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Article

Evaluating an Italian public health's approaches in response to COVID-19 pandemic challenges: the performance of Spoleto Hospital during the first five waves

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Abstract: The healthcare emergency was one of the most severe consequences of the outbreak of the COVID-19 pandemic that occurred from March 2020 until today, in subsequent waves. In this scenario, the Hospital of Spoleto "San Matteo degli Infermi" (located in the Umbria region, Italy) became a COVID-19 referral centre, therefore having to make organizational changes. This study aims to evaluate the quality of care and the health policies applied during the pandemic time, through interviews and survey results. Twenty-eight referents of Operational Units (OUs) from three Organizational Articulations (OAs) agreed to respond. The questionnaire consisted of 81 items, relating to ten topics inflected in the first five pandemic waves. Survey results were analyzed by the "SPRIS system", a tiered decisional matrix already described and applied successfully. In particular, it provides a measure of performance highlighting skills and issues. Findings showed that the individual OUs fluctuated from "good" to "very high" performance index, however "very high" performance range was reached cumulatively. Remarkably, the situation was improved after the first sudden wave, driven by adopting safety measures. In conclusion, this evaluation showed an optimal reaction of Spoleto Hospital during the first five waves, due to approaches taken in response to pandemic challenges.

Keywords: COVID-19; SWOT analysis; healthcare management; Streetlight PRIority Swot system (SPRIS)

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1. Introduction

The SARS-CoV-2-related disease negatively impacted our society in all its spheres, without precedent in contemporary history. It was first reported at the end of December 2019, during an outbreak that emerged in China and spread rapidly around the world [1]. On 30th January 2020, the World Health Organization (WHO) declared the COVID-19 outbreak as a public emergency of international concern [2] and as a pandemic on 11th March 2020, alarming all countries to immediately take notice and act [3].

In Italy, the COVID-19 pandemic occurred from late February – early March 2020 until today, as consequent waves and peaks [4]. In particular, the peaks were identified by calculating the incidence and prevalence of cases recorded at a national level [5]: i) 27th February 2020 – 28th June 2020; ii) 1st October 2020 – 2nd February 2021; iii) 26th February 2021 – 5th July 2021; iv) 14th July 2021 – 11th October 2021; v) 23rd October 2021 – 31st March 2022. During this period, the health crisis exerted pressure on Italian National Health System (I-NHS) at multiple levels, demonstrating itself as one of the most strenuous challenges ever faced [6]. The pandemic spread, on the human resources ground, caused prolonged periods of stress and a high emotional load. All this affected also the health status and the psycho-physical well-being of healthcare professionals through extended working time, and continuous exposure to the virus [7], [8]. On the care resources ground, the growing demand for COVID-19 treatment had to be coped with in a short time [9], concurrently maintaining the healthcare support for non-SARS-CoV-2-related disorders [10]. To address this emergency and guarantee the well-being of both patients and staff, the I-NHS redesigned its network adopting structural, organizational and management changes.

The I-NHS is divided at the territorial level into local health authorities (*Azienda Sanitaria Locale,* ASL), responsible for the delivery of socio-healthcare interventions, which each citizen can access [11].

Throughout the pandemic, the changes experienced by hospitals and local health centres were undertaken with high quality and timely, to enhance the likelihood of improved outcomes and satisfaction. Although several studies assessed the impact of the COVID-19 pandemic on specific areas, such as care units for neuromuscular [12] and chronic liver [13] disorders and surgical services [14], [15]. Currently, there is a lack of evidence regarding how issues manifested during the COVID-19 pandemic or what was done to address these challenges at the hospital-care level, as a complex network including multiple medical facilities.

In the case of health policy, the experience of those working in the hospital represents a very valuable input for the policy-making process. Therefore, gathering this evidence through interviews or survey results is one of the best ways to evaluate the quality of care and the policy itself [16].

Here, we developed a survey based on hospital workers' experience to outline the impact of the COVID-19 emergency on the hospital of Spoleto, during each five "wave" (time-point) and for each medical facility enrolled. Moreover, the survey aimed to evaluate the effectiveness of organizational models applied by the hospital as follows: i) identifying strengths, weaknesses and critical issues faced during the five pandemic waves, ii) providing a detailed score as a monitoring and improvement tool for health system performance and for appropriate intervention actions.

2. Materials and Methods

2.1 Study setting, design and participants

Umbria region is located in central Italy and accounts for around 855,000 citizens [17]. The regional NHS is composed of 2 ASL including several hospitals. Among these, the Spoleto "San Matteo degli Infermi" hospital has become a COVID-19 referral centre during the pandemic [18].

In this context, a retrospective observational study was conducted, based on an online survey. The study period runs from February 2020 to March 2022, divided into the first five pandemic waves identified.

Three Organizational Articulations of the hospital of Spoleto "San Matteo degli Infermi" were enrolled (Inpatient Units, Diagnosis and Care Services and Hospital Polyclinics), each one subdivided in 7, 14 and 7 Operational Units (OUs) respectively (**Table 1**). All referents voluntarily took part in the survey.

The study was conducted anonymously, following the provisions of the World Medical Association Declaration of Helsinki. The Ethical Committee of "Sapienza" University of Rome, Italy, was acquired (RIF. CE 5773_2020).

Table 1 - Medical facilities enrolled. The Organizational Articulations (OAs) network is subdivided into several Operational Units (OUs). Here is the correspondence list of their referring alphanumerical identifiers.

Organizational Articulations (OAs)					
OA1	**Inpatient Units**	**OA2**	**Diagnosis and Care Services**	**OA3**	**Hospital Polyclinics**
A	General Medicine	A	Pathological Anatomy	A	Audiology, Phoniatrics and Ear-nose-laryngology
B	Onco-haematology	B	Anesthesiology	B	General Surgery
C	General Surgery	C	Angiology	C	Orthopaedics
D	Obstetrics and Gynecology	D	Cardiology	D	Paediatrics
E	Ophthalmology	E	Dietetics	E	Hospital Polyclinics
F	Orthopaedic-Traumatology	F	Gastrointestinal Endoscopy	F	Accident and Emergency
G	Reanimation	G	Haepatology	G	Pain Therapy
		H	Analysis Laboratory		
		I	Nephrology and Dialysis		
		J	Neurophysiopathology		
		K	Radiology		
		L	Radiotherapy		
		M	Cardiovascular Rehabilitation		
		N	Transfusional and immunological Medicine		
Operational Units (OUs)					

2.2 Survey and data collection

The survey was developed on the "Microsoft Forms" platform (Microsoft Office 365, 2021) and administered via a cross-sectional online questionnaire to members responsible for the enrolled wards. The questionnaire was divided into ten sections by thematic area,

reaching a total of 81 items, as shown in **Table 2**. The used tool was previously designed and validated [19]–[22].

Data collection was made up of multiple-choice-answers for each query, identifying four graduated feedback (yes, enough, not enough, not at all) and "Not applicable" if the item is not relevant. Respondents were asked to indicate the qualitative category that comes closest to their position.

Table 2 - Structure and content of the survey administered.

Section Number	Section Title	Sub-sections	Items
1	Context Analysis	1	5
2	Patient Access to the hospital	2	10
3	Impact on taking charge of NON-COVID-19 patients	2	2
4	Impact on taking charge of COVID-19 patients	2	10
5	Impact on patient management	2	10
6	Experience at COVID-19 referral centre	6	6
7	Procedures and recommendations for healthcare personnel/users	2	10
8	Education-Information-Training: healthcare professionals' management	2	10
9	Analysis of factors internal to the organization	10	10
10	Analysis of factors external to the organization	8	8
			Total: 81

2.3 Data analysis

To analyze survey findings, qualitative results were converted into quantitative data using a five points Likert scale [23]: "yes" is equal to 4, "enough" to 3, "not enough" to 2, "not at all" to 1 and "not applicable" to 0, considered as a null value and ignored. The means and standard deviations (SDs) of values were calculated at multiple degrees of aggregation, for both query and respondent: i) for each item and section of the questionnaire; ii) for respondents cumulatively and for each OA and OU individually. A mean score > 2.99 was considered as a good level of performance, representing a strength; while a mean score > 1.80 was the cutoff for an acceptable level of performance and a mean score < 1.80 was the cutoff for a not acceptable level of performance, identifying a faint and a strong weakness respectively (**Table 3**).

Subsequently, a three-tiered decisional matrix was applied to these values. This analysis tool was proposed as Streetlight PRIority Swot system (SPRIS), already developed and previously described [22], [24]. Briefly, the Streetlight colour system shows results using a coloured scale (green for strengths, yellow for faint weaknesses and red for strong weaknesses), providing an immediate snapshot of the survey findings. The Priority score system converts the mean scores in a classification scale from 1 to 10, based on sub-intervals, and thus assigns a priority score (PS) to them (**Table 3**). The priority score numerically defines how important the query is for strategic planning: i) establishing the priority of improving actions to take for weaknesses, ii) indicating the valuable impact for strengths.

Table 3 – Criteria for data analysis. Thresholds and conversion scale.

Established cut-offs	Category	Sub-intervals		Classification scale	Priority score (PS)
Not Acceptable <1.80	Strong Weakness	0,00	0,45	1	5
		0,46	0,89	2	4
		0,90	1,35	3	3
		1,36	1,79	4	2
1.80≤ Acceptable ≤2.98	Faint Weakness	1,80	2,20	5	1,5
		2,21	2,60	6	1
		2,61	2,98	7	0,5
Good ≥2.99	Strength	2,99	3,33	8	1,5
		3,34	3,66	9	3
		3,67	4,00	10	4,5

Finally, the SWOT Analysis is performed to assess factors (i.e., strengths, weaknesses, opportunities, and threats) that might affect the reality considered. Since the survey is only based on objective items, the SWOT Analysis presents two groups of elements (i.e., strengths and weaknesses) and the priority scores were used directly by themselves [24]. By inserting numerical values of the queries divided into the group of elements belonging to, the Next-Generation SWOT Analysis calculates a quantitative performance index, in addition to descriptively correlating data.

$$PERFORMANCE\ INDEX\ (\%) = \frac{\sum PS_{\text{Strenghts}}\ X\ 100}{\sum PS_{\text{Strenghts}} + \sum PS_{\text{Weaknesses}}}$$

The queries had the same "weight" and the inserted variables were considered independent ones. To evaluate the response, we considered five ranges of performance (23): i) <5 is equal to "null", ii) >5 and <30 to "low", iii) >30 and <60 to "good", iv) >60 and <80 to "high" and v) >80 to "very high".

Overall, we performed the analysis at two levels of query aggregation: the deeper one for items and the shallower one for sections, obtaining two performance indexes for each respondent. Consequently, results were released cumulatively for all the Organizational Articulations, whereas for each Organizational Articulation and Operational Unit individually.

3. Results

3.1 Survey findings

We collected twenty-seven out of twenty-eight completed surveys from the referents enrolled (*Neurophysiopathology*, OA2-J, was not available, na). Regarding all the queries, for each participant qualitative results were converted into quantitative data and formatted by the *Streetlight colour system* (**Table 4**).

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Table 4 – Summary of survey findings by the Streetlight colour system (first tier). Quantitative results are identified by conversion scale: "yes"=4 and "enough"=3 are coloured in green as strength, "not enough"=2 is in yellow as faint weakness whilst "not at all"=1 in red as strong weakness. The value "not applicable"=0 is excluded and therefore coloured in grey. Questionnaire items are listed here. Respondents (i.e., OA and OU individually) are referred to as their alphanumerical identifiers (see Table 1).

			OA/OU	ALL Oas			OA1 (ALL OUs)			Inpatient Units							OA2 (ALL OUs)			Diagnosis and Care Services														OA3 (ALL OUs)			Hospital Polyclinics						
# SECTION	SECTION	# ITEM	ITEM (query)	SD	Mean	Sum	SD	Mean	Sum	A	B	C	D	E	F	G	SD	Mean	Sum	A	B	C	D	E	F	G	H	I	J	K	L	M	N	SD	Mean	Sum	A	B	C	D	E	F	G
1	Context Analysis		**Did the amount of medical procedures increase?**																																								
		1	During the first wave	0,12	1,85	49,00	1,21	1,83	11,00	1	0	3	1	1	1	4	0,88	2,00	26,00	3	2	1	3	2	1	2	3	3	0	1	1	3	1	0,88	1,71	12,00	3	3	1	2	1	1	1
		2	During the second wave	0,34	1,87	40,00	1,47	2,20	11,00	4	0	0	1	1	1	4	1,13	2,00	22,00	3	2	1	0	2	1	2	4	4	0	1	1	0	1	0,49	1,40	7,00	0	0	1	2	2	1	1
		3	During the third wave	0,18	2,09	51,00	1,47	2,20	11,00	4	0	0	1	1	1	4	1,05	2,23	29,00	3	1	3	2	4	1	2	4	3	0	1	1	2	2	0,69	1,83	11,00	2	0	1	3	2	2	1
		4	During the fourth wave	0,31	2,35	63,00	1,16	2,29	16,00	4	4	2	2	2	1	1	1,16	2,75	33,00	4	0	4	3	3	1	2	3	4	0	1	1	3	4	0,76	2,00	14,00	3	2	1	3	2	2	1
		5	During the fifth wave	0,19	2,20	61,00	0,93	2,00	14,00	2	4	2	2	2	1	1	1,22	2,46	32,00	4	1	4	2	4	1	2	3	3	0	1	1	2	4	0,99	2,14	15,00	2	2	1	4	2	3	1
2	Patient Access to the hospital		**Were safety protocols adopted?**																																								
		6	During the first wave	0,06	3,63	98,00	1,05	3,57	25,00	1	4	4	4	4	4	4	0,74	3,62	47,00	4	3	4	2	4	4	4	4	4	0	4	4	2	4	0,70	3,71	26,00	2	4	4	4	4	4	4
		7	During the second wave	0,00	4,00	104,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,00	4,00	24,00	4	4	4	4	4	4	0
		8	During the third wave	0,07	3,95	107,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		9	During the fourth wave	0,09	3,83	104,00	0,35	3,86	27,00	3	4	4	4	4	4	4	0,27	3,92	51,00	4	4	4	4	4	4	4	3	4	0	4	4	4	4	0,45	3,71	26,00	4	4	4	4	3	4	3
		10	During the fifth wave	0,10	3,78	103,00	0,45	3,71	26,00	3	4	4	4	3	4	4	0,27	3,92	51,00	4	4	4	4	4	4	4	3	4	0	4	4	4	4	0,45	3,71	26,00	4	4	4	4	3	4	3
			Were social distancing measures taken?																																								
		11	During the first wave	0,12	3,48	93,00	1,05	3,57	25,00	1	4	4	4	4	4	4	1,07	3,31	43,00	4	3	4	1	4	4	3	3	4	0	4	4	1	4	1,05	3,57	25,00	1	4	4	4	4	4	4
		12	During the second wave	0,06	3,93	106,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,27	3,92	51,00	4	4	4	4	4	4	3	4	4	0	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		13	During the third wave	0,06	3,93	106,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,27	3,92	51,00	4	4	4	4	4	4	3	4	4	0	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		14	During the fourth wave	0,08	3,68	100,00	0,73	3,57	25,00	2	4	4	4	4	4	3	0,42	3,77	49,00	4	4	4	4	4	4	3	3	3	0	4	4	4	4	0,45	3,71	26,00	4	4	4	4	3	4	3
		15	During the fifth wave	0,20	3,56	97,00	1,16	3,29	23,00	1	4	4	4	4	4	2	0,61	3,69	48,00	4	4	4	4	4	4	3	3	2	0	4	4	4	4	0,45	3,71	26,00	4	4	4	4	3	4	3
3	Impact on taking charge of NON-COVID-19 patients		**During the first two waves, considered as the most critical for adjustment, related to NON-COVID-19 patients:**																																								
		16	Have canceled visits been rescheduled and retrieved?	0,10	3,55	88,00	0,49	3,57	25,00	4	4	3	4	3	4	3	0,76	3,42	41,00	0	2	4	3	4	3	4	4	4	0	4	4	3	2	0,47	3,67	22,00	3	3	4	4	4	0	4
		17	Have remote clinical services been activated for patients who cannot interrupt their treatment (telemedicine)?	0,16	2,80	60,00	1,02	2,60	13,00	1	4	0	3	0	3	2	1,28	3,00	33,00	0	0	4	1	1	3	4	3	4	0	4	4	1	4	1,17	2,80	14,00	1	0	3	4	4	0	2
4	Impact on taking charge of COVID-19 patients		**Did you treat COVID-19 patients?**																																								
		18	During the first wave	0,61	1,84	52,00	0,47	1,33	8,00	2	0	1	1	1	1	2	1,43	2,69	35,00	4	1	4	1	4	4	2	4	4	0	4	1	1	1	1,12	1,50	9,00	1	1	1	1	1	4	0
		19	During the second wave	0,47	2,41	65,00	1,34	2,17	13,00	4	0	2	1	1	1	4	1,21	3,08	40,00	4	4	4	2	4	4	2	4	4	0	4	1	2	1	1,00	2,00	12,00	2	2	1	2	1	4	0
		20	During the third wave	0,52	2,12	58,00	1,11	1,67	10,00	1	0	2	1	1	1	4	1,35	2,85	37,00	4	4	4	1	3	4	2	4	4	0	4	1	1	1	1,07	1,83	11,00	1	2	1	2	1	4	0
		21	During the fourth wave	0,58	1,90	53,00	0,47	1,33	8,00	2	0	1	1	1	1	2	1,43	2,69	35,00	4	4	4	1	1	4	2	4	4	0	4	1	1	1	1,11	1,67	10,00	1	1	1	2	1	4	0
		22	During the fifth wave	0,46	1,88	51,00	0,47	1,33	8,00	2	0	1	1	1	1	2	1,45	2,46	32,00	4	1	4	1	1	4	2	4	4	0	4	1	1	1	1,21	1,83	11,00	1	1	1	3	1	4	0
			Have clinical pathways for COVID-19 and NON-COVID-19 patients been separated?																																								
		23	During the first wave	0,12	3,63	77,00	1,12	3,50	21,00	1	4	4	0	4	4	4	0,40	3,80	38,00	4	3	4	0	4	4	3	0	4	0	4	4	0	4	0,80	3,60	18,00	0	4	4	4	0	4	2
		24	During the second wave	0,04	3,97	95,00	0,00	4,00	24,00	4	4	4	0	4	4	4	0,28	3,92	47,00	4	4	4	4	4	4	3	0	4	0	4	4	4	4	0,00	4,00	24,00	4	4	4	4	0	4	4
		25	During the third wave	0,14	3,86	93,00	0,75	3,67	22,00	2	4	4	0	4	4	4	0,28	3,92	47,00	4	4	4	4	4	4	3	0	4	0	4	4	4	4	0,00	4,00	24,00	4	4	4	4	0	4	4
		26	During the fourth wave	0,12	3,75	91,00	0,75	3,67	22,00	4	4	4	0	4	2	4	0,28	3,92	47,00	4	4	4	4	4	4	3	0	4	0	4	4	4	4	0,75	3,67	22,00	4	4	2	4	0	4	4
		27	During the fifth wave	0,20	3,64	89,00	0,76	3,50	21,00	4	4	3	0	4	2	4	0,28	3,92	47,00	4	4	4	4	4	4	3	0	4	0	4	4	4	4	0,76	3,50	21,00	4	3	2	4	0	4	4
5	Impact on patient management		**Was the continuity of care ensured for NON-COVID-19 patients?**																																								
		28	During the first wave	0,08	3,59	94,00	1,12	3,50	21,00	4	4	4	0	4	1	4	0,61	3,69	48,00	4	3	3	4	2	4	4	4	4	0	4	4	4	4	1,05	3,57	25,00	4	4	1	4	4	4	4
		29	During the second wave	0,72	2,92	79,00	1,41	2,00	12,00	1	4	1	0	4	1	1	0,42	3,77	49,00	4	4	3	4	3	4	3	4	4	0	4	4	4	4	1,41	3,00	18,00	4	1	1	4	4	4	0
		30	During the third wave	0,51	3,29	86,00	1,37	2,67	16,00	4	4	1	0	4	2	1	0,28	3,92	47,00	4	0	4	4	4	4	3	4	4	0	4	4	4	4	1,16	3,29	23,00	4	1	2	4	4	4	4
		31	During the fourth wave	0,28	3,63	93,00	0,75	3,33	20,00	4	4	2	0	4	3	3	0,00	4,00	48,00	4	0	4	4	4	4	4	4	4	0	4	4	4	4	0,73	3,57	25,00	4	2	3	4	4	4	4
		32	During the fifth wave	0,22	3,69	98,00	0,76	3,50	21,00	4	4	2	0	4	3	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,73	3,57	25,00	4	2	3	4	4	4	4
			Was the continuity of care ensured for COVID-19 patients?																																								
		33	During the first wave	0,85	2,17	49,00	0,00	1,00	3,00	1	0	1	0	0	0	1	1,29	3,00	36,00	4	1	4	1	4	2	3	4	4	0	4	0	1	4	1,50	2,50	10,00	1	1	0	4	0	4	0
		34	During the second wave	0,27	3,31	66,00	1,41	3,00	9,00	4	0	1	0	0	0	4	0,62	3,67	44,00	4	3	4	4	4	2	3	4	4	0	4	0	4	4	1,30	3,25	13,00	4	1	0	4	0	4	0
		35	During the third wave	0,31	3,33	67,00	1,41	3,00	9,00	4	0	1	0	0	0	4	0,60	3,75	45,00	4	4	4	4	4	2	3	4	4	0	4	0	4	4	1,30	3,25	13,00	4	1	0	4	0	4	0
		36	During the fourth wave	0,74	3,00	64,00	1,41	2,00	6,00	4	0	1	0	0	0	1	0,60	3,75	45,00	4	4	4	4	4	2	3	4	4	0	4	0	4	4	1,30	3,25	13,00	4	1	0	4	0	4	0
		37	During the fifth wave	0,71	2,97	63,00	1,41	2,00	6,00	4	0	1	0	0	0	1	0,62	3,67	44,00	4	3	4	4	4	2	3	4	4	0	4	0	4	4	1,30	3,25	13,00	4	1	0	4	0	4	0
6	Experience as COVID-19 referral center		**During the second wave, Spoleto Hospital became COVID-19 referral center:**																																								
		38	In your opinion, was it the most complex pandemic phase?	0,06	3,62	94,00	0,73	3,57	25,00	4	4	4	2	3	4	4	0,86	3,58	43,00	0	4	4	3	4	4	4	4	1	0	4	4	3	4	0,45	3,71	26,00	3	4	4	3	4	4	4
		39	Were all medical procedures guaranteed despite the closure of some clinical wards?	0,36	2,04	58,00	1,03	1,71	12,00	1	2	1	2	4	1	1	1,01	2,54	33,00	4	1	4	2	1	2	3	2	4	0	3	2	2	3	0,83	1,86	13,00	2	1	1	3	2	3	1
		40	Did the closure of some clinical wards create inconvenience to users?	0,26	3,55	94,00	0,35	3,86	27,00	4	4	4	4	3	4	4	0,97	3,23	42,00	4	4	3	4	4	4	3	3	1	0	4	2	4	2	0,73	3,57	25,00	4	4	4	2	4	4	3
		41	Has the timing been respected in the passage of the patient from one care setting to another within the Hospital?	0,14	3,17	76,00	0,76	3,00	21,00	2	3	3	2	4	3	4	0,94	3,18	35,00	0	4	4	4	2	4	3	3	1	0	0	3	4	3	0,47	3,33	20,00	4	3	3	0	3	3	4
		42	Were multidisciplinary discussions on the health status of patients carried out?	0,46	2,76	60,00	1,07	2,17	13,00	1	4	2	1	3	0	2	0,90	3,30	33,00	0	4	4	4	2	2	2	4	4	0	0	3	4	0	0,98	2,80	14,00	4	2	0	0	2	2	4
		43	Have structural and organizational changes been made in your medical facility?	0,16	3,68	98,00	0,45	3,71	26,00	3	4	4	4	3	4	4	1,01	3,46	45,00	2	4	4	4	4	4	2	4	4	0	4	4	4	1	0,35	3,86	27,00	4	4	4	4	4	4	3
7	Procedures and recommendations for healthcare personnel/users		**Was the proper use of PPE monitored in patients and their families?**																																								
		44	During the first wave	0,12	3,29	89,00	1,05	3,43	24,00	1	4	3	4	4	4	4	1,07	3,31	43,00	4	3	4	1	3	4	3	4	4	0	4	4	1	4	1,12	3,14	22,00	1	3	4	4	4	4	2
		45	During the second wave	0,07	3,95	107,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		46	During the third wave	0,18	3,76	103,00	0,45	3,71	26,00	4	4	3	4	4	3	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,49	3,57	25,00	4	3	3	4	4	4	3
		47	During the fourth wave	0,21	3,64	100,00	0,49	3,57	25,00	4	4	3	4	4	3	3	0,27	3,92	51,00	4	4	4	4	4	4	4	4	3	0	4	4	4	4	0,49	3,43	24,00	4	3	3	4	3	4	3
		48	During the fifth wave	0,22	3,59	98,00	0,45	3,71	26,00	4	4	3	4	4	3	4	0,42	3,77	49,00	4	4	4	3	4	4	4	4	3	0	4	4	3	4	0,45	3,29	23,00	3	3	3	4	3	4	3
			Were the procedures/recommendations made clear and visible and respected?																																								
		49	During the first wave	0,13	3,33	94,00	1,05	3,43	24,00	1	4	3	4	4	4	4	0,73	3,43	48,00	4	3	4	2	3	4	3	3	4	4	4	4	2	4	1,12	3,14	22,00	2	3	4	4	4	4	1
		50	During the second wave	0,07	3,90	109,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,35	3,86	54,00	4	4	4	4	4	4	3	3	4	4	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		51	During the third wave	0,00	3,86	108,00	0,35	3,86	27,00	3	4	4	4	4	4	4	0,35	3,86	54,00	4	4	4	4	4	4	3	3	4	4	4	4	4	4	0,35	3,86	27,00	4	4	4	4	4	4	3
		52	During the fourth wave	0,12	3,71	105,00	0,45	3,71	26,00	3	4	3	4	4	4	4	0,35	3,86	54,00	4	4	4	4	4	4	3	3	4	4	4	4	4	4	0,49	3,57	25,00	4	3	4	4	3	4	3
		53	During the fifth wave	0,13	3,62	102,00	0,45	3,71	26,00	3	4	3	4	4	4	4	0,45	3,71	52,00	4	4	4	3	4	4	3	3	4	4	4	4	3	4	0,49	3,43	24,00	3	3	4	4	3	4	3
8	Education-Information-Training: healthcare professionals' management		**Have healthcare workers been educated and trained on PPE dressing/dusting procedurs?**																																								
		54	During the first wave	0,32	2,93	85,00	1,12	2,86	20,00	1	4	2	4	4	3	2	0,81	3,36	47,00	4	3	3	2	2	4	4	4	4	3	4	4	2	4	1,05	2,57	18,00	2	2	3	4	2	4	1
		55	During the second wave	0,17	3,69	105,00	0,49	3,57	25,00	3	4	3	4	4	3	4	0,26	3,93	55,00	4	4	4	4	4	4	4	4	4	3	4	4	4	4	0,49	3,57	25,00	4	3	3	4	4	4	3
		56	During the third wave	0,34	3,31	96,00	1,20	3,00	21,00	2	4	2	4	4	1	4	0,77	3,79	53,00	4	4	4	4	4	4	4	4	4	1	4	4	4	4	1,12	3,14	22,00	4	2	1	4	4	4	3
		57	During the fourth wave	0,37	3,26	95,00	1,20	3,00	21,00	2	4	2	4	4	1	4	0,77	3,79	53,00	4	4	4	4	4	4	4	4	4	1	4	4	4	4	1,07	3,00	21,00	4	2	1	4	3	4	3
		58	During the fifth wave	0,37	3,26	95,00	1,20	3,00	21,00	2	4	2	4	4	1	4	0,77	3,79	53,00	4	4	4	4	4	4	4	4	4	1	4	4	4	4	1,07	3,00	21,00	4	2	1	4	3	4	3
			Was the staff equipped with different types of PPE in accordance with the professional exposure risk?																																								
		59	During the first wave	0,42	2,63	70,00	0,94	2,33	14,00	1	4	2	2	3	0	2	1,05	3,23	42,00	4	3	3	1	3	3	4	4	4	0	4	4	1	4	1,25	2,33	14,00	1	2	0	4	1	4	2
		60	During the second wave	0,16	3,78	96,00	0,47	3,67	22,00	4	4	4	4	3	0	3	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,47	3,67	22,00	4	4	0	4	3	4	3
		61	During the third wave	0,28	3,61	93,00	0,47	3,33	20,00	3	4	3	4	3	0	3	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,50	3,50	21,00	4	3	0	4	3	4	3
		62	During the fourth wave	0,31	3,53	91,00	0,69	3,17	19,00	3	4	3	4	3	0	2	0,27	3,92	51,00	4	4	4	4	4	3	4	4	4	0	4	4	4	4	0,50	3,50	21,00	4	3	0	4	3	4	3
		63	During the fifth wave	0,31	3,53	91,00	0,69	3,17	19,00	3	4	3	4	3	0	2	0,27	3,92	51,00	4	4	4	4	4	3	4	4	4	0	4	4	4	4	0,50	3,50	21,00	4	3	0	4	3	4	3
9	Analysis of factors internal to organization	64	When Spoleto Hospital became COVID-19 referral center, were healthcare workers periodically tested for COVID-19 by nasopharyngeal swab?	0,13	3,90	106,00	0,00	4,00	28,00	4	4	4	4	4	4	4	0,00	4,00	52,00	4	4	4	4	4	4	4	4	4	0	4	4	4	4	0,45	3,71	26,00	4	4	4	4	4	3	3
		65	When Spoleto Hospital became COVID-19 referral center, did the fear of contagion between staff/patients increase?	0,06	3,62	94,00	0,45	3,71	26,00	4	4	3	4	3	4	4	0,64	3,58	43,00	0	4	4	4	4	4	3	4	2	0	4	3	4	3	0,49	3,57	25,00	4	3	4	4	4	3	3
		66	Has the working time been adequately reorganized for the possible lack of personnel due to the COVID-19 positivity?	0,10	3,13	82,00	0,83	3,14	22,00	2	3	2	4	4	3	4	0,83	3,25	39,00	4	1	3	4	0	3	3	3	4	0	4	3	4	3	0,76	3,00	21,00	4	2	3	3	3	4	2
		67	In your opinion, have there been any changes in the internal atmosphere of your medical facility regarding the organizational well-being?	0,19	3,58	95,00	0,70	3,71	26,00	4	4	4	4	2	4	4	0,82	3,31	43,00	4	4	4	4	4	2	2	3	2	0	4	3	4	3	0,45	3,71	26,00	4	4	4	3	4	3	4
			Evaluate how much the following factors influenced the internal atmosphere when Spoleto Hospital was COVID-19 referrel center:																																								
		68	The presence of a coordination team	0,67	2,72	67,00	0,75	1,80	9,00	1	0	2	0	3	1	2	0,64	3,36	37,00	0	0	4	4	3	3	3	3	2	0	4	3	4	4	1,07	3,00	21,00	4	2	1	3	3	4	4
		69	The closeness and support of colleagues	0,25	3,46	88,00	0,50	3,50	21,00	4	3	4	0	3	3	4	0,43	3,75	45,00	0	4	4	4	4	4	3	4	3	0	4	3	4	4	0,99	3,14	22,00	4	4	3	3	1	3	4
		70	The possibility of being able to rely on one's contacts both as individuals and as a working group	0,34	2,89	77,00	0,73	2,43	17,00	1	2	3	3	3	2	3	0,72	3,25	39,00	0	4	4	3	2	2	3	4	4	0	4	3	3	3	0,76	3,00	21,00	3	3	2	3	2	4	4
		71	Sharing the most difficult moments even with new colleagues	0,27	3,19	79,00	0,58	3,00	18,00	2	3	3	3	3	0	4	0,64	3,58	43,00	0	4	4	4	2	4	3	4	4	0	4	3	4	3	0,82	3,00	18,00	4	3	0	3	2	2	4
		72	The collaborative atmosphere and willingness to listen of the working group	0,17	3,19	78,00	0,58	3,00	18,00	3	2	3	3	3	0	4	0,64	3,42	41,00	0	4	4	4	2	3	3	3	4	0	4	3	4	3	0,69	3,17	19,00	4	3	0	3	2	3	4
		73	The inclusion of telemedicine in diagnosis and monitoring	0,60	2,68	61,00	0,49	2,60	13,00	0	3	2	3	3	0	2	0,50	3,45	38,00	0	4	4	3	0	3	3	3	4	0	4	3	3	4	0,63	2,00	10,00	3	2	0	2	1	2	0
10	Analysis of factors external to organization		**Evaluate how much the following external factors influenced the objective achievement of the Hospital:**																																								
		74	Human resources implementations	0,37	2,55	72,00	0,70	2,29	16,00	2	2	2	2	2	2	4	1,07	3,08	40,00	2	4	3	4	1	2	2	4	4	0	4	2	4	4	1,16	2,29	16,00	4	2	2	1	1	4	2
		75	Greater collaboration between local medical centers and the Hospital	0,26	2,47	58,00	0,73	2,43	17,00	2	2	2	4	3	2	2	0,87	2,80	28,00	2	0	3	3	1	3	3	4	0	0	0	2	3	4	0,69	2,17	13,00	3	2	2	2	1	3	0
		76	Effectiveness of mass vaccination	0,18	3,51	95,00	0,45	3,71	26,00	3	4	4	4	4	3	4	0,63	3,54	46,00	3	4	4	3	2	4	4	4	4	0	4	3	3	4	0,70	3,29	23,00	3	4	3	3	2	4	4
		77	Persistence of the COVID-19 pandemic	0,06	3,39	91,00	0,90	3,43	24,00	4	4	4	2	4	4	2	0,72	3,31	43,00	4	4	2	3	4	3	4	4	2	0	4	3	3	3	0,73	3,43	24,00	3	4	4	3	2	4	4
		78	Lack of willingness to change of the "senior" staff	0,15	2,23	55,00	0,69	2,17	13,00	3	0	2	1	3	2	2	0,64	2,08	25,00	2	2	2	2	1	2	3	3	2	0	0	1	2	3	0,49	2,43	17,00	2	2	2	3	3	2	3
		79	Possible redistribution of medical procedures based on their complexity between hospitals in Umbria	0,11	2,56	66,00	0,50	2,50	15,00	2	3	3	0	3	2	2	0,75	2,46	32,00	2	2	2	3	1	2	3	4	3	0	2	2	3	3	0,45	2,71	19,00	3	3	2	3	2	3	3
		80	Recruitment of non-trained personnel	0,31	2,86	75,00	0,83	3,14	22,00	4	4	2	4	3	2	3	0,41	3,00	36,00	2	4	3	3	3	3	3	3	3	0	0	3	3	3	0,49	2,43	17,00	3	2	2	3	3	2	2
		81	Lack of public funds	0,24	3,12	84,00	0,83	2,86	20,00	4	2	4	2	3	3	2	0,73	3,08	40,00	2	2	3	3	4	4	3	4	3	0	2	3	3	4	0,49	3,43	24,00	3	4	3	3	4	3	4

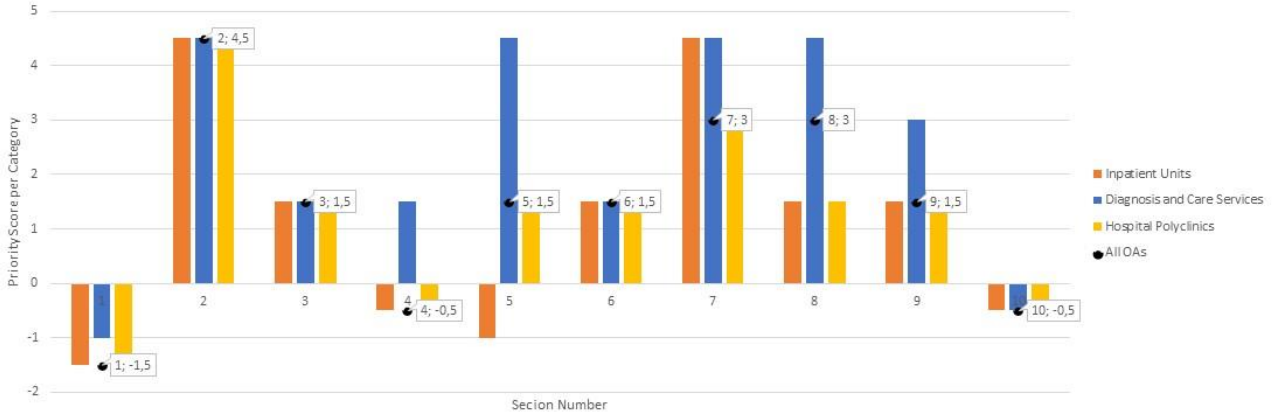
By applying the *Priority score system*, results related to sections for each OA were described in **Figure 1A**. Additionally, **Supplementary Tables 1-3** provided the results related to items both for OAs and OUs individually. Overall, the survey sections 1, 4 and 10 ("Context Analysis", "Impact on taking charge of COVID-19 patients", "Analysis of factors external to the organization") were the ones that were identified as weaknesses (faint) (**Figure 1B**). The remaining sections resulted in strengths, among them section 2 ("Patient Access to the hospital") ranked the highest priority score (**Figure 1B**).

Figure 1 – Summary of Priority score system (second tier). (A) Results related to sections for each OA, based on the conversion scale. **(B)** The bar chart shows the priority scores along Y-axis: negative values for weakness and positive ones for strengths.

A

	OA/OU	ALL OAs				Inpatient Units				Diagnosis and Care Services				Hospital Polyclinics			
# SECTION	SECTION	Mean	Classification scale	Priority Score	Category	Mean	Classification scale	Priority Score	Category	Mean	Classification scale	Priority Score	Category	Mean	Classification scale	Priority Score	Category
1	Context Analysis	2,07	5	1,5	Faint Weakness	2,10	5	1,5	Faint Weakness	2,29	6	1	Faint Weakness	1,82	5	1,5	Faint Weakness
2	Patient Access to the hospital	3,78	10	4,5	Strength	3,76	10	4,5	Strength	3,81	10	4,5	Strength	3,77	10	4,5	Strength
3	Impact on taking charge of NON-COVID-19 patients	3,18	8	1,5	Strength	3,09	8	1,5	Strength	3,21	8	1,5	Strength	3,23	8	1,5	Strength
4	Impact on taking charge of COVID-19 patients	2,90	7	0,5	Faint Weakness	2,62	7	0,5	Faint Weakness	3,32	8	1,5	Strength	2,76	7	0,5	Faint Weakness
5	Impact on patient management	3,19	8	1,5	Strength	2,60	6	1	Faint Weakness	3,72	10	4,5	Strength	3,25	8	1,5	Strength
6	Experience as COVID-19 referral center	3,14	8	1,5	Strength	3,00	8	1,5	Strength	3,22	8	1,5	Strength	3,19	8	1,5	Strength
7	Procedures and recommendations for healthcare personnel/users	3,67	9	3	Strength	3,71	10	4,5	Strength	3,77	10	4,5	Strength	3,51	9	3	Strength
8	Education-Information-Training: healthcare professionals' management	3,35	9	3	Strength	3,11	8	1,5	Strength	3,77	10	4,5	Strength	3,18	8	1,5	Strength
9	Analysis of factors internal to organization	3,24	8	1,5	Strength	3,09	8	1,5	Strength	3,50	9	3	Strength	3,13	8	1,5	Strength
10	Analysis of factors external to organization	2,83	7	0,5	Faint Weakness	2,82	7	0,5	Faint Weakness	2,92	7	0,5	Faint Weakness	2,77	7	0,5	Faint Weakness
	Cumulatively	**3,13**	**8**	**1,5**	**Strength**	**2,99**	**7**	**0,5**	**Faint Weakness**	**3,35**	**9**	**3**	**Strength**	**3,06**	**8**	**1,5**	**Strength**

B



3.2 Conduct of medical facilities

Therefore, we defined the performance of medical facilities enrolled using the *Next-Generation SWOT Analysis*. Cumulatively, the performance indexes showed "very high" performance in both settings (i.e. query aggregation for items and sections), as they were 87% and 86,8% respectively (**Table 5a**).

For each OA results were shown in **Table 5b**. *Inpatient Units* reached the "very high" range (performance indexes of 79.9% and 81.1%). *Diagnosis and Care Services* (performance indexes of 95.1% and 94.4%) and *Hospital Polyclinics* (performance indexes of 85.7% and 85.7%) reached a complete "very high" performance range in both analyses.

Specifically, the results varied from "good" (>30-60%) to a "very high" range of performance among the OUs. Thus, we chose the best and the worst OU/ward for each Organizational Articulation to report here (**Table 5c**). For OA1, *Orthopaedic-Traumatology* registered the lowest performance indexes (48.7% and 40%), reaching "good" ranges; and *Reanimation* ranked the highest ones (80,6% and 86,8%), reaching "very high" ranges. For OA2, the worst OUs were *Radiotherapy* and *Pathological Anatomy* (indexes of 77,5% and 69,9% respectively, however, included in the "high" performance range); whereas the best OU was *Angiology*, which reached the "very high" performance range indexes of 96,7%

and 98,7%. For OA3, *Orthopaedics and Hospital Polyclinics* returned "good" range of performance with indexes of 52,5% and 41,7% respectively; conversely *Accident and Emergency* registered a "very high" range of performance with indexes of 93% and 88,5%.

Table 5 – Summary of performances (third tier). Results for respondents by both the deeper and the shallower analysis.

Respondent Aggregation Level	Respondent	Query Aggregation Level	Strengths	Weaknesses	Performance Index (%)
(a) All the OAs	-	for items	174	26	87
		for sections	16	2,5	86,5
(b) for each OA	Inpatient Units	for items	166,5	42	79,9
		for sections	15	3,5	81,1
	Diagnosis and Care Services	for items	234	12	95,1
		for sections	25,5	1,5	94,4
	Hospital Polyclinics	for items	174	29	85,7
		for sections	15	2,5	85,7
(c) for each OU	Orthopaedic-Traumatology	for items	135	142	48,7
		for sections	9	13,5	40
	Reanimation	for items	226,5	54,5	80,6
		for sections	16,5	2,5	86,8
	Radiotherapy	for items	225	65,5	77,5
	Pathological Anatomy	for sections	25,5	11	69,9
	Angiology	for items	309	10,5	96,7
		for sections	37,5	0,5	98,7
	Orthopaedics	for items	148,5	134,5	52,5
	Hospital Polyclinics	for sections	7,5	10,5	41,7
	Accident and Emergency	for items	283,5	21,5	93
		for sections	27	3,5	88,5

Legend of performance ranges	
0	null
5	
10	
20	low
30	
40	
50	good
60	
70	high
80	very high
90	

3.3 Impact of 'wave'

In order to evaluate the impact of 'wave' (time-point), we considered six of 10 sections (i.e., survey sections 1, 2, 4, 5, 7 and 8), which investigated the corresponding query during every pandemic wave, for a total of 11 sub-sections and 55 items. The findings for OUs individually were described in **Table 6**.

Table 6 – Summary of performances divided into every wave. Results related to respondents individually.

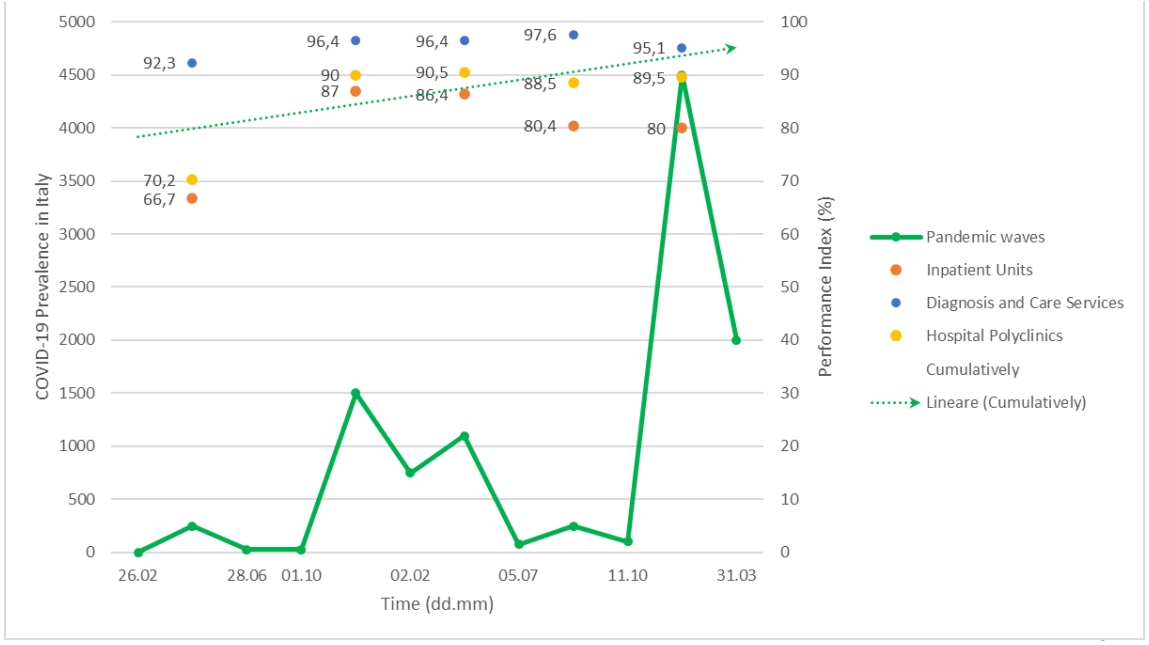
Respondent Aggregation Level	Respondent	Performance Index (%) per time-point ("wave")				
		i	ii	iii	iv	v
for each OU	General Medicine	13,6	93,3	83,3	85,7	75
	Onco-haematology	70,6	70,6	70,6	80,2	80,2
	General Surgery	60	63,2	55,7	51,6	63,2
	Obstetrics and Gynecology	50	48,4	48,4	47,9	58,1
	Ophthalmology	67,1	67,1	67,1	66,3	65,4
	Orthopaedic-Traumatology	49,4	50	45,6	37	46,8
	Reanimation	80,8	93,3	93,3	60	72
	Pathological Anatomy	100	100	100	100	100
	Anesthesiology	61,5	96,6	83,5	80,3	86,2
	Angiology	92,3	93,3	100	100	100
	Cardiology	19,7	86,2	90	93,3	88,5
	Dietetics	85,7	96,6	100	93,3	93,8
	Gastrointestinal Endoscopy	89,3	90	90	89,3	89,3
	Hepatology	89,5	89,5	89,5	90,5	90,5
	Analysis Laboratory	87,8	89,4	89,4	86,8	86,8
	Nephrology and Dialysis	100	100	100	100	100
	Neurophysiopathology	na	na	na	na	na
	Radiology	93,8	93,8	93,8	93,8	93,8
	Radiotherapy	76,6	76,6	76,6	76,6	76,6
	Cardiovascular	19,7	86,2	90	93,3	88,5
	Rehabilitation	87,1	87,1	90	93,8	93,8
	Audiology, Phoniatrics and Ear-nose-laryngology	19,7	86,2	90	93,3	88,5
	General Surgery	71,4	69,5	60	63,2	58,8
	Orthopaedics	55,8	55,8	48,8	44,6	44,6
	Paediatrics	90	93,1	96,6	96,6	100
	Hospital Polyclinics	52,3	66,3	66,3	48,2	48,2
	Accident and Emergency	93,8	93,8	96,8	96,8	100
	Pain Therapy	36,5	34,3	58,1	58,1	58,1

Legend of performance ranges

0	null
10	
20	low
30	
40	good
50	
60	high
70	
80	very high
90	

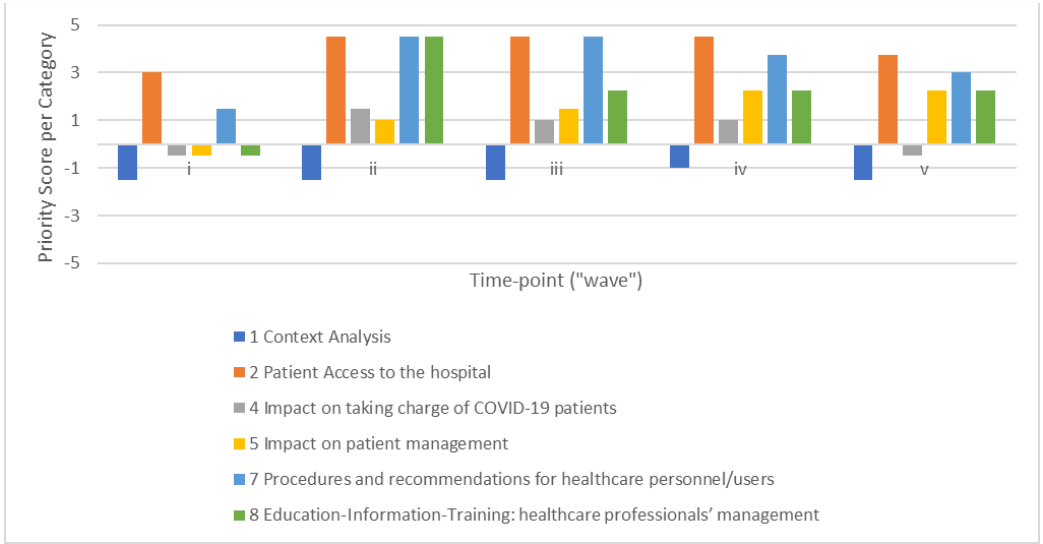
This scenario resulted in an improving trend for each OA during subsequent pandemic waves (**Figure 2,** coloured dots). Even though the first sudden pandemic event returned an acceptable performance index of 73,2% cumulatively; the situation was rapidly improved (**Figure 2**, dashed arrow), always ranking "very high" performances (i.e., overall performance indexes of 91,7%; 90,9%; 92,3% and 87,9% per time-point respectively).

Figure 2 - Performance trend during the first five waves.



Remarkably, the improvement was driven by guaranteeing continuity of care for patients (Section 5) and by adopting Personal Protective Equipment (PPE) (Section 8). Specifically, these approaches turned from faint weaknesses to strengths already after the first wave (**Figure 3**).

Figure 3 – Category evolution during the first five waves. The bar chart shows the priority scores of sections included along the Y-axis: negative values for weakness and positive ones for strengths. Results related to respondents cumulatively.



4. Discussion

In this study, we reported an impact evaluation of the COVID-19 pandemic on the network of Spoleto Hospital and the operational policies implemented in response to challenges. This is an Italian public hospital with a catchment area of around 45,000 people [17]. Since the COVID-19 pandemic is a multifaceted and rapidly evolving phenomenon, it was important to examine its effects at the hospital-care level [25], [26], as a complex network of several medical facilities, and during each of five waves [27], [28]. First, it was possible to highlight how care pathways have acted during the overall COVID-19 pandemic, identifying strengths, weaknesses and intervention actions needed. The OAs achieved an optimal level of care (Table 5a-5b), indicating the adequacy of the approaches taken. Considering the results for each OU, *Angiology* (ward C of OA2) conducted the best performance and *Orthopaedic-Traumatology* (ward F of OA1) registered the worst one (Table 5c). This reflected the pathogenesis of COVID-19 disease and its epidemiology. Indeed, Coronavirus disease predisposes patients to arterial and venous thrombotic complications [29] and therefore, the management of patients with preexisting cardiovascular disease and of those infected who develop thrombosis, had to be dramatically faced and protected by the *Angiology Unit* [30], [31]. On the contrary, orthopaedic and trauma surgery are not disciplines directly involved in the clinical management of COVID-19 patients. Moreover, the rate of traumas and fragility fractures appeared to decrease during the pandemic era [32], demonstrating significant temporal associations with daily population mobility and social distancing measures. Nevertheless, strategic planning of improvement actions is required in orthopaedic services, as confirmed by the literature [33]–[35].

In addition, a comparison of conditions over time was performed (Figure 2). Briefly, the first wave had a smaller prevalence and duration than the others, although it was the wave that most stressed the healthcare system, being taken by surprise and not having emergency management protocols and processes. Considering this, the national lockdown was introduced as a suppression strategy. After the looseness of containment measures, there were two tight and higher waves between autumn 2020 and spring 2021. However, it was evidenced a lower case-fatality rate (CFR, i.e. the number of confirmed deaths divided by the number of confirmed cases), due to a more effective COVID-19 case tracking system (identifying asymptomatic cases more often than in the first wave) and the refinement of the quality of care provided. In Italy, from January 2021 took place a large vaccination campaign and, subsequently, the fourth wave showed lower cases, deaths and hospitalizations. Starting from autumn-winter 2022, the fifth wave reached the highest prevalence values and the lowest lethality rate, driven by the emergence of new, less aggressive virus variants, in addition to all the factors above-mentioned. Finally, on 31st March 2022, the Italian government declared the end of the emergency status [36] and from then on, the subsequent waves became less definable and perceptible, even if more frequent [37]. To date, the WHO could announce the end of the COVID-19 pandemic in 2023 because statistics on the virus keep declining. These temporal dynamics show the strong contribution of multiple interventions, both pharmaceutical and non-pharmaceutical ones, to the control of the pandemic. Our findings match this evidence by demonstrating an improvement in clinical-organizational management after the first wave (Figure 2). Moreover, several prior studies confirmed that the implementation of tangible operational policies in hospitals during the first wave provided a benefit in addressing major healthcare demand and staffing strain [38]–[40]. In particular, non-pharmaceutical approaches helped to mitigate the outbreaks; however, their impact might be dynamic, due to variations in the execution and the degree of compliance [41]. Considering this, we focus on those actions that were implemented by Spoleto Hospital and have improved along subsequent pandemic phases: separation of clinical pathways for COVID-19 patients from NON-COVID-19 patients (Section 4); preservation of the continuity of care both for COVID-19-positive and -negative patients (Section 5); education and training on PPE dressing/dusting procedures for healthcare workers and equipment of staff with different

types of PPE, in accordance with the professional exposure risk (Section 8). Here, there is to highlight how the individual and combined impact of these five specific interventions has driven the improvement of health system performance. Interestingly, the literature also reports safety pathway design [42], [43], maintenance of routine primary care [44] and PPE use [45] as some of the most effective interventions in preventing nosocomial infection transmission.

Finally, for these items, we developed a survey based on hospital workers' experience and then we applied the SPRIS system. This is an organizational analysis tool previously validated [24], that converted the qualitative survey findings into quantitative data, providing a single performance indicator and allowing a direct comparison between the subjects investigated in different systems and scenarios. In particular, we performed the analysis at two levels of depth, the first for items and the latter for sections, obtaining two performance indexes for each respondent. It should be noted that the performance indexes obtained for items were similar to the ones calculated for sections, but they could not match. This is because the section aggregation level hides the impact of items. As an exemplary case, if the worst items are grouped into a single section, their impact is smaller and the performance index for the section is higher than the one for the item. However, the performance range was always the same. Therefore, the shallower analysis is more rapid but less precise, whereas the deeper one is more accurate but less immediate and the choice depends on the analysis context.

In conclusion, from the survey results we identified key issues in the approaches taken by Spoleto Hospital over the COVID-19 pandemic: adopting safety measures as strength and the influence of factors external to the organization (i.e., mass vaccination, lack of funds, etc) as weakness. Moreover, these factors were quantitatively evaluated by a SWOT Analysis, achieving detailed performance indexes. Obtained scores monitor the conduct of medical facilities and suggest the need for improvement actions, where required. During the first five waves, the nosocomial performance shows an increasing trend, highlighting an optimal reaction of Spoleto Hospital.

4.1 Limitations and Future prospectives

Nevertheless, this study has some limitations. Indeed, only referents were invited to respond. It can be considered a starting point, however, all healthcare workers should take part in the interviews. Future wider surveys are required to fully describe the hospital experience. Moreover, the SPRIS system maintains several limits [24] (i.e., standardization, not friendly use), but they can be overcome by the continuous application of the SPRIS system contributing to its validation and improvement process.

5. Conclusions

This study revealed a changing pattern in medical facilities management during the five consecutive pandemic waves in the Hospital of Spoleto (Italy). Health management protocols and processes have been successfully reviewed, monitored by a performance index provided by the SPRIS system. This survey could be seen as a starting point for the analysis, monitoring and evaluation, through the SPRIS system, of new healthcare facility management strategies during emergency periods.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: Results related to items for each OU of OA1, based on the conversion scale; Table S2: Results related to items for each OU of OA2, based on the conversion scale; Table S3: Results related to items for each OU of OA3, based on the conversion scale.

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review and editing, C.N. and S.O.; visualization, S.C.; supervision, C.N., G.B., V.V., S.R. and R.M.; project administration, M.P., A.C. and O.R.; funding acquisition, R.M. All authors have read and agreed to the published version of the manuscript.

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