

## RESEARCH ARTICLE

# Burden of delayed discharge on acute hospital medical wards: A retrospective ecological study in Rome, Italy

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**Data Availability Statement:** Data are property of ASL Roma 1 Public Health Authority. Data cannot be shared publicly because of National and EU Privacy regulation. The study did not involve demographic or clinical data (i.e. age, diagnosis or procedures), but only administrative data (i.e. attendance or discharge/transfer request), routinely collected by public service. Data usage granted by General Authorization of Italian National Privacy Board no. 9068972 (Provvedimento che individua le prescrizioni contenute nelle Autorizzazioni generali nn. 1/2016, 3/2016, 6/2016, 8/2016 e 9/

## Abstract

### Introduction

Delayed discharge represents the difficulty in proceeding with discharge of patients who do not have any further benefit from prolonged stay. A quota of this problem is related to organizational issues. In the Lazio region in Italy, a macro service re-organization is on the way, with a network of hospital and territorial centers engaged in structuring in- and out- of hospital patient pathways, with a special focus on intermediate care structures. Purpose of this study is to quantify the burden of delayed discharge on a single hospital structure, in order to estimate costs and occurrence of potential resource misplacement.

### Material and methods

Observational Retrospective study conducted at the Santo Spirito Hospital in Rome, Italy. Observation period ranged from 1/09/2022, when the local database was instituted, to 1/03/2023 (6 months). Data from admissions records was anonymously collected. Data linkage with administrative local hospital database was performed in order to identify the date a discharge request was fired for each admission. Surgical discharges and Intensive Care Unit (ICU) discharges were excluded from this study. A Poisson hierarchical regression model was employed to investigate for the role of ward, Severity of Disease (SoD) and Risk of Mortality (RoM) on elongation of discharge time.

2016 che risultano compatibili con il Regolamento e con il d.lgs. n. 101/2018 di adeguamento del Codice - 13 dicembre 2018 [9068972]). Data are available from the Roma 1 Institutional Data Access (e-mail at: [protocollo@pec.aslroma1.it](mailto:protocollo@pec.aslroma1.it)), of from corresponding author (e-mail at: [antonio.vinci@aslroma1.it](mailto:antonio.vinci@aslroma1.it)) for researchers who meet the criteria for access to confidential data.

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## Results

1222 medical ward admissions were recorded in the timeframe. 16% of them were considered as subject to potentially elongated stay, and a mean Delay in discharge of 6.3 days (SD 7.9) was observed.

## Discussion and conclusions

Delayed discharge may cause a "bottleneck" in admissions and result in overcrowded Emergency Department, overall poor performance, and increase in overall costs. A consisted proportion of available beds can get inappropriately occupied, and this inflates both direct and indirect costs. Clinical conditions on admission are not a good predictor of delay in discharge, and the root causes of this phenomenon likely lie in organizational issues (on structure/system level) and social issues (on patient's level).

## Introduction

### The problem of delayed discharge

Delayed Discharge represents the difficulty, in hospital ordinary wards, in proceeding with discharge of patients that are still admitted, but do not have any further benefit from prolonged stay [1, 2]. This usually happens after situations with resolution of the acute event that brought the patient to the hospital, but with the persistence of other problems that stall discharge, and do not always have a clinical root cause. A fundamental role in this is often played by social and organizational components [3].

Among organizational components, we can list the waiting time for bed availability within a structure of lesser intensity of care, or waiting times due to territorial services activation. Among social components, most impact comes from the patient's frailty condition, with elements (such as comorbidities, dementia or difficulty in performing normal daily activities, not to mention psychiatric or social disabilities and/or disadvantages) that are known risk factor for increase length of stay in hospital ward [4–6]. Also, the very same frailty condition is known to be a predictor of increased and inappropriate use of health services [7]. Social factors are present in a large percentage of emergency department (ED) frequent user group: loneliness, poverty, poor quality of life, difficulties in daily self-management [8–11].

Delayed discharge has been subject of many studies, and it is believed to have a significant impact on both direct and indirect costs. Among direct costs we can find primary admission costs, and secondary costs due to complication during the excessive hospitalization time [12]. Among indirect costs, we can find those relative to the missing service provision due to the unavailability of a bed occupied by a patient who has already been treated, without further clinical necessities. Also, indirect costs are those relative to the inefficient usage of ward personnel, that is not used at its best in order to solve acute clinical problems, or problems that deserve an hospital admission [13]. Adding on to this, the experience of delayed discharge has a strong impact on the patient, who has to deal with anxiety elements due to feeling rejected and "in the wrong place", and on assistance personnel, who is often unsatisfied with the whole discharge process [14–16].

Moreover, ethical themes, relative to the increasing inequality towards frailty patients in relation of their usage of health services that are on paper available to them, increase the complexity of this matter. Actually, it is well-known that frailty patients who undergo delayed

discharge are exposed to a clinical treatment inferior in quality, even in the rehabilitation setting, causing an increased risk of functional decline, falls, and adverse events such as Healthcare Associated Infections, complications, and errors in therapy [17–20].

Last but not the least, delayed discharge has a heavy impact on the appropriateness of setting of care, as it hinders the opportunities of making good use of hospital resources and anticipating clinical readiness for discharge [21]. This inflates overall management costs, with a bottleneck phenomenon given by the unavailability of hospital beds, especially in hospital with active ED [3, 22–25].

Several proposals have been made, in the hope of keeping in check the occurrence of delayed discharge. Most initiatives have been implemented on hospital levels, rather than in a more comprehensive way [26–30].

It has been observed that the phenomenon is related to expenditure cuts in social expenditure, and interventions towards the increase of the beds availability in intermediate care structures are suggested by many authors [31, 32].

Likewise, it would be opportune to offer frailty people a wide range of possibilities for their subsequent treatment after an acute event, in order to promote their independence after their admission. For this reason, interventions with a strong coordinated component of social and health services, be it institutional, private or volunteer (i.e. charities), have an high impact on the matter [33].

Beyond macro scale strategical solutions, further ideas have been proposed for implementation on micro scale, including strict monitoring of patients with high admission duration, initiatives towards bettering communication among clinicians and families, and models in order to ensure accountability of personnel on the subject [26, 34, 35]. Active patient involvement is also considered an important aspect; however, in the Italian context, research on patient involvement in the caring process is in its infancy, and the existing studies highlight poor engagement in this process by healthcare professionals [36].

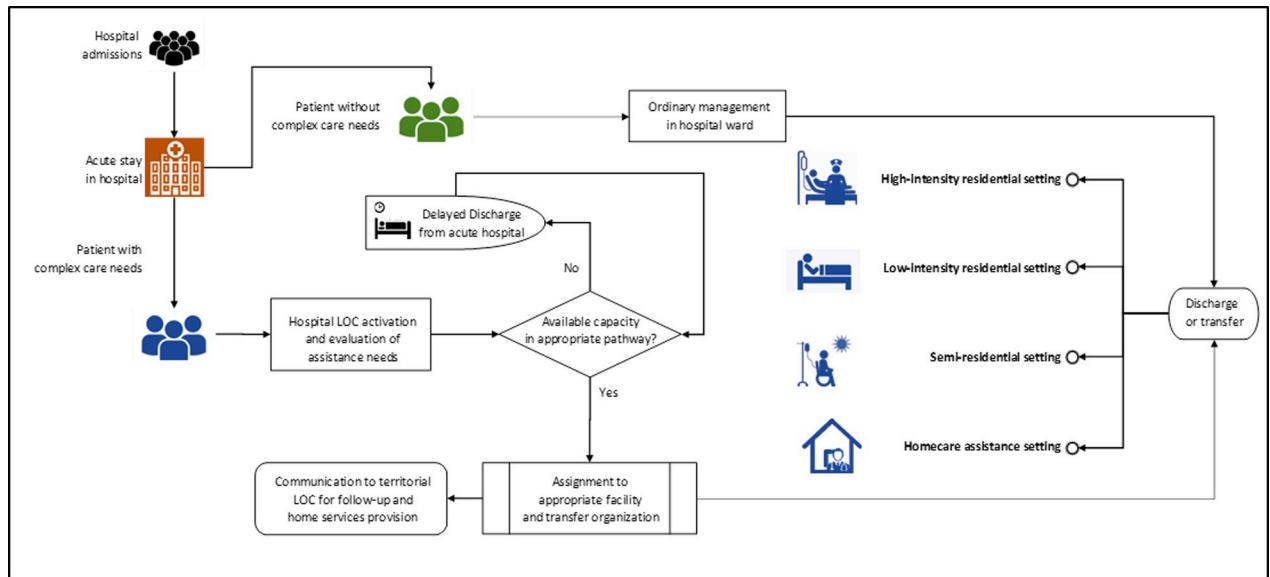
In Italy, in most recent years, there has been a continuous reduction in beds availability, due to spending cuts and budget reasons, on a regular basis and on nation-wide level. This was very impactful during COVID-19 emergency, as the health system was put under strong pressure, due to reductions in hospital beds and capacity and underinvestment in community-based care [37]. This meant that it was necessary to increase beds usage efficiency, dealing with healthcare demands despite a reduction in available resources.

In such scenario, evaluating and quantifying the problem of delayed discharge deserve a specific and deep attention, especially at the hospital level, being the operative element of the healthcare system most directly involved in this process.

## Patient discharge process in the Italian National Health Service

In the Italian National Health Service (NHS), intermediate care facilities fill the gap between acute hospital and usual place of residence. The rationale is that patients are admitted into acute hospital and treated for their acute illness, and then dismissed either home, or in a territorial structure that is better suited for their needs, as soon as there is no further need of acute care. This model is detailed in Fig 1, and is widely shared in European and American Health systems [38]. Italian NHS is a Beveridge health system which has adopted DRG payments to hospitals; Italian DRGs follow the US (CMS) model. In order to obtain a DRG payment, each structure must generate and transmit Hospital Discharge Forms (*SDO—Scheda Dimissione Ospedaliera*), in anonymous form, for every admitted patient [39].

Italian health system provides not only for hospital assistance, but also for intermediate, homecare, and territorial (outpatient and diagnostics) assistance. In 2007, the national



**Fig 1. Organization of intermediate care services in the Italian National Health Service (NHS).** Adapted from *Onen-Dumlu et Al.* with permission from the Authors [38].

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government produced documentation on the residential and semi-residential typologies of assistance, distinguishing between Social-oriented and Health-oriented [40].

The main assistance structures can fall into one of the following categories:

- Care for elderly and frailty people;
- Rehabilitation facilities;
- Care for disabled people;
- Psychiatric care;
- Palliative care.

These structures can operate on a full residential regime (full 24h/die), on a semi-residential regime (patients access on daytime and goes back home on nighttime), or on a home-care basis. Some structures can take care of patients in different regimes at the same times [41]. **Table 1** synthetizes the different typology of structure provided by NHS, either directly or indirectly via convention and accreditation programs.

## Local background

Local Health Authority (ASL) Roma 1 is the Public Health Authority in charge of the Historical Centre and North-western area of the Metropolitan city of Rome, Italy. It has a resident population of over 1 million, extending on an area of 524,0 km<sup>2</sup>, which is almost 40% of the metropolitan city of Rome [42]. Territorial needs are managed through 6 district, with General Practitioners, outpatient clinics and lab facilities. In terms of ordinary hospital wards, ASL Roma 1 directly manages two hospitals, St. Spirito (SSP) and St. Filippo Neri (SFN), and it commits services towards 11 other private hospitals in the area, in accreditation regime [43].

In order to facilitate patients' flow across the wards of SSP and SFN, especially for patients with complex needs who cannot be directly discharged home, Roma 1 adopted a network model, in which every directly managed structure has its own Center of Operations (COT),

**Table 1. Non-acute care facilities provided by Italian NHS.**

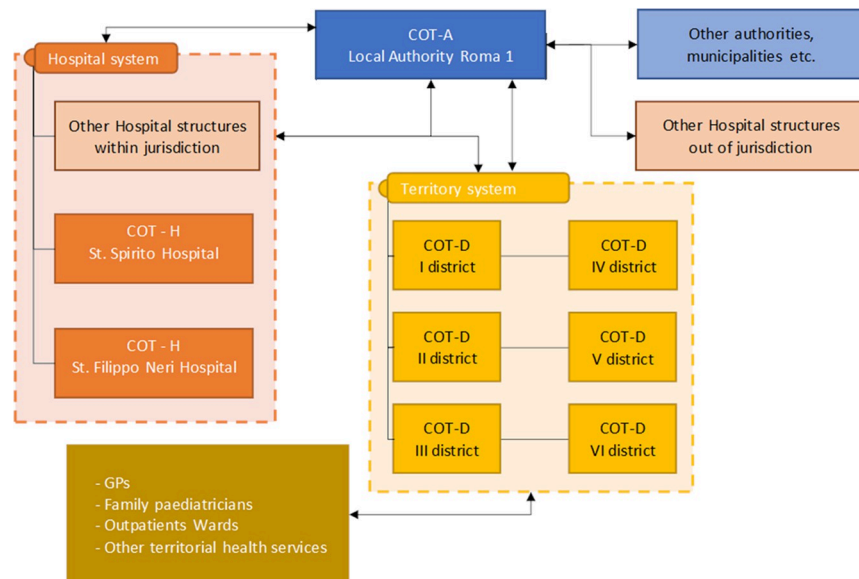
Assistance level	Description
<b>Health facilities for Elderly people</b>	
R1	Patients needed intensive treatment, such as invasive mechanical ventilation, or other support to vital functions.
R2	Non self-sufficient patients with healthcare needs, such as daily nursing or medical care.
R2D	Patients with senile dementia\Alzheimer disease, with need of rehabilitation, re-orientation or personal tutelage, with need of both daycare and night care.
R3	Non self-sufficient patients with long-term assistance needs, with low need of healthcare assistance.
SR	Semi-residential maintenance assistance.
SRD	Semi-residential assistance for patients with senile dementia\Alzheimer disease, with need of rehabilitation, re-orientation or personal tutelage but no need of night care.
<b>Extensive rehabilitation facilities</b>	
RRE1	Post-Acute Extensive Rehabilitation for care prosecution after intensive care, or for patients who cannot undergo intensive treatment.
RRE2	Long-term Post-Acute Extensive Rehabilitation for treatment against chronic, evolving and invalidating illnesses.
<b>Social and Health care facilities for Disabled people</b>	
RD1	Diagnosis, therapy and rehabilitation for disabled people with need for extensive or intensive rehabilitation, and maintenance treatment for patients in need of high intensity level of care, including minimally responding patients.
RD2	Diagnosis, rehabilitation and therapy for children with behavior disturbs, or neuro-psychiatric syndromes.
RD3	Maintenance therapy and rehabilitation, coupled with tutelage for people with strong disabilities.
RD4	Maintenance therapy and rehabilitation, coupled with tutelage for people with strong disabilities and no family support.
<b>Facilities for people with Psychiatric needs</b>	
RP1	Care and rehabilitation post-acute programs. Treatment duration and precise therapeutic objectives must be defined before admission.
RP2	Facilities for people pa who are partially self-sufficient, but cannot be assisted in their own family environment and need housing, with some healthcare tutelage.
SRP	Semi-residential facilities for patients with psychiatric needs and no need of night care.
<b>Facilities for Palliative care</b>	
H1	Residential palliative care
H2	Homecare palliative care
HP	Pediatric palliative care

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staffed with both social and healthcare personnel, communicating with a Central Hub and with external territorial structures. This is structured in order to allow clean management of patients' flow across each service, and is built up in order to better territorial-hospital integration across the area (Fig 2).

Hospital Clinicians had the option to request COT support in case they had difficulties with discharge process, either bureaucratic, or depending from complex social situations or in need of specific evaluation (such as the case for palliative care). SSP hospital required COT intervention for all patients in need of nursing home care or admission to secondary care structure; SFN hospital allowed instead full discretion to the treating physician when deciding if involving or not COT in patient management.

This model started initially in small scale, and became fully operational at the end of September 2022. Each COT was provided with a specific data analysis tool that was internally developed and used for case management and for general reporting to Management Office.



**Fig 2. Roma 1 operation centers model for discharge management.** COT-A: Authority Center of Operation; COT-H: Hospital Center of Operation; COT-D: District Center of Operation; GP: General Practitioner.

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## Study objectives

Primary objective of present study is to quantify the impact of delayed discharge on a hospital ward bed availability, both in terms of inappropriate bed usage, and in terms of economic direct costs.

Secondary objectives are to understand the most common reasons behind the Delayed Discharge phenomenon, assuming that the causes are likely to lie in potential unknown or unmet needs of the impatient population, especially given the severity of the affliction that led them to hospital ward admission in the first place, and to investigate characteristics of patients deceased while awaiting discharge.

## Materials and methods

### Study design

This is an Observational Retrospective study; Ethical Board approval n° 238/CE Lazio 1. Patient Consent was waived because the study was conducted on data routinely collected for administrative purpose. Data was fully anonymized before being accessed for analysis.

### Setting and participants

All patients admitted in SSP Hospital in ordinary medical (i.e. non-surgical) wards, for which was requested social/healthcare support in discharge to the COT, and who were either discharged or deceased during the process, were eligible for inclusion in the study. Patients admitted in Intensive Care Unit (ICU) wards and discharged to other acute or intermediate care facilities were not included, since they represent a peculiar subgroup of patients with peculiar needs [44]. However, patients admitted to ICU, transferred to a different in-hospital ward and then discharged were eligible for inclusion. The involved medical wards were Cardiology, Internal medicine, and Emergency medicine, as no other medical ward is active in SSP hospital beside those mentioned.

Patients who had no problematic delaying their discharge, thus not being referred to COT, were not eligible for inclusion neither those admitted in non-ordinary regimen (day hospital, day surgery or outpatient setting). Gynecology, neonatology and obstetric wards were excluded from this analysis as well, since they represent the needs of a very specific set of patients, who mostly do not need COT-H activation anyway. [Table 2](#) details the characteristics of the wards included in this study.

In order to better depict Wards activity, the Barber nomogram was used. Barber nomogram allows the setup of a range of values in order to assess the performance in the delivery of care [45].

Observation time ranged from 1 September, 2022 to 1 March, 2023. Data was collected on 1 March, 2023.

## Variables and data sources

Principal investigators (AV and GF) had full access to each COT hospital database, due to the respective Operating Role within the Local Health Authority. All data were extracted anonymously and put into a comprehensive dataset that was subsequently used for statistical analysis and reporting. In this phase, data was cleaned by hand, correcting misspells and obvious inaccuracies (such as wrong admission or discharge century).

Two investigators (AM and OC) had access to SDO database, used for calculation of All Patient Refined-Diagnosis Related Group (APR-DRG, 3M Company, Pioltello, Italy) APR-DRG is an instrument to assess illness severity and defined as risk for in-hospital death (on a scale ranging from 1 to 4 for both items) [46].

Linkage between SDO repository and COT databases was done via the unique admission identifier.

No other database was used for this study.

The following variables were retrieved:

- From SDO repository;
  - ICD-9-CM diagnosis code.
  - Aggregate hospital wards volume data:
    - Number of total admitted patients.
    - Number of total discharged patients.
    - Average Length of Stay (LOS).
    - Number of total days of stay.
- From COT database:
  - Patient admission identifier.
  - Hospital.
  - Discharge ward.
  - Date of potential discharge.
  - Date of actual discharge.
  - Discharge type.

Table 2. Characteristics of SSP hospital wards included in the study.

Ward type	Beds availability	Admissions	Patients' LOS (days)	COT-H assisted discharges	eLOS in COT-H assisted discharges (days)
Internal Medicine	25	245 (primary) + 416 (secondary)	14.9	188 (31 deceased)	7.3
Emergency Medicine	13	178	5.9	76 (11 deceased)	4.6
Cardiology	17	383	5.1	22 (3 deceased)	3.4
<b>Total Medical Area</b>	<b>55</b>	<b>1222</b>	<b>7.9</b>	<b>286 (45 deceased)</b>	<b>6.3</b>

Beds availability defined as average of active beds during the investigation period (rounded without decimals). LOS: average Length of Stay during the investigation period. Patients discharged to homecare are included in this count.

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“Potential discharge” was defined as the day the patient had no more need of acute hospital care, and was requested for specific intermediate care assistance.

Since all investigated data were required for the admission\discharge process, there was no missing data.

### Sources of Bias and Bias reduction

A potential source of Bias has been recognized in patients that experience a potential delayed discharge are those who are the most frailty and with a more severe illness. In order to quantify this, the All-Patient Refined Diagnosis-Related Groups (APR-DRG) Severity of Illness (SOI) and Risk of Mortality (ROM) was calculated and used for secondary and sensitivity analyses. These scores have already been proven to be useful for hospital or benchmarking and epidemiological analysis, and also to define economic burden and overall DRG value [47].

### Statistical methods

Data were summarized using absolute and relative frequencies for categorical variables, mean, median and range for numerical variables. Chi-squared ( $\chi^2$ ) test for association was used to investigate the relation between categorical variables. Patients were subdivided based on the admission ward, and on the post-discharge facility they were programmed for, in order to better understand and quantify the needs of this specific population.

In order to control for confounding, a separate analysis on SOI and ROM was performed, considering ROM as a potential moderator variable of SOI, and evaluating their impact on discharge delay. In this form of sensitivity analysis, null hypothesis ( $H_0$ ) was that SOI and ROM do not influence inappropriate excessive LOS (eLOS).

Given the investigated setting, a hierarchical Poisson regression model (Patient < Ward) was proposed for inferential analysis. This model was used because eLOS had a Poisson distribution rather than a normal one. SOI and ROM were tested for correlation using Pearson's  $\rho$ , while their distribution was investigated using Wilcoxon signed-rank test. ROM role was then investigated as SOI moderator variable.

Wards were considered as the superior grouping level. Then, a similar model but with discharge type as predictor instead of wards was investigated.

Italian Ministry for Economy and Finance provided an estimation of €670 as the daily cost of an acute hospital bed occupation; this was used for a quick estimation of direct costs of delayed discharge [48].

The REporting of studies Conducted using Observational Routinely-collected Data (RECORD) guidelines were used for reporting [49].



## Results

### Participants

2618 patients (1097 M, 1521 F) were admitted in the SSP hospital from 01/09/2022 to 01/03/2023. Of those, 806 (30.7%) were admitted directly in a Medical Ward, while other 416 (15.9%) were admitted in the Internal Medicine Ward as secondary admission, after a primary Surgical/ICU admission. Thus, the patients admitted in the SSP Medical Wards were 1222 (46.7%). Among those, for 186 (15%) COT-H assistance was requested due to intermediate care facility needs, while 81 (6.6%) were in need of homecare or social support. The remaining 955 (78.2%) patients were discharged without necessity of COT-H activation.

Distribution of patients among wards is synthetized in [Table 2](#). The patients' study flow is depicted in [Figs 3](#) and [4](#) depicts each ward occupation status during the mentioned period using a Barber nomogram; its implications are described in the **Interpretation** section.

### Main results

During a 6-months observation period, a consistent proportion (nearly 22%) of medical patients has been in need of some form of intermediate care assistance from Italian NHS. 103 patients (36%) were in need of RRE1. These represented the largest group, followed by Nursing Homecare (68, 24%) and Palliative Care (64, 23%). A more detailed description is provided in [Table 3](#), where LOS of these patients are also provided.

A separate analysis of time spent while awaiting available bed in discharge destination shows that patients in need of RRE1 facilities are the ones most impactful on all wards, with a mean delay from discharge of 7.5 days (SD: 8.7).

### Secondary results

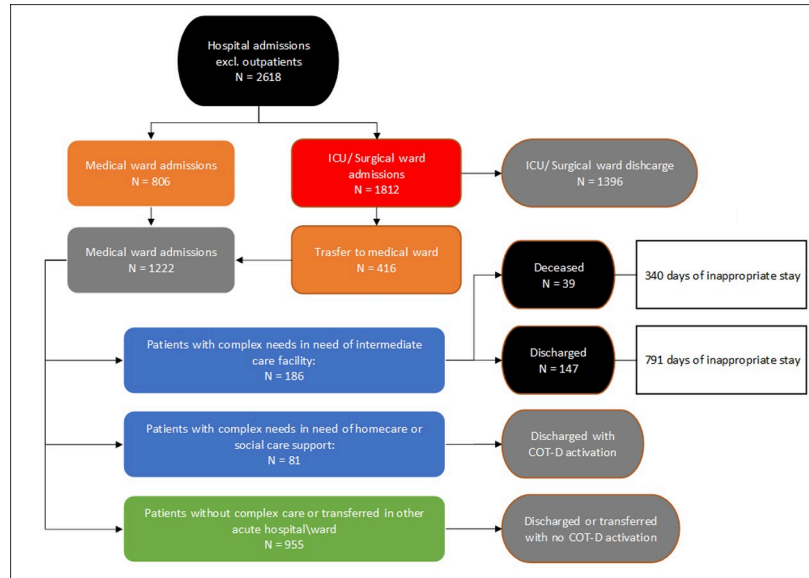
SOI and ROM were found to be strongly correlated (Pearson's  $\rho = 0.77$ ), while no significant difference in their distribution was found using Wilcoxon rank-signed test ( $p = 0.15$ ). No significant difference has been found in the patients' distribution between admitted wards and discharge facility ([Table 4](#)). Likewise, no significant difference has been found in LOS distribution by ward nor by discharge facility. Likewise, sensitivity analysis done using a Hierarchical Poisson regression model (Patient < Ward) between eLOS, SOI and ROM did not show any association significance, with the exception of R3 discharge and low SOI\ROM; this is of course expected because patients discharged to such facilities are typically patients with no further need of medical assistance. On the other hand, the facility type has a much stronger impact on eLOS, with highest delay observed for low-level care assistance needs (mean impact of almost 20 days), regardless of SOI\ROM moderation effects.

Nested Poisson regression model results are provided in [Table 5](#).

## Discussion and conclusions

### Key results

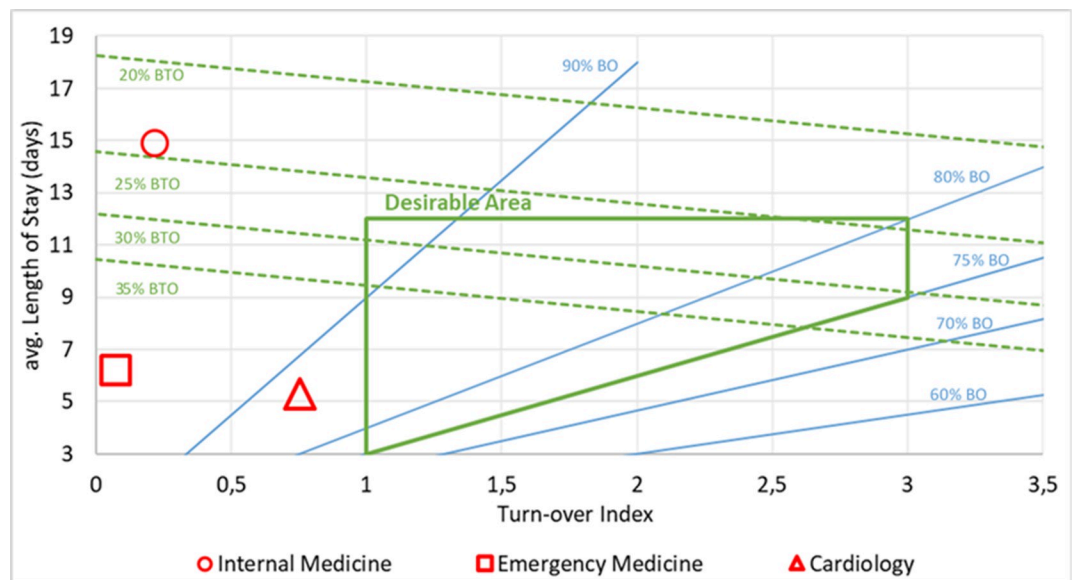
Patients admitted in SSP hospital medical wards who were recognized as a "difficult discharge" were needlessly prolonging their acute stay of almost a week (Mean delay in discharge value 6.7 days, SD 7.9 days). Almost one fifth of SSP patients occupying a bed at any given time in a Medical ward is likely being treated in an acute setting in an inappropriate way. Prevalence of Delayed discharge was found to be in line with current literature, albeit unequally present, and too high in some wards compared to others (with values ranging from 6% to 32%). As comparison, a recent meta-analysis of Landeiro et al. found it ranging from 1.6% to 91.3%, depending



**Fig 3. Study patients flow.** COT-H: Hospital Center of Operation; COT-D: District Center of Operation.

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on the context, with an average of 22.8% [50]. SOI and ROM do not play any role in determining the prolonged LOS, since they become an independent variable once a patient is fully treated and ready for discharge. This means that delay in discharge is due to systemic and organizational causes, such as demand and supply of intermediate and homecare facilities, rather than clinical reasons.



**Fig 4. Barber nomogram for the wards included in the study in the selected period.** Dashed green lines represent Bed Turn-Over percentage (BTO). Solid Blue lines represent Bed Occupancy percentage (BO). Solid Green Area represent the desirable area for medical divisions.

<https://doi.org/10.1371/journal.pone.0294785.g004>

Table 3. Raw estimation of yearly cost of inappropriate hospital beds' occupation.

Ward type	Patients with delayed discharge (N)	Mean delay of discharge in days (SD)	Cumulative Length of delayed assistance (days)	Mean beds used for delayed discharge (% of ward beds)	Yearly costs of Delayed Discharge (€)
Internal Medicine	177	7.4 (8.6)	1306	8 (32%)	1,750,040.00
Emergency Medicine	73	4.7 (6.1)	332	2 (8%)	444,880.00
Cardiology	20	3.5 (2.7)	72	1 (6%)	96,480.00
<b>Total Medical Area</b>	<b>270</b>	<b>6.3 (7.9)</b>	<b>1710</b>	<b>11 (20%)</b>	<b>2,291,400.00</b>

<https://doi.org/10.1371/journal.pone.0294785.t003>

## Limitations

Data used for this study were created for administrative purposes. This limitation was however overcome by the possibility of performing data linkage with local clinical digital platforms, so that the resulting summaries did encompass the entire discharged population. This allowed the usage of descriptive statistical framework in most of the analysis and reporting, with inferential issues kept to a minimum.

Usage of a standardized tool for SOI and ROM (APR-DRG tool) increases the quality of evidence of the study, as it allowed sensitivity analysis and the clarification of potential confounding factors [47].

The final result is a downward estimate of the real necessity, since it monitored only publicly-provided assistance: it is possible that patients may have chosen to get discharged, and then provide for intermediate out-of-pocket assistance by themselves. While this is unlikely for the case of residential acute care and palliative care, it is a possibility in case of low-intensity homecare, for which unprofessional caretakers are often employed in Italy, sometimes partaking an informal economic network whose extent is hardly tracked [51]. Such situation is common in other European countries, although organizational differences and state funding or expense participation may vary [52].

Lastly, a potential limitation may lie in the un-adjustment for COVID-19 related issues. However, there is no evidence to suggest that COVID-19 had any impact on the investigated phenomenon. While it is true that COVID-19 had a great impact on health system worldwide, this was mostly true in its early stages and on emergency departments, in both hospital wards and pre-hospital services [53–58].

On the other hand, delay of clinical discharge should be independent from the patients' conditions. Destination facilities may require some further safety procedures (and consequent bureaucratic delay) in case of COVID-19 infection, but while this had a substantial impact in the early pandemic stage (2020–2021), after the full-fledged Italian vaccination campaign and the subsequent lifting of many restriction measures COVID-19 was fairly manageable from

Table 4. Distribution of patients by wards and discharge facility.

Ward	Hospice	Other	R3	RRE1	Total
Emergency Medicine	12	2	6	27	48
Internal Medicine	49	3	5	66	123
Cardiology	3	1	2	10	16
<b>Total</b>	<b>64</b>	<b>6</b>	<b>13</b>	<b>103</b>	<b>186</b>

Patients discharged with public-assisted nursing homecare were excluded.

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Table 5. Poisson regression model results and marginal effect of facility on exceeding length of stay.

Predictor variable	Coefficient	95% CI	p-value
<b>SOI (ref: 0)</b>			
1	0.48	-.031–0.99	0.07
2	0.67	0.2–1.15	0.01
3	0.58	0.15–1.02	0.01
4	0.40	-0.05–0.85	0.08
<b>ROM (ref: 0)</b>			
1	-0.22	-0.54–0.10	0.18
2	-0.47	-0.72 --0.22	0.01
3	-0.43	-0.64 --0.22	0.01
4	N\A	N\A	N\A
<b>Discharge facility (ref: homecare)</b>			
Other	0.48	0.19–0.77	0.01
RRE1	0.35	0.19–0.51	0.01
R3	1.05	0.74–0.22	0.01
Hospice	-0.36	-0.85–0.13	0.15
<b>Ward (ref: emergency medicine)</b>			
Internal Medicine	0.31	0.04–2.47	0.01
Cardiology	0.01*	0.01–0.01	0.01
<b>Marginal predicted mean effect (days)</b>		<b>95% CI</b>	<b>p-value</b>
Homecare	6.8	3.1–10.5	0.01
Other	10.9	4.4–17.5	0.01
RRE1	9.6	4.4–14.9	0.01
R3	19.3	7.6–30.9	0.01
Hospice	4.7	1.4–8.1	0.01

Effect of predictors on extended Length of Stay (days). SOI: Severity of Illness. ROM: Risk of Mortality. Ward is in the model a second-level predictor variable.

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the organizational standpoint; thus it should have had little to no impact in affecting present study conclusions [59–63]. Evolving population knowledge, attitude, and perception of vaccination effects also played a role, as positive intention in vaccination meant a higher vaccine coverage in the following months, and therefore impacted on COVID management [64, 65]. As is known, vaccine hesitancy played an important role in COVID, even more than what is expected for other type of pathogens; such behavior impacts on disease spread and consequent drug prescription attitudes on the territory, and this all has a foreseeable impact on hospital demand [66–68]. In particular, antibiotic over prescription (by all types of health personnel) is constantly been linked with the occurrence of antimicrobial resistance, and thus with more difficulties in patient care management and further hospitalization increase [69–72].

During the study period, a positive swab, regardless of symptoms, forced clinicians to isolate the patients, thus reducing the number of available beds, also in the intermediate facilities. This may have had an impact on the length of stay of patients, due to reduced output supply. As a matter of fact, a high delay is found for low-level assistance facilities, while homecare solution are superseded only by palliative care provisioning. It must be noted however that such provisioning can be provided in both residential and homecare setting. Since home-based solution have already been proved the most optimal from both clinical and logistical point-of-view, a more proactive use of such setting is to be expected, even using novel approaches such as telemedicine and IT-based solutions [73–75].

## Interpretation

The main results of this study show that, in SSP hospital, up to 20% of available hospital beds were occupied by patients who could have had more benefit in a different setting, and were also subtracting the ward bed to other patients awaiting for hospital admission from ED, potentially resulting in chronic ED overcrowding. This situation appears to be so common worldwide that is often taken as a given among health practitioners, even in literature [76–79]. It is also responsible of staff stress and burnout, as result of constant high bed occupancy despite high bed turnover and low ward LOS [13]. This situation was indeed present in SSP hospital, as Fig 4 shows: while there was an efficient usage of beds, LOS was above average and admissions were difficult. Moreover, high-level specialty wards are usually encouraged to transfer their patients to generalist wards in order to free specialty beds, henceforth dragging down their own average LOS while not influencing patients' overall LOS. This behavior can be further reinforced by opportunistic or poorly designed incentive mechanisms (such as budget increments in case of ward LOS under a certain threshold). On the other hand, delay in discharge process represent an important cost for the structures experiencing it: for SSP, it resulted in a yearly loss of over 17% of total medical wards production value, due to assistance in inappropriate setting of care. Furthermore, as prolonged in-hospital stay is known to be linked to raise in incidence of complications and hospital-acquired-infections, patients' stay gets even more prolonged as planned discharge gets more and more postponed, with raise in healthcare costs, and diminishing benefit for the patient who is needlessly put at increased health risk [80].

## Generalizability

This work is a single-center observational study focused on a limited number of wards, whose common denominator is given by the fact that they mostly admit their patients from the same population, and with non-surgical necessities. While the organization of SSP hospital within ASL Roma 1 may be peculiar, its difficulties in the discharge process are not, as they are worldwide encountered [22, 81, 82]. A recent work of Manning and Islam highlighted that most of the challenges in patient flow management are not directly related to clinical situation, and solution must be found at organizational level [83]. To our knowledge, this is one of the few works that gives a magnitude of the Delayed Discharge phenomenon with a patient-level analysis. Other papers focused on estimation using excessive length of stay as a proxy, or focused on risk factors and causes from individual perspective [4, 76, 84]. This work adds evidence to the notion that delay in discharge process is not due to clinical factors but organizational ones. Such organizational elements transcend the hospital system as they represent the addition of a further level of uncertainty in a system that is structurally characterized by high levels of complexity. As such, solution and policies to the Delayed Discharge problems cannot be found exclusively inside the hospital system, but must encompass the entire galaxy of systems and facilities that revolves around hospital structures [31]. Quantification of direct and indirect costs of delayed discharge may help both policy makers and middle managers in deciding the most optimal way for resource allocation when designing their local health systems, in the ever-ongoing quest for providing each patient the right setting of care.

## Supporting information

**S1 Checklist.** *PLOS ONE* clinical studies checklist.  
(DOCX)

**S2 Checklist. The RECORD statement—checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.**

(DOCX)

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## References

1. Manzano-Santaella A. From bed-blocking to delayed discharges: precursors and interpretations of a contested concept. *Health Serv Manage Res.* 2010; 23: 121–127. <https://doi.org/10.1258/hsmr.2009.009026> PMID: 20702889
2. Allen D. Delayed discharge. *Nurs Stand.* 2016; 30: 15–15. <https://doi.org/10.7748/ns.30.45.15.s17> PMID: 27380673
3. Pellico-López A, Fernández-Feito A, Cantarero D, Herrero-Montes M, Cayón-De Las Cuevas J, Parás-Bravo P, et al. Delayed Discharge for Non-Clinical Reasons in Hip Procedures: Differential Characteristics and Opportunity Cost. *Int J Environ Res Public Health.* 2021; 18: 9407. <https://doi.org/10.3390/ijerph18179407> PMID: 34502013
4. Glasby J, Littlechild R, Pryce K. All dressed up but nowhere to go? Delayed hospital discharges and older people. *J Health Serv Res Policy.* 2006; 11: 52–58. <https://doi.org/10.1258/135581906775094208> PMID: 16378533
5. Heckman GA, Arthur S, Costa AP. Delayed discharge and frailty, delirium and functional decline. *Can Med Assoc J.* 2021; 193: E221–E221. <https://doi.org/10.1503/cmaj.77712> PMID: 33558410
6. McGilton KS, Vellani S, Krassikova A, Robertson S, Irwin C, Cumal A, et al. Understanding transitional care programs for older adults who experience delayed discharge: a scoping review. *BMC Geriatr.* 2021; 21: 210. <https://doi.org/10.1186/s12877-021-02099-9> PMID: 33781222
7. Moore G, Hartley P, Romero-Ortuno R. Health and social factors associated with a delayed discharge amongst inpatients in acute geriatric wards: A retrospective observational study: Frailty and delayed discharge. *Geriatr Gerontol Int.* 2018; 18: 530–537. <https://doi.org/10.1111/ggi.13212> PMID: 29230961
8. Afonso S, Lopes S. Differences in Clinical Characteristics and Utilization of Emergency Department by High-Frequency Users. *J Emerg Med.* 2020; 59: 153–160. <https://doi.org/10.1016/j.jemermed.2020.03.012> PMID: 32349880
9. Gobbens RJ, Luijckx KG, Wijnen-Sponselee MT, Schols JM. Toward a conceptual definition of frail community dwelling older people. *Nurs Outlook.* 2010; 58: 76–86. <https://doi.org/10.1016/j.outlook.2009.09.005> PMID: 20362776

10. Furia G, Vinci A, Colamesta V, Papini P, Grossi A, Cammalleri V, et al. Appropriateness of frequent use of emergency departments: A retrospective analysis in Rome, Italy. *Front Public Health*. 2023; 11: 1150511. <https://doi.org/10.3389/fpubh.2023.1150511> PMID: 37081951
11. Gentili S, Emberti Gialloreti L, Riccardi F, Scarcella P, Liotta G. Predictors of Emergency Room Access and Not Urgent Emergency Room Access by the Frail Older Adults. *Front Public Health*. 2021; 9: 721634. <https://doi.org/10.3389/fpubh.2021.721634> PMID: 34540791
12. Tanke MAC, Feyman Y, Bernal-Delgado E, Deeny SR, Imanaka Y, Jeurissen P, et al. A challenge to all. A primer on inter-country differences of high-need, high-cost patients. Urbanos Garrido RM, editor. *PLOS ONE*. 2019; 14: e0217353. <https://doi.org/10.1371/journal.pone.0217353> PMID: 31216286
13. Rojas-García A, Turner S, Pizzo E, Hudson E, Thomas J, Raine R. Impact and experiences of delayed discharge: A mixed-studies systematic review. *Health Expect*. 2018; 21: 41–56. <https://doi.org/10.1111/hex.12619> PMID: 28898930
14. Borthwick R, Newbronner L, Stuttard L. 'Out of Hospital': a scoping study of services for carers of people being discharged from hospital. *Health Soc Care Community*. 2009; 17: 335–349. <https://doi.org/10.1111/j.1365-2524.2008.00831.x> PMID: 19175427
15. Kydd A. The patient experience of being a delayed discharge. *J Nurs Manag*. 2008; 16: 121–126. <https://doi.org/10.1111/j.1365-2834.2008.00848.x> PMID: 18269541
16. Cofini V, Muselli M, Lolli C, Fabiani L, Necozone S. Does Quality of Care (QoC) Perception Influence the Quality of Life (QoL) in Women with Endometriosis? Results from an Italian Nationwide Survey during Covid Pandemic. *Int J Environ Res Public Health*. 2022; 20: 625. <https://doi.org/10.3390/ijerph20010625> PMID: 36612945
17. Kuluski K, Ho JW, Cadel L, Shearkhani S, Levy C, Marcinow M, et al. An alternate level of care plan: Co-designing components of an intervention with patients, caregivers and providers to address delayed hospital discharge challenges. *Health Expect*. 2020; 23: 1155–1165. <https://doi.org/10.1111/hex.13094> PMID: 32602628
18. McCloskey R, Jarrett P, Stewart C, Nicholson P. Alternate Level of Care Patients in Hospitals: What Does Dementia Have To Do With This? *Can Geriatr J*. 2014; 17: 88–94. <https://doi.org/10.5770/cgj.17.106> PMID: 25232367
19. Overall AC, Guilcher SJT, Cadel L, Asif M, Li J, Kuluski K. Patient and caregiver experience with delayed discharge from a hospital setting: A scoping review. *Health Expect*. 2019; 22: 863–873. <https://doi.org/10.1111/hex.12916> PMID: 31099969
20. Licata F, Quirino A, Pepe D, Matera G, Bianco A, Collaborative Group. Antimicrobial Resistance in Pathogens Isolated from Blood Cultures: A Two-Year Multicenter Hospital Surveillance Study in Italy. *Antibiotics*. 2020; 10: 10. <https://doi.org/10.3390/antibiotics10010010> PMID: 33374232
21. Valente R, Santori G, Stanton L, Abraham A, Thaha MA. Introducing a structured daily multidisciplinary board round to safely enhance surgical ward patient flow in the bed shortage era: a quality improvement research report. *BMJ Open Qual*. 2023; 12: e001669. <https://doi.org/10.1136/bmjopen-2021-001669> PMID: 36972925
22. Pellico-López A, Fernández-Feito A, Cantarero D, Herrero-Montes M, Cayón-de las Cuevas J, Parás-Bravo P, et al. Cost of stay and characteristics of patients with stroke and delayed discharge for non-clinical reasons. *Sci Rep*. 2022; 12: 10854. <https://doi.org/10.1038/s41598-022-14502-5> PMID: 35760829
23. Weir BS, Vordtriede C, Lee JE, Metter EJ, Talbot LA. An Interdisciplinary Dashboard to Streamline Medication Processing at Patient Discharge: A Quality Improvement Initiative. *Mil Med*. 2021; usab526. <https://doi.org/10.1093/milmed/usab526> PMID: 34950952
24. Van Der Linden MC, Van Loon M, Feenstra NSF, Van Der Linden N. Assessing bottlenecks in Emergency Department flow of patients with abdominal pain. *Int Emerg Nurs*. 2018; 40: 1–5. <https://doi.org/10.1016/j.ienj.2018.03.006> PMID: 29636284
25. Patel S, Alshami A, Douedi S, Campbell N, Hossain M, Mushtaq A, et al. Improving Hospital Length of Stay: Results of a Retrospective Cohort Study. *Healthc Basel Switz*. 2021; 9: 762. <https://doi.org/10.3390/healthcare9060762> PMID: 34205327
26. Cadel L, Guilcher SJT, Kokorelias KM, Sutherland J, Glasby J, Kiran T, et al. Initiatives for improving delayed discharge from a hospital setting: a scoping review. *BMJ Open*. 2021; 11: e044291. <https://doi.org/10.1136/bmjopen-2020-044291> PMID: 33574153
27. Simmons FM. Hospital overcrowding: an opportunity for case managers. *Case Manag*. 2005; 16: 52–54; quiz 55. <https://doi.org/10.1016/j.casemgr.2005.06.004> PMID: 16061159
28. Simmons FM. CEU: Hospital overcrowding: An opportunity for case managers. *Case Manag*. 2005; 16: 52–54. <https://doi.org/10.1016/j.casemgr.2005.06.004> PMID: 16061159

29. Clay-Williams R, Plumb J, Luscombe GM, Hawke C, Dalton H, Shannon G, et al. Improving Teamwork and Patient Outcomes with Daily Structured Interdisciplinary Bedside Rounds: A Multimethod Evaluation. *J Hosp Med*. 2018; 13: 311–317. <https://doi.org/10.12788/jhm.2850> PMID: 29698537
30. Patel H, Morduchowicz S, Mourad M. Using a Systematic Framework of Interventions to Improve Early Discharges. *Jt Comm J Qual Patient Saf*. 2017; 43: 189–196. <https://doi.org/10.1016/j.jcjq.2016.12.003> PMID: 28325207
31. Bryan K. Policies for reducing delayed discharge from hospital. *Br Med Bull*. 2010; 95: 33–46. <https://doi.org/10.1093/bmb/ldq020> PMID: 20647227
32. Pecoraro F, Clemente F, Luzi D. The efficiency in the ordinary hospital bed management in Italy: An in-depth analysis of intensive care unit in the areas affected by COVID-19 before the outbreak. Gianino MM, editor. *PLOS ONE*. 2020; 15: e0239249. <https://doi.org/10.1371/journal.pone.0239249> PMID: 32960908
33. Baumann M, Evans S, Perkins M, Curtis L, Netten A, Fernandez J-L, et al. Organisation and features of hospital, intermediate care and social services in English sites with low rates of delayed discharge: Hospital, intermediate care and social services. *Health Soc Care Community*. 2007; 15: 295–305. <https://doi.org/10.1111/j.1365-2524.2007.00697.x> PMID: 17578390
34. Adlington K, Brown J, Ralph L, Clarke A, Bhooyroo T, Henderson M, et al. Better care: reducing length of stay and bed occupancy on an older adult psychiatric ward. *BMJ Open Qual*. 2018; 7: e000149. <https://doi.org/10.1136/bmj-2017-000149> PMID: 30515462
35. Caminiti C, Meschi T, Braglia L, Diodati F, Iezzi E, Marcomini B, et al. Reducing unnecessary hospital days to improve quality of care through physician accountability: a cluster randomised trial. *BMC Health Serv Res*. 2013; 13: 14. <https://doi.org/10.1186/1472-6963-13-14> PMID: 23305251
36. Galletta M, Piazza MF, Meloni SL, Chessa E, Piras I, Arnetz JE, et al. Patient Involvement in Shared Decision-Making: Do Patients Rate Physicians and Nurses Differently? *Int J Environ Res Public Health*. 2022; 19: 14229. <https://doi.org/10.3390/ijerph192114229> PMID: 36361109
37. Giulio de Belvis A, Merregaglia M, Morsella A, Adduci A, Perilli A, Cascini F, et al. Italy: Health System Review. *Health Syst Transit*. 2022; 24: 1–236. PMID: 36951263
38. Onen-Dumlu Z, Harper AL, Forte PG, Powell AL, Pitt M, Vasilakis C, et al. Optimising the balance of acute and intermediate care capacity for the complex discharge pathway: Computer modelling study during COVID-19 recovery in England. Pietrantonio F, editor. *PLOS ONE*. 2022; 17: e0268837. <https://doi.org/10.1371/journal.pone.0268837> PMID: 35671273
39. Sheaff R, Morando V, Chambers N, Exworthy M, Mahon A, Byng R, et al. Managerial workarounds in three European DRG systems. *J Health Organ Manag*. 2020; 34: 295–311. <https://doi.org/10.1108/JHOM-10-2019-0295> PMID: 32364346
40. Gruppo di Lavoro Ristretto. Prestazioni residenziali e semiresidenziali - Relazione Finale (Mattone 12 – Prestazioni residenziali e semiresidenziali). Ministero della Salute; 2007. Available: [http://www.mattoni.salute.gov.it/mattoni/documenti/MDS\\_MATTONI\\_SSN\\_Resid\\_e\\_Semiresid\\_v1.0.pdf](http://www.mattoni.salute.gov.it/mattoni/documenti/MDS_MATTONI_SSN_Resid_e_Semiresid_v1.0.pdf)
41. Commissione nazionale per la definizione e l'aggiornamento dei livelli essenziali di assistenza. Prestazioni Residenziali e Semiresidenziali. Ministero Della Salute; 2007. Available: [https://www.salute.gov.it/imgs/C\\_17\\_pubblicazioni\\_646\\_allegato.pdf](https://www.salute.gov.it/imgs/C_17_pubblicazioni_646_allegato.pdf)
42. Turatto F, Sassano M, Goletti M, Severoni S, Grossi A, Parente P. Ensuring Equitable Access to the COVID-19 Vaccine: The Experience of A Local Health Unit in Rome, Italy. *Healthcare*. 2022; 10: 2246. <https://doi.org/10.3390/healthcare10112246> PMID: 36360587
43. Subjects I of M (US) C on A the S for PHR. Models of Accreditation. Preserving Public Trust: Accreditation and Human Research Participant Protection Programs. National Academies Press (US); 2001. Available: <https://www.ncbi.nlm.nih.gov/books/NBK43596/>
44. Connolly B, Salisbury L, O'Neill B, Geneen LJ, Douiri A, Grocott MP, et al. Exercise rehabilitation following intensive care unit discharge for recovery from critical illness. Cochrane Emergency and Critical Care Group, editor. *Cochrane Database Syst Rev*. 2015;2018. <https://doi.org/10.1002/14651858.CD008632.pub2>
45. Pietrantonio F, Rosiello F, Alessi E, Pascucci M, Rainone M, Cipriano E, et al. Burden of COVID-19 on Italian Internal Medicine Wards: Delphi, SWOT, and Performance Analysis after Two Pandemic Waves in the Local Health Authority “Roma 6” Hospital Structures. *Int J Environ Res Public Health*. 2021; 18: 5999. <https://doi.org/10.3390/ijerph18115999> PMID: 34204972
46. Iezzoni LI. Predicting Who Dies Depends on How Severity Is Measured: Implications for Evaluating Patient Outcomes. *Ann Intern Med*. 1995; 123: 763. <https://doi.org/10.7326/0003-4819-123-10-199511150-00004> PMID: 7574194
47. Santos JV, Viana J, Pinto C, Souza J, Lopes F, Freitas A, et al. All Patient Refined-Diagnosis Related Groups' (APR-DRGs) Severity of Illness and Risk of Mortality as predictors of in-hospital mortality. *J Med Syst*. 2022; 46: 37. <https://doi.org/10.1007/s10916-022-01805-3> PMID: 35524075



48. Commissione Tecnica per la Finanza Pubblica. Libro verde sulla spesa pubblica. Spendere meglio: alcune prime indicazioni. Ministero dell'Economia e delle Finanze; 2007. Available: [https://www.mef.gov.it/ministero/commissioni/ctfp/documenti/Libro\\_verde\\_spesa\\_pubblica.pdf](https://www.mef.gov.it/ministero/commissioni/ctfp/documenti/Libro_verde_spesa_pubblica.pdf)
49. Nicholls SG, Quach P, von Elm E, Guttman A, Moher D, Petersen I, et al. The REporting of Studies Conducted Using Observational Routinely-Collected Health Data (RECORD) Statement: Methods for Arriving at Consensus and Developing Reporting Guidelines. *PloS One*. 2015; 10: e0125620. <https://doi.org/10.1371/journal.pone.0125620> PMID: 25965407
50. Landeiro F, Roberts K, Gray AM, Leal J. Delayed Hospital Discharges of Older Patients: A Systematic Review on Prevalence and Costs. *The Gerontologist*. 2019; 59: e86–e97. <https://doi.org/10.1093/geront/gnx028> PMID: 28535285
51. Simeone S, Vellone E, Pucciarelli G. Homecare workers in Italy: a narrative review. *Ann Ig Med Prev E Comunità*. 2021; 163–176. <https://doi.org/10.7416/ai.2021.2422> PMID: 33570088
52. Van Eenoo L, Declercq A, Onder G, Finne-Soveri H, Garms-Homolová V, Jónsson PV, et al. Substantial between-country differences in organising community care for older people in Europe—a review. *Eur J Public Health*. 2016; 26: 213–219. <https://doi.org/10.1093/eurpub/ckv152> PMID: 26338722
53. Huy NT, Chico RM, Huan VT, Shaikhkhalil HW, Uyen VNT, Qarawi ATA, et al. Awareness and preparedness of healthcare workers against the first wave of the COVID-19 pandemic: A cross-sectional survey across 57 countries. Gesser-Edelsburg A, editor. *PLOS ONE*. 2021; 16: e0258348. <https://doi.org/10.1371/journal.pone.0258348> PMID: 34936646
54. Vinci A, Pasquarella A, Corradi MP, Chatzichristou P, D'Agostino G, Iannazzo S, et al. Emergency Medical Services Calls Analysis for Trend Prediction during Epidemic Outbreaks: Interrupted Time Series Analysis on 2020–2021 COVID-19 Epidemic in Lazio, Italy. *Int J Environ Res Public Health*. 2022; 19: 5951. <https://doi.org/10.3390/ijerph19105951> PMID: 35627487
55. Ferron R, Agarwal G, Cooper R, Munkley D. The effect of COVID-19 on emergency medical service call volumes and patient acuity: a cross-sectional study in Niagara, Ontario. *BMC Emerg Med*. 2021; 21: 39. <https://doi.org/10.1186/s12873-021-00431-5> PMID: 33781229
56. Alfonsi V, Scarpelli S, Gorgoni M, Couyoumdjian A, Rosiello F, Sandroni C, et al. Healthcare Workers after Two Years of COVID-19: The Consequences of the Pandemic on Psychological Health and Sleep among Nurses and Physicians. *Int J Environ Res Public Health*. 2023; 20: 1410. <https://doi.org/10.3390/ijerph20021410> PMID: 36674167
57. De Vita E, Sbrana F, Quattrone F, Dal Pino B, Megaro M, Lombardi R, et al. Adverse events and humoral response after two doses of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) mRNA vaccine in the hospital personnel of a cardiopulmonary tertiary-care center. *Infect Control Hosp Epidemiol*. 2022; 43: 1532–1534. <https://doi.org/10.1017/ice.2021.321> PMID: 34261574
58. Muselli M, Cofini V, Mammarella L. The impact of covid-19 pandemic on emergency services. *Ann Ig Med Prev E COMUNITÀ*. 2021 [cited 25 May 2023]. <https://doi.org/10.7416/ai.2021.2480> PMID: 34652412
59. Ricco M, De Nard F, Peruzzi S. Mosaic vaccination schedule: An unexpected card to play against SARS-CoV-2? *Infect Dis Now*. 2021; 51: 402–405. <https://doi.org/10.1016/j.idnow.2021.03.001> PMID: 33748805
60. Silenzi A, Siddu A, D'Amelio AC, Cataldi S, Fasano C, Maraglino F, et al. The new Italian National Immunization Technical Advisory Group (NITAG) and its commitment to endorse a new efficient National Immunization Plan in COVID-19 times. *Ann Ist Super Sanita*. 2023; 59: 26–30. [https://doi.org/10.4415/ANN\\_23\\_01\\_04](https://doi.org/10.4415/ANN_23_01_04) PMID: 36974701
61. Schiavone M, Sozzi FB, Gasperetti A, Gobbi C, Gherbesi E, Barbieri L, et al. Clinical Management of New-Onset Atrial Fibrillation in COVID-19 Patients Referred to a Tertiary Cardiac Arrhythmia Center after Hospital Discharge. *J Clin Med*. 2022; 11: 5661. <https://doi.org/10.3390/jcm11195661> PMID: 36233529
62. Pelullo CP, Tortoriello P, Angelillo S, Licata F, Napolitano F, Di Giuseppe G. Assessment of Perceived Health Status and Access to Health Service during the COVID-19 Pandemic: Cross-Sectional Survey in Italy. *Vaccines*. 2022; 10: 2051. <https://doi.org/10.3390/vaccines10122051> PMID: 36560461
63. Genovese C, La Fauci V, Di Pietro A, Trimarchi G, Odone A, Casuccio A, et al. COVID-19: opinions and behavior of Italian general population during the first epidemic phase. *Acta Biomed Atenei Parm*. 2022; 93: e2022262. <https://doi.org/10.23750/abm.v93i3.12262> PMID: 35775780
64. Genovese C, Costantino C, Odone A, Trimarchi G, La Fauci V, Mazzitelli F, et al. A Knowledge, Attitude, and Perception Study on Flu and COVID-19 Vaccination during the COVID-19 Pandemic: Multi-centric Italian Survey Insights. *Vaccines*. 2022; 10: 142. <https://doi.org/10.3390/vaccines10020142> PMID: 35214601

65. Rosiello DF, Anwar S, Yufika A, Adam RY, Ismaeil Mh, Ismail AY, et al. Acceptance of COVID-19 vaccination at different hypothetical efficacy and safety levels in ten countries in Asia, Africa, and South America. *Narra J*. 2021; 1. <https://doi.org/10.52225/narra.v1i3.55>
66. Tivoschi L, Quattrone F, De Vita E, Lopalco PL. Impact of mandatory law on vaccine hesitancy spectrum: The case of measles vaccine catch-up activities in Tuscany, Italy. *Vaccine*. 2019; 37: 7201–7202. <https://doi.org/10.1016/j.vaccine.2019.09.092> PMID: 31606250
67. Napolitano F, Miraglia Del Giudice G, Angelillo S, Fattore I, Licata F, Pelullo CP, et al. Hesitancy towards Childhood Vaccinations among Parents of Children with Underlying Chronic Medical Conditions in Italy. *Vaccines*. 2022; 10: 1254. <https://doi.org/10.3390/vaccines10081254> PMID: 36016141
68. Licata F, Romeo M, Riillo C, Di Gennaro G, Bianco A. Acceptance of recommended vaccinations during pregnancy: a cross-sectional study in Southern Italy. *Front Public Health*. 2023; 11: 1132751. <https://doi.org/10.3389/fpubh.2023.1132751> PMID: 37250080
69. Licata F, Di Gennaro G, Cautela V, Nobile CGA, Bianco A. Endodontic Infections and the Extent of Antibiotic Overprescription among Italian Dental Practitioners. *Antimicrob Agents Chemother*. 2021; 65: e00914–21. <https://doi.org/10.1128/AAC.00914-21> PMID: 34252306
70. Bianco A, Cautela V, Napolitano F, Licata F, Pavia M. Appropriateness of Antibiotic Prescription for Prophylactic Purposes among Italian Dental Practitioners: Results from a Cross-Sectional Study. *Antibiotics*. 2021; 10: 547. <https://doi.org/10.3390/antibiotics10050547> PMID: 34066881
71. Bianco A, Licata F, Nobile CG, Napolitano F, Pavia M. Pattern and appropriateness of antibiotic prescriptions for upper respiratory tract infections in primary care paediatric patients. *Int J Antimicrob Agents*. 2022; 59: 106469. <https://doi.org/10.1016/j.ijantimicag.2021.106469> PMID: 34757133
72. Bianco A, Licata F, Trovato A, Napolitano F, Pavia M. Antibiotic-Dispensing Practice in Community Pharmacies: Results of a Cross-Sectional Study in Italy. *Antimicrob Agents Chemother*. 2021; 65: e02729–20. <https://doi.org/10.1128/AAC.02729-20> PMID: 33781998
73. Pietrantonio F, Vinci A, Maurici M, Ciarambino T, Galli B, Signorini A, et al. Intra- and Extra-Hospitalization Monitoring of Vital Signs—Two Sides of the Same Coin: Perspectives from LIMS and Greenline-HT Study Operators. *Sensors*. 2023; 23: 5408. <https://doi.org/10.3390/s23125408> PMID: 37420575
74. Viana Pereira F, Tavares J, Oliveira T. Adoption of video consultations during the COVID-19 pandemic. *Internet Interv*. 2023; 31: 100602. <https://doi.org/10.1016/j.invent.2023.100602> PMID: 36694630
75. Pietrantonio F, Vinci A, Rosiello F, Alessi E, Pascucci M, Rainone M, et al. Green Line Hospital-Territory Study: A Single-Blind Randomized Clinical Trial for Evaluation of Technological Challenges of Continuous Wireless Monitoring in Internal Medicine, Preliminary Results. *Int J Environ Res Public Health*. 2021; 18: 10328. <https://doi.org/10.3390/ijerph181910328> PMID: 34639631
76. Wise J. Delayed discharge: One in six patients in hospital in England are medically fit to leave. *BMJ*. 2023; p578. <https://doi.org/10.1136/bmj.p578> PMID: 36898729
77. Gonçalves-Bradley DC, Lannin NA, Clemson L, Cameron ID, Shepperd S. Discharge planning from hospital. *Cochrane Effective Practice and Organisation of Care Group*, editor. *Cochrane Database Syst Rev*. 2022; 2022. <https://doi.org/10.1002/14651858.CD000313.pub6> PMID: 35199849
78. Franklin BJ, Vakili S, Huckman RS, Hosein S, Falk N, Cheng K, et al. The Inpatient Discharge Lounge as a Potential Mechanism to Mitigate Emergency Department Boarding and Crowding. *Ann Emerg Med*. 2020; 75: 704–714. <https://doi.org/10.1016/j.annemergmed.2019.12.002> PMID: 31983501
79. Chen JJ, Finn CT, Homa K, St. Onge KP, Caller TA. Discharge Delays for Patients Requiring In-Hospital Guardianship: A Cohort Analysis. *J Healthc Qual*. 2016; 38: 235–242. <https://doi.org/10.1097/01.JHQ.0000462680.47759.53> PMID: 26042759
80. Giraldo G, Montesano M, Sandorfi F. Excess length of hospital stay due to healthcare acquired infections: methodologies evaluation. *Ann Ig Med Prev E Comunità*. 2019; 507–516. <https://doi.org/10.7416/ai.2019.2311> PMID: 31304530
81. Martins M, Mesquita A, Carvalho L, Martins F, Silva M, Leitão H, et al. Factores de Risco para Alta Prorogada por Motivos Sociais: Um Estudo Retrospectivo. *Acta Médica Port*. 2023 [cited 4 Apr 2023]. <https://doi.org/10.20344/amp.18888> PMID: 36780660
82. Rameli PM, Rajendran N. Outcomes of complex discharge planning in older adults with complex needs: a scoping review. *J Int Med Res*. 2022; 50: 030006052211105. <https://doi.org/10.1177/03000605221110511> PMID: 35903858
83. Manning L, Islam MdS. A systematic review to identify the challenges to achieving effective patient flow in public hospitals. *Int J Health Plann Manage*. 2023; 38: 805–828. <https://doi.org/10.1002/hpm.3626> PMID: 36855322
84. Sakamoto M, Phinney A, Thompson G. Waiting for home: The experience of delayed discharge for people with dementia. *Int J Older People Nurs*. 2023; 18. <https://doi.org/10.1111/opn.12516> PMID: 36394957