)					*incidence class 2*	estimate class 2	*incidence class 3*	estimate class 3	patients actually sent in ER *
				total	class 0	class 1	class 2	class 3					
2020	July	21	3.15	4	1	2	0	1	*0.0000*	0.0	*0.2500*	5.3	1
	August	50	7.5	8	0	2	2	4	*0.2500*	12.5	*0.5000*	25.0	1
	September	39	5.85	6	1	0	1	4	*0.1667*	6.5	*0.6667*	26.0	2
	October	32	4.8	5	0	0	3	2	*0.6000*	19.2	*0.4000*	12.8	6
	November	48	7.2	8	2	0	0	6	*0.0000*	0.0	*0.7500*	36.0	23
	Dicember	98	14.7	15	1	1	4	9	*0.2667*	26.1	*0.6000*	58.8	18
2021	January	42	6.3	7	2	1	1	3	*0.1429*	6.0	*0.4286*	18.0	6
	February	33	4.95	5	1	0	1	3	*0.2000*	6.6	*0.6000*	19.8	14
	March	114	17.1	17	1	3	4	9	*0.2353*	26.8	*0.5294*	60.4	38
	April	89	13.35	14	0	2	5	7	*0.3571*	31.8	*0.5000*	44.5	8
	May	71	10.65	11	1	1	3	6	*0.2727*	19.4	*0.5455*	38.7	6
	June	16	2.4	4	0	2	0	2	*0.0000*	0.0	*0.5000*	8.0	5
	July	10	1.5	5	2	1	0	2	*0.0000*	0.0	*0.4000*	4.0	3
	August	16	2.4	2	0	0	1	1	*0.5000*	8.0	*0.5000*	8.0	4
	September	16	2.4	4	1	1	1	1	*0.2500*	4.0	*0.2500*	4.0	1
	October	17	2.55	3	2	0	0	1	*0.0000*	0.0	*0.3333*	5.7	0
	November	16	2.4	4	0	0	1	3	*0.2500*	4.0	*0.7500*	12.0	4
	Dicember	24	3.6	5	0	1	2	2	*0.4000*	9.6	*0.4000*	9.6	6
2022	January	106	15.9	16	1	4	2	9	*0.1250*	13.3	*0.5625*	59.6	13
	February	66	9.9	10	0	2	5	3	*0.5000*	33.0	*0.3000*	19.8	10
	March	49	7.35	8	2	1	0	5	*0.0000*	0.0	*0.6250*	30.6	8
	April	63	9.45	10	0	2	5	3	*0.5000*	31.5	*0.3000*	18.9	7
	May	37	5.55	6	1	2	1	2	*0.1667*	6.2	*0.3333*	12.3	6
	June	17	2.55	4	0	0	2	2	*0.5000*	8.5	*0.5000*	8.5	0
TO-TAL	24 MONTHS	1090	163.5	181	19	28	44	90	*0.2431*	265.0	*0.4972*	542.0	190

Note: * including deaths, see table 1.

USCA Figline has certainly avoided the presence in the emergency room of 352 cases (542 class 3 minus 190 actually sent to the ER, including deceased, Table 1) and probably avoided it in another 265 case (classes 2). Maybe a fraction of the 169 cases in class 1 (estimate: 28/181 x 1090) would also have been sent to ER by GPs. Probably also a significant part of the cases revealed negative later and not considered by us (1535-1090 = 445, Table 1) would have been sent to ER by GPs in the absence of the USCA, because they were patients with presumed COVID-19 symptoms and who necessitated an urgent home visit in absence of a swab - a visit that GPs, without USCA, could not guarantee.

In the next Cost-Effectiveness Analysis (CEA) we will consider only classes 2 and 3 in Table 7, not including both classes 1 and negative patients. As a result, the developed CEA is to be considered as very conservative

5.3. CEA: how much does USCA Figline spend for each ER access avoided?

A first unequivocal objective identified for our analysis are the avoided admissions to ER and, consequently, in the CEA, the costs incurred by the ASL for USCA for each access to ER that USCA Figline has avoided.

To be cautious, we assume 3 scenarios: a maximal one, in which, in absence of USCA, only classes 3 would have been sent to ER by GPs, a minimal one, in which classes 3 and classes 2 would have been, and an intermediate one, in which classes 3 and 50% of classes 2 would have been sent to ER. The cost for each ER avoided admission is shown in Table 8. In this Table we used the USCA Figline specific full cost (723,884€, Table 6)[9].

Table 8. Cost for each avoided ER access. USCA Figline, 1st july 2020 to 30th june 2022. Description in the text.

SCENARIOS	A	B	C
	minimal	intermediate	maximal
number of cases estimated to be sent to ER *	807	674	542
cases actually sent to ER	190	190	190
sents in ER avoided by USCA Figline	617	484	352
USCA Figline specific costs §	723.883	723.883	723.883
USCA cost for case not sent to ER	1.173	1.494	2.056

Note: * see table 7, § see table 6.

To go further, now we must find out how much each ER COVID-19 access costs (cost-outcome[10]) and compare it with the USCA cost for each avoided access. Unfortunately, we were not able to calculate it or to find anything in the literature about ER COVID-19 costs.

What can we do? After ER doctors' examinations, patients can be hospitalized or sent home, and in Italy we do have literature about how much COVID-19 hospitalizations cost. Now we have two ways: (1) estimate how many patients would have been hospitalized among those not sent to ER by USCA Figline, or (2) analyze how many avoided hospitalizations would have been necessary to balance the cost of USCA Figline. The first way is more difficult[11], so we followed the second way. But first of all we must investigate cost-outcomes for hospitalized COVID-19 patients.

[9]We took the "specific total full cost" instead of the "total full cost" because, in the absence of USCA, the patient would have been sent by their GP to ER where they would have been swabbed anyway. Therefore, the additional cost incurred by ASL to make available USCA must exclude the swab.

[10]Health cost-outcome is the cost of the final result (or each of the final results) of a health program.

[11]USCA had already sent the most critical subgroup of classes 2 and 3 (190 patients) to the ER. USCA Figline's doctors decided that the other 617 were not so bad as to have to be sent to the Emergency Room. Why would they have been judged worthy of hospitalization by ER's doctors?

5.4. Cost-outcome determination for hospitalized COVID-19 patient in Italy

Dealing with avoided admissions, monetization is implicit for structures paid to DRG (the DRG rate), but to develop an actual costs analysis is more complex; in this regard, in the last two years there have been some studies of the actual costs of hospitalized COVID-19 patients in Italy and all of them agree on the presence of a significant positive discrepancy between actual costs incurred by hospital structures and the DRG rates with which they are reimbursed (BJ Liguria, 2020; Pasdera et al, 2022; Bianciardi et al, 2022), despite the government provided an important increase in DRG rates for COVID-19 patients[12].

To be clear, in Table 9 we summarize both accounting approaches, taking as cost-outcomes:

- the rate of DRG 89 ("*simple pneumonia and pleurisy with CC, age> 17 years*"), one of the most conservative DRGs among those of COVID-19 patients[13], that reimburses a rate of 3,558 euros (Regione Toscana, 2016), increased, by 3,713€ for each patient discharged without days in intensive care unit (ICU) (Decreto Ministeriale, 2021), and the mean days of LOS (length of stay) of patients hospitalized by USCA Figline.
- the cost-outcomes, and mean LOS of COVID-19 patients hospitalized, based on the most recent work on Italian hospitals (Bianciardi et al, 2022), which resembles results that are comparable to other Italian published works (BJ Liguria, 2000; Pasdera et al 2022).

In both cases we excluded, to stay conservative, the possibility that the hospitalizations avoided by USCA Figline, would result, if hospitalized, in intensive care unit (ICUs) hospitalizations.

Table 9. Cost-outcomes for patients hospitalized for COVID-19. Description in the text.

DEGREE OF RESOURCES ABSORPTION	cost	mean LOS	cost per day
USCA Figline §	7.271	14.56	499.53
low *	9.157	17.45	524.76
medium *	14.873	15.50	959.58
high *	22.212	23.21	957.02

Note: § DRG 89 rate (del. RT 947/16), increased according with DM 265/21, * Bianciardi et al, 2022.

After cost outcome determination, we need to establish how many hospitalizations avoided by USCA Figline would be necessary to balance USCA Figline costs. This is the task of break-even analysis.

5.5. Break-even analysis

"Break-Even Analysis (BEA) is an economic calculation tool that allows prediction of the operating results of a production process as a function of the level of production" (Moisello, 2000, page 91). This result comes from the ratio of total cost to unit cost-outcome of a hospitalization and generates the minimum necessary number of hospitalizations avoided to cover USCA costs.

[12]With comma 2 of the Decreto Ministeriale, 2021.

[13]Among the many DRGs in which COVID-19 patients are classified, DRGs 89 and 90 are the most conservative. We chose the variant CC, "with complications", (DRG 89 instead of 90) because all hospitalized patients have at least one "acute respiratory failure" (ICD9CM code 518.81), otherwise they would not have been hospitalized.

To be prudent, we excluded the highest of the four cost-outcomes in Table 9 because it referred to COVID-19 patients who accessed an intensive care unit (ICU).

Again in this case we have developed three scenarios: a maximal one, in which specific USCA costs have been divided by the lowest cost-outcome (the increased DRG 89), an intermediate one, in which the cost-outcome is the one of a hospitalization with mean resource consumption, and a minimal one, in which the cost-outcome is the one defined as low resource consumption in the article by Bianciardi et al, 2022.

The BEA developed in Table 10 shows a Break-Even Point (BEP) expressed in number of hospitalizations that USCA Figline should avoid in order to break even with its costs.

Table 10. Break-even point (BEP) expressed in number of cases in two years. A minimal scenario: class 2 and 3 cases; B intermediate scenario: 50% classes 2 and 100% classes 3; C maximal scenario: classes 3 only (see Table 7). USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

SCENARIOS	A	B	C
	minimal	intermediate	maximal
USCA specific cost *	723.884	723.884	723.884
cost-outcome per hospitalized patient §	14.873	9.157	7.271
BEP (number of hospitalizations that USCA Figline should avoid in order to break even with its costs.)	49	79	100

Note: * see table 6, § see table 9.

In Table 11 we show again the break-even point for USCA Figline, but now in form of incidences: over all positive patients who have come to USCA Figline observation and over all cases taken in charge by USCA Figline in the two years.

Table 11. Break-even point Analysis (BEA) expressed as incidence over the number of cases. USCA Figline, 1st July 2020 to 30th June 2022. Description in the text.

SCENARIOS	A	B	C
	minimal	intermediate	maximal
BEP: n° of cases in the period 1 July 2020 to 30 June 2022	49	79	100
BEP: mean n° of cases in every year	24	40	50
all positive cases USCA Figline from 1 July 2020 to 30 June 2022	1090	1090	1090
BEP incidence	*4.47%*	*7.25%*	*9.13%*
all cases taken over by USCA Figline from 1 July 2020 to 30 June 2022	1535	1535	1535
BEP incidence	*3.17%*	*5.15%*	*6.49%*

This Table shows that for USCA Figline it is enough to avoid the hospitalization of a small number of patients (24–50 per year) to break even. These numbers represent a small share of total USCA cases (3.17–6.49%). In other words, it would be enough for USCA Figline to avoid hospitalization even for a single patient every thirty visited (or even just one every two weeks) to result in a net zero cost for the health trust. And we were very prudent with our calculations.

6. What would have happened without USCAs?

We have seen clearly so far that the accesses to ER were contained by USCA Figline activity (Table 7). We tried to measure how much the USCAs in the area could have influenced reference hospital ER COVID-19 accesses, to understand what would happened if the data of USCA Figline alone, which includes about 20% of the inhabitants of the area that gravitates to the reference hospital, could be extrapolated to all the USCAs in the same hospital area.

To do so, we built Table 12 assuming, conservatively, that without USCAs the GPs would have sent to ER all classes 3 and 50% of the classes 2 referred to in Table 7[14]. The Table shows that without USCAs dozens of COVID-19 patients per day would go to the reference hospital ER and would do so for months. The absence of a brake within the territory would have led to a serious ER crisis and, as a consequence, of the hospital, especially in the most critical months.

What would happen if USCAs were missing can be seen much more clearly by plotting the data of the daily excess flow of COVID-19 patients to the reference hospital ER on a graph (Figure 6).

No ER could have withstood an additional flow of patients estimated at hundreds per month and dozens per day for prolonged periods, as in the period November 2020 to May 2021 and, although curbed by vaccinations, in the winter of 2021–2022. In the absence of USCAs' filter, the hyper influx would have overwhelmed not only ER, but the entire hospital, especially in the months of greatest activity of the epidemic, which corresponded precisely to the period of greatest stress on hospital facilities. In this respect, the establishment of the USCAs has certainly proved indispensable, at least in the experience of the territory we analyzed.

Table 12 Estimation of monthly and daily excess accesses to the reference hospital ER in the absence of all the USCAs. Period 1st July 2020 to 30th June 2022. Description in the text.

PERIOD		ACTIVITY USCA FIGLINE for home patients		COVID-19 patients sent to ER from USCA Figline's area only *					COVID-19 patients sent to ER from the whole reference hospital's area			
				actual by USCA		estimated by GPs **			linear extrapolation §		excess of ER sendings	
YEAR	MONTH	total patients	positive patients	each month	mean per day	each month	mean per day	*percentage of increase*	each month	mean per day	each month	mean per day
2020	July	66	21	1	0	5	0	*525%*	32	1	27	1
	August	69	50	1	0	31	1	*3125%*	193	6	188	6
	September	46	39	2	0	29	1	*1463%*	181	6	171	6
	October	102	32	6	0	22	1	*373%*	138	5	108	3
	November	140	48	23	1	36	2	*157%*	222	7	107	4
	Dicember	109	98	18	1	72	3	*399%*	444	15	354	11
2021	January	70	42	6	0	21	1	*336%*	130	4	98	3
	February	64	33	14	0	23	1	*165%*	143	5	73	3
	March	137	114	38	1	74	4	*194%*	455	15	265	9
	April	109	89	8	0	60	2	*779%*	373	12	334	11

Continued on next page

[14]First, we calculated the percentage of increase in COVID-19 ER accesses from the USCA Figline area without USCA Figline activity. Then, considering that the inhabitants of the USCA Figline district are only 19.33% of the inhabitants of the whole area of the reference hospital, the accesses to ER were linearly extrapolated to model a situation in which no USCAs were active in the hospital's area.

PERIOD		ACTIVITY USCA FIGLINE for home patients		COVID-19 patients sent to ER from USCA Figline's area only *					COVID-19 patients sent to ER from the whole reference hospital's area			
				actual by USCA		estimated by GPs **			linear extrapolation §		excess of ER sendings	
YEAR	MONTH	total patients	positive patients	each month	mean per day	each month	mean per day	*percentage of increase*	each month	mean per day	each month	mean per day
	May	88	71	6	0	48	2	*807%*	299	10	269	9
	June	24	16	5	0	8	0	*160%*	49	2	24	1
	July	17	10	3	0	4	0	*133%*	25	1	10	0
	August	19	16	4	0	12	1	*300%*	74	2	54	2
	September	22	16	1	0	6	0	*600%*	37	1	32	1
	October	19	17	0	0	6	0		35	1	35	1
	November	24	16	4	0	14	1	*350%*	86	3	66	2
	Dicember	31	24	6	0	14	1	*240%*	89	3	59	2
2022	January	121	106	13	0	66	3	*510%*	409	14	344	11
	February	70	66	10	0	36	2	*363%*	224	7	174	6
	March	53	49	8	0	31	1	*383%*	189	6	149	5
	April	73	63	7	0	35	1	*495%*	214	7	179	6
	May	44	37	6	0	15	1	*257%*	95	3	65	2
	June	18	17	0	0	13	0		79	3	79	3
TOTAL		1535	1090	190		683		*359%*	4214		3264	

Note: * including the deceased, ** it is estimated that, in the absence of USCA, the GPs sent all classes 3 + 50% classes 2 to the DEA (see table 7), § the inhabitants of the territory of USCA Figline are 19.33% of the inhabitants of the territory pertaining to the zonal hospital.

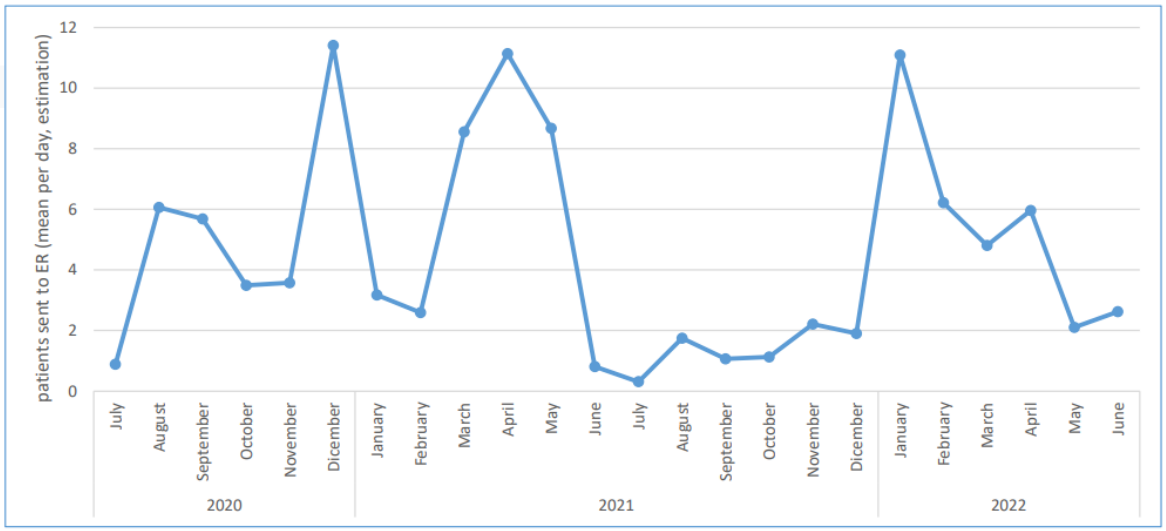

Figure 6. Estimation of the mean daily increase influx of COVID-19 cases to the reference hospital ER in the absence of USCAs. Description in the text.

7. Conclusions

What can we say in conclusion? That if a USCA is well directed and does its duty, as in the case of USCA Figline, it is unlikely to represent an increase on the regional health budget because the costs incurred by its operation are compensated for by avoided hospitalizations and all other benefits are at no cost. Among the benefits at no cost the following are worth noting: the safety of the population that

feels reassured in its possible needs, the low incidence of COVID-19 among GPs in the area, the reduction in the influx in the most critical periods of dozens of patients each day in the emergency room and the reduced need for hospital beds. However, we cannot extend what happens in USCA Figline to all the other USCAs, especially given the differences in USCAs operation in Italy, but we can affirm that USCA Figline represents a good example of management and that useful suggestions can be drawn from its experience.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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