Breaking the Bottleneck: Investigating Delayed Discharges and Their Impact on Healthcare Efficiency in a Small European Acute General Hospital

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Article

Breaking the Bottleneck: Investigating Delayed Discharges and Their Impact on Healthcare Efficiency in a Small European Acute General Hospital

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Abstract

Delayed discharge represents a persistent challenge in healthcare systems, contributing to inefficiencies in hospital bed utilization, increased costs, and reduced patient flow. In small and centralized healthcare systems, these effects may be further amplified due to limited post-acute care capacity and restricted patient redistribution. This study quantified the prevalence of inappropriate hospital days as a proxy for delayed discharge and examined their relationship with patient demographics, medical specialty, and associated costs in an acute general hospital. A quantitative retrospective analysis of 220 medical records was conducted using a modified Appropriateness Evaluation Protocol (AEP). Descriptive statistics and non-parametric tests were applied to identify significant associations between inappropriate hospital days and selected variables. The results showed that approximately 50% of inpatient days were inappropriate, with most delays attributed to waiting for long-term care and rehabilitation placement. Age and medical specialty were significantly associated with delayed discharge, while no consistent relationship was observed with gender. Cost analysis indicated a substantial financial burden, with annual estimates exceeding €2.5 million for the units studied. These findings suggest that delayed discharge is driven by a combination of external capacity constraints and internal operational inefficiencies. The study highlights the need to strengthen post-acute care provision, improve discharge coordination processes, and enhance system integration to optimize hospital efficiency and patient flow.

Keywords: delayed discharge; inappropriate hospital days; hospital bed utilization; patient flow; healthcare efficiency; small states health systems

1. Introduction

Healthcare systems in both developed and developing countries have faced increasing pressures in recent decades, driven by rising demand, constrained resources, and evolving population needs (Marmot et al., 2012). These challenges were further intensified during the COVID-19 pandemic, which placed significant strain on both human and financial resources. In this context, reducing cost and waste has gained renewed importance in public health systems, particularly through efforts to improve operational efficiency (Thwaites et al., 2017).

Hospital bed availability has emerged as a critical resource within this framework, as it directly influences admission capacity, discharge processes, and the overall quality of patient care (Bauer and Becker, 2014; Jasinarachchi et al., 2009). Length of stay remains a key determinant of bed utilisation,

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with evidence linking prolonged hospitalisation to patient age, clinical conditions, and socio-economic characteristics (Philp et al., 2013; Sarfo et al., 2017). At the same time, healthcare systems are inherently complex (Fowler et al., 2008), and ongoing demographic and societal changes, particularly population ageing and shifts in family structures, have further increased pressure on acute care services (Hendy et al., 2012).

When these pressures are combined with limitations in community based and post-acute care services, hospital discharge processes become increasingly constrained. This often results in delayed discharges, whereby patients who are medically fit for discharge remain in acute hospital settings due to non-clinical factors (Thwaites et al., 2017; Hendy et al., 2012). Delayed discharge has been conceptually defined as a situation in which patients experience unnecessary continued hospitalisation due to internal organisational factors or external constraints related to transitions of care, including limited availability of alternative care arrangements (Micallef et al., 2020). However, despite this conceptual clarity, the operational definition of delayed discharge remains inconsistent across the literature, and there is a lack of comprehensive tools specifically designed to capture all contributing causes (Micallef et al., 2020).

To address this challenge, delayed discharge is often operationalised through the concept of inappropriate hospital days, which is a widely used proxy indicator in hospital efficiency research. The Appropriateness Evaluation Protocol (AEP), originally developed by Gertman and Restuccia and later applied in hospital settings by Aruldas (1999), provides a structured method to assess whether individual hospital days meet predefined clinical criteria. These criteria relate to medical interventions, nursing care requirements, or patient clinical condition. Hospital days that do not meet these criteria are classified as inappropriate. Previous applications of this approach have demonstrated that a substantial proportion of inappropriate hospital days are attributable to organisational inefficiencies, including delays in diagnostic investigations, specialist consultations, and discharge planning processes (Aruldas, 1999). In this context, delayed discharge can be understood as the cumulative outcome of inappropriate hospital days occurring throughout a patient's stay, reflecting inefficiencies in both internal hospital operations and external care transition systems.

Delayed discharge has significant implications for healthcare systems, both operationally and clinically. It is widely recognised as a major bottleneck in patient flow, reducing bed availability and limiting access to acute care services. Beyond logistical concerns, delayed discharges have also been associated with adverse patient outcomes, including increased mortality rates (Green et al., 2017; Berger et al., 2020; Lenzi et al., 2014; Mendoza Giraldo et al., 2012). As a result, policymakers and healthcare managers have prioritised interventions aimed at reducing discharge delays to improve efficiency and patient flow while controlling costs (El Eid et al., 2015).

A substantial body of research has examined the determinants of delayed discharge, identifying several key contributing factors. These include shortages in community and social care services (Mendoza Giraldo et al., 2012; Mann, 2016; Mustafa et al., 2016), limited availability of long term care and rehabilitation beds (Landeiro et al., 2019; Feigal et al., 2014; Majeed et al., 2012), procedural inefficiencies within hospitals (Sant et al., 2015), and inadequate discharge planning processes (Hollande et al., 2016; Rojas Garcia et al., 2018). Often referred to as bed blocking, delayed discharge represents a form of operational inefficiency whereby acute hospital resources are utilised by patients who no longer require that level of care (Landeiro et al., 2019). Consequently, delayed discharge has increasingly been adopted as an important performance indicator for evaluating healthcare system efficiency and discharge planning effectiveness (El Eid et al., 2015).

The impact of delayed discharge is expected to intensify in the coming years due to global demographic trends. The United Nations (UN) has highlighted that population ageing is affecting nearly all countries, leading to increased demand for healthcare services and hospital-based care (United Nations, 2017; World Health Organization, 2015). Projections suggest that by 2030, the demand for geriatric and chronic care services will rise significantly, further increasing pressure on hospital capacity and healthcare expenditure (Van der Heede et al., 2019; Ha et al., 2014). Hospital

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beds are therefore likely to become an increasingly scarce resource, particularly in smaller countries where the ability to redistribute patients across multiple institutions is limited (Eurostat, 2021).

Despite the growing literature in this area, most empirical studies on delayed discharge have been conducted in large multi hospital healthcare systems, particularly in countries such as the United Kingdom, Canada, and the United States (Landeiro et al., 2019; Guilcher et al., 2023). There remains a relative lack of research focusing on small, centralised healthcare systems, where limited infrastructure and restricted patient redistribution capacity may amplify the operational consequences of delayed discharge. Furthermore, few studies have provided detailed quantitative assessments of the financial impact of delayed discharges at the level of individual hospital units. This represents an important gap, particularly for small European states where structural constraints may exacerbate both operational inefficiencies and cost implications.

Malta provides a relevant case study in this context. The country's healthcare system is characterised by a high degree of centralisation, with one-only hospital serving as the primary public acute care provider. The system has been significantly affected by demographic changes, including population ageing and recent increases in population size due to migration and tourism (Azzopardi et al., 2017). As a result, high bed occupancy rates, frequent bed blocking, and overcrowding in emergency departments have become persistent challenges (Azzopardi et al., 2017). The centralised structure of the healthcare system limits flexibility in patient redistribution, thereby intensifying the impact of delayed discharges on overall system performance.

In such settings, efficient bed management and the reduction of operational inefficiencies are of critical importance. Delayed discharges in a single acute hospital can have system wide implications, directly affecting national healthcare capacity. This makes Malta an important context for examining delayed discharge dynamics and identifying targeted operational interventions. This study contributes to the existing literature by providing a quantitative and financial analysis of delayed discharges within a centralised healthcare system, with a particular focus on operational bottlenecks and their managerial implications.

Accordingly, this study aims to quantitatively assess the extent of delayed discharges in an acute general hospital and to identify the key factors contributing to these delays. The specific objectives are to measure delays using a quantitative approach, to identify and quantify the contributing factors associated with delayed discharges, and to utilise the findings to propose a framework of managerial recommendations.

2. Materials and Methods

2.1. Study Design

This study was conducted at Malta's primary acute care hospital, the only government-run general hospital, over a three-month period between October 2024 and December 2024. A quantitative retrospective design was adopted, based on the analysis of patients' medical records to evaluate hospital bed utilisation.

Document analysis was used as the primary methodological approach. This method is defined as a systematic procedure for reviewing and evaluating documents in order to extract meaningful data (Maxwell, 2005). It is considered particularly suitable in healthcare research due to its stability and non-reactive nature, allowing for the collection of information without influencing the observed processes (Harvey, 2018).

2.2. Target Population and Sampling Technique

The study population was drawn from admission records across two hospital units covering medical, surgical, urology, orthopaedic, and vascular specialties. The sampling approach followed the principles outlined by Anieting (2017), whereby a defined subset of records is selected based on study relevance.

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Based on a total of 3,511 admissions in 2024, a sample size calculator using a 95 percent confidence level indicated that a minimum of 220 medical records was required for statistical robustness. A quota sampling technique was applied to ensure representation across key clinical categories (Clinical Performance Unit, 2021; Clinical Performance Unit, 2022).

Medical records were selected chronologically twice per week starting in October 2024. Following informed consent, each case was followed from admission to discharge. To focus on cases more likely to experience discharge delays, only patients with a length of stay exceeding seven days were included. This threshold reflects the hospital's average length of stay, which ranges between 6.9 and 7.6 days for medical and surgical patients (Clinical Performance Unit, 2021; Clinical Performance Unit, 2022).

Patients admitted to specialised units were excluded from the study, as these units operate under different clinical and administrative protocols that could affect comparability.

2.3. Data Collection

Data were collected using a revised version of the Appropriateness Evaluation Protocol developed by Aruldas (1999), which is based on the original model by Gertman and Restuccia (VandenEnde et al., 2023). The AEP is a structured and widely used tool designed to assess the appropriateness of each inpatient day.

The protocol evaluates hospital stay using 27 explicit criteria across three domains: medical activity, nursing care requirements, and patient clinical condition (Lenzi et al., 2014). These criteria are independent of specific diagnoses and allow for the classification of each hospital day as either appropriate or inappropriate (VandenEnde et al., 2023). An inappropriate day is defined as a day during which the patient no longer requires acute care but remains hospitalised, often due to delays in discharge processes.

The adapted version of the AEP used in this study required that a specific reason be assigned to each inappropriate day, enabling the identification of underlying causes of delayed discharge (Aruldas, 1999).

To ensure contextual relevance, two additional components were incorporated into the data collection tool. A comments section was included to capture contextual information related to daily patient management. An additional category labelled undetected delays was introduced to identify system-level factors not captured by standard AEP criteria.

Due to the limited availability of electronic health records at the study site, data were extracted from physical medical files. Following written informed consent, a trained healthcare professional acted as an intermediary and was responsible for reviewing the records. The intermediary was trained in the use of the AEP tool and the objectives of the study, and recorded data in an anonymised format. Extracted data were subsequently entered into a coded dataset for analysis.

Routine procedures performed for all patients, such as daily blood tests, admission chest X-rays, and electrocardiograms, were excluded from the assessment. This ensured that the classification of appropriate days reflected clinically meaningful interventions rather than standard routine care.

2.4. Data Analysis

Statistical analysis was conducted to examine associations between inappropriate hospital days and selected independent variables, including patient age, gender, and medical specialty. Descriptive statistics were used to summarise demographic characteristics and the frequency of delays.

Given the non-random sampling method and the distribution of the data, non-parametric statistical tests were applied (Chavan and Kulkarni, 2017). The Mann–Whitney U test was used to compare differences between two independent groups, while the Kruskal–Wallis test was used for comparisons across multiple groups.

Statistical significance was set at a p value of less than 0.05. Confidence intervals at 95 percent were calculated to assess the precision of the estimates. These analyses allowed for the identification of statistically significant factors associated with delayed discharge.

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2.5. Ethical Considerations

Ethical approval for the study was obtained from hospital management, including the Chief Executive Officer, the Nursing Director, and the Data Protection Officer. The study adhered to the principles of autonomy, beneficence, and non-maleficence throughout.

All participants were provided with written information outlining the purpose of the study and their right to withdraw at any stage. Written informed consent was obtained prior to data collection. Patient confidentiality was strictly maintained through the use of an intermediary, ensuring that the research team did not have direct access to identifiable patient information.

3. Results

3.1. Sample Characteristics and Inappropriate Hospital Days

A total of 220 patient records were analysed. Males accounted for 57% of the sample, while females represented 43%. The majority of patients were older adults, with 93.1% aged over 66 years.

The average length of stay increased with age and was highest among patients admitted under medical and orthopaedic specialties, with mean values of 23.5 and 25.1 days, respectively. Most patients were managed under medical specialties (65.9%), followed by surgical specialties (17.7%).

Overall, inappropriate hospital days accounted for approximately 50% of total inpatient days, indicating a substantial proportion of hospital utilisation that was not clinically required.

Table 1 summarises the demographic characteristics of the sample, including average length of stay and proportion of inappropriate days.

Table 1. Sample characteristics, length of stay, and inappropriate hospital days.

Variable	Category	n (%)	Mean LOS (days)	Inappropriate days n (%)
Gender	Male	127 (57.7)	24.7	1543 (61.7)
	Female	93 (42.3)	19.8	962 (38.3)
Age (years)	26–35	4 (1.8)	9.7	7 (0.3)
	36–45	9 (4.0)	11.6	23 (0.9)
	46–55	23 (10.4)	14.8	47 (1.9)
	56–65	31 (14.0)	14.1	123 (5.0)
	66–75	53 (24.0)	22.9	561 (22.6)
	76–85	67 (30.4)	23.9	780 (31.5)
	>86	44 (20.0)	33.0	966 (39.0)
Specialty	Medicine	145 (65.9)	23.5	1969 (79.5)
	Surgery	39 (17.7)	19.3	279 (11.3)
	Urology	7 (3.1)	17.2	22 (0.9)
	Orthopaedic	7 (3.1)	25.1	118 (4.8)
	Vascular	22 (10.0)	20.2	119 (4.8)

3.2. Causes of Inappropriate Hospital Days

Each patient record was analysed to identify the cause and duration of inappropriate hospital days. The most frequent cause was waiting for long term care placement, accounting for 45.4% of all inappropriate days. This was followed by delays related to rehabilitation (14.5%) and COVID-19 related factors (9.56%).

Other contributing factors included delays in medical imaging (6.93%), consultations (6.13%), and multidisciplinary reviews such as geriatrician and social worker assessments.

Inappropriate hospital days were more frequently observed among older patients and those admitted under medical specialties. No consistent association was observed with gender.

A detailed breakdown of causes of inappropriate hospital days across age, gender, and specialty is presented in Appendix A (Table A1).

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3.3. Statistical Analysis

Statistical analysis showed no significant association between gender and inappropriate hospital days.

In contrast, patient age was significantly associated with several key delay categories, particularly long-term care placement, rehabilitation delays, and multidisciplinary reviews including geriatrician and social worker assessments ($p < 0.001$).

Medical specialty was also significantly associated with certain causes of delay. Strong relationships were observed for rehabilitation delays, geriatrician reviews, and theatre related delays ($p < 0.001$).

Table 2 presents the statistical relationships between inappropriate hospital days and the independent variables.

Table 2. Statistical associations between inappropriate hospital days and patient characteristics.

Cause of delay	n (%)	Gender (p-value)	Age (p-value)	Specialty (p-value)	95% CI
Awaiting long term care	1140 (45.4)	0.06	<0.001	0.12	4.6–8.76
Awaiting rehabilitation	365 (14.5)	0.45	<0.001	<0.001	0.98–2.62
Awaiting geriatrician	122 (4.89)	0.67	<0.001	<0.001	0.26–0.57
Awaiting consultation	154 (6.13)	0.71	0.51	0.33	0.32–0.63
Awaiting theatre	7 (0.28)	0.16	0.21	<0.001	0.10–0.50
Awaiting relocation	25 (0.85)	0.87	0.006	0.77	0.26–0.63
Awaiting medical imaging	175 (6.93)	0.86	0.26	0.002	0.40–0.79
Awaiting social worker	115 (4.59)	0.59	<0.001	<0.001	0.28–0.60
COVID-related delays	240 (9.56)	0.48	0.98	0.12	0.51–1.24

3.4. Temporal Patterns of Patient Activity

Analysis of patient activity across the first 20 days of hospitalisation showed that clinical and nursing interventions were most frequent during the initial stages of admission and declined progressively over time.

This decline in activity corresponded with an increase in inactive days, indicating a higher likelihood of discharge delays as the length of stay (LOS) increased.

Figure 1 shows the distribution of patient-related activity over time.

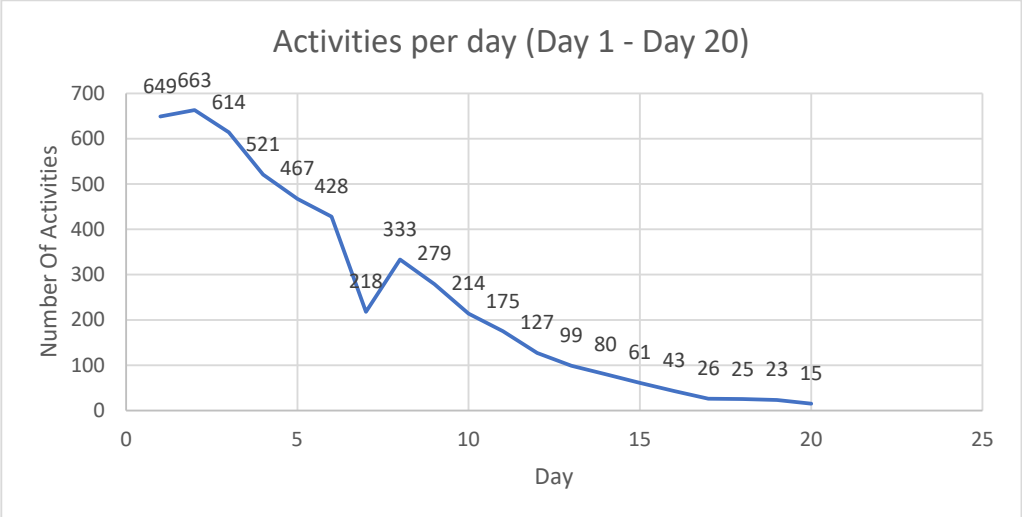

Figure 1. Patient-related activity from Day 1 to Day 20 of hospitalization.

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Figure 2 illustrates the increasing frequency of inactive days across the duration of hospital stay.

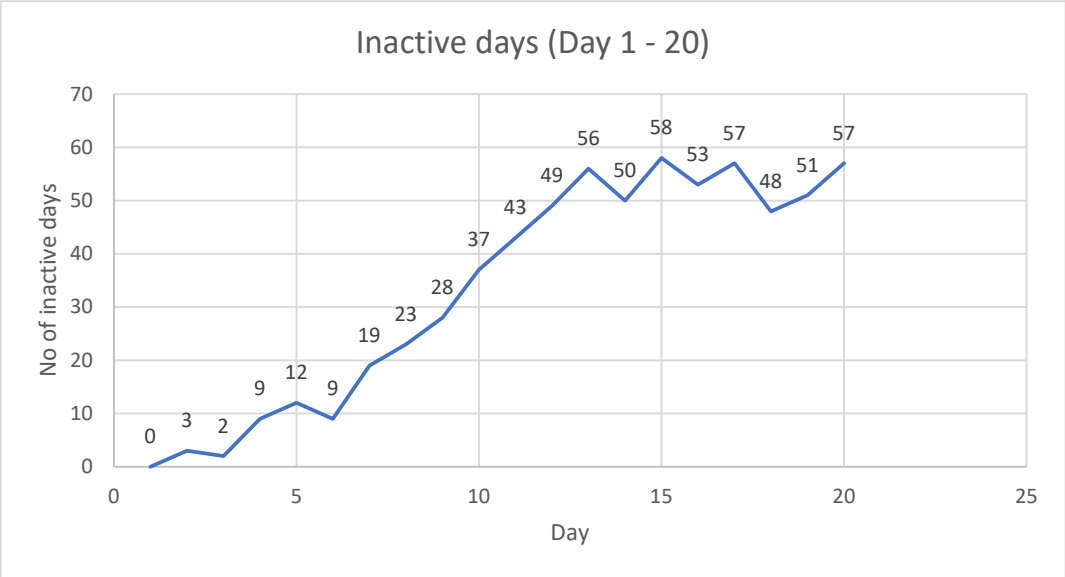

Figure 2. Frequency of inactive days from Day 1 to Day 20 of hospitalisation.

3.5. Cost of Inappropriate Hospital Days

To estimate the financial impact of inappropriate hospital days, data from the three-month study period were extrapolated to annual values using a multiplication factor of four.

The estimated cost per hospital bed day was €256.25. Based on this value, the total cost of inappropriate hospital days was €640,544 for the study period, corresponding to an estimated annual cost of €2,550,193.

The largest proportion of costs was associated with delays in long term care and rehabilitation placement. Additional cost drivers included procedural delays and COVID-19 related delays.

Table 3 presents the estimated costs associated with inappropriate hospital days.

Table 3. Estimated cost of inappropriate hospital days.

Category	Cause	Inappropriate days (actual)	Inappropriate days (annual)	Cost (€ actual)	Cost (€ annual)
Long term care delays	Awaiting LTC	1140	4560	292,125	1,168,500
	Awaiting rehabilitation	365	1460	93,531	374,125
	Social worker	115	460	29,468	117,875
	Geriatrician	122	488	31,262	125,050
Procedural delays	Consultation	154	616	39,462	157,850
	Medical imaging	175	700	44,843	179,375
COVID-related	Quarantine delays	240	960	61,500	246,000
Administrative	Management delays	29	116	7,431	29,725
Total				**640,544**	**2,550,193**

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4. Discussion

This study examined delayed discharge using inappropriate hospital days as an operational indicator of hospital bed utilisation. The findings show that a substantial proportion of inpatient days were inappropriate, with delays concentrated mainly among older patients and those admitted under medical specialties. The results also indicate that delays were driven primarily by waiting times for long term care and rehabilitation placement, together with internal bottlenecks related to professional reviews, consultations, and discharge processes. From a managerial perspective, these findings support the usefulness of the Appropriateness Evaluation Protocol as a structured method for distinguishing between hospital days that require genuine acute care and those that reflect inefficiencies in patient flow and care transition processes (Aruldas, 1999).

The AEP was particularly useful because it linked each inappropriate day to a documented cause. This allowed the study to move beyond simple measurement of excess length of stay (LOS) and instead identify specific operational points at which delays occurred. In this sense, inappropriate hospital days can be viewed not only as a measure of resource inefficiency, but also as a practical management indicator that can support service redesign, discharge planning improvements, and better allocation of post-acute resources.

4.1. Appropriate Hospital Days

Although the focus of the study was delayed discharge, the analysis of appropriate hospital days provides important context for interpreting the findings. Appropriate days accounted for 49.3% of the total recorded days. Most of these were concentrated within the nursing and medical service components of the AEP, particularly in relation to daily monitoring, parenteral therapy, and routine observation.

The most frequent reasons for classifying a day as appropriate were essential daily monitoring by nurses or doctors, parenteral therapy, and essential monitoring of vital signs. Fluid balance charting and medical imaging also contributed to appropriate stay classification. Taken together, these findings suggest that a large proportion of appropriate days were characterised by relatively low intensity but still necessary hospital care, rather than high acuity episodes requiring complex intervention.

This pattern is consistent with the composition of the study sample, which was largely made up of older patients admitted under medicine and staying for prolonged periods. It also suggests that the distinction between appropriate and inappropriate use in this population is not always between acute and non-acute care in absolute terms, but often between ongoing low intensity inpatient management and the absence of a more suitable alternative care setting. This point is important because it highlights the burden placed on acute hospitals when community, rehabilitation, or long-term care pathways are insufficiently responsive.

4.2. Inappropriate Hospital Days and Delayed Discharge

The findings indicate that delayed discharge was concentrated in older age groups and among patients admitted under medicine. This is in line with wider evidence showing that older adults are more likely to experience prolonged hospital stays due to frailty, multimorbidity, reduced functional reserve, and increased need for post-acute support (Landeiro et al., 2019; Van der Heede et al., 2019). It is also consistent with the demographic profile of Malta, where population ageing continues to place growing pressure on acute and long-term care services (Azzopardi et al., 2017).

The largest single contributor to inappropriate hospital days was waiting for long term care placement, followed by rehabilitation delays. Together, these categories accounted for most delayed discharge days in the sample. These delays were especially pronounced among the oldest patients and were strongly associated with age. This finding is consistent with previous research showing that inadequate long term care capacity and limited rehabilitation availability are among the most

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important system level causes of discharge delay (Landeiro et al., 2019; Majeed et al., 2012; Mendoza Giraldo et al., 2012).

The results also showed that delays in social worker review, geriatrician review, and discharge facilitation processes made a meaningful contribution to the overall burden of inappropriate days. These functions are central to the identification and coordination of patients who no longer require acute treatment but cannot yet leave hospital safely. In the present study, the association between these delays and both age and specialty suggests that the problem lies not only in external bed availability, but also in the pace and responsiveness of the internal flagging and referral process. This is particularly relevant in a paper-based environment, where requests for review and progression through discharge pathways may be slower and more fragmented than in systems supported by integrated electronic workflows.

The temporal pattern identified in the figures further supports this interpretation. Activity levels were highest early in the admission and declined over time, while inactive days increased as length of stay progressed. This suggests that discharge planning may not always begin early enough in the patient journey. Instead, barriers appear to become more visible only after the acute phase has passed, by which point delays are already established. Similar observations have been made in the literature, where late discharge planning and weak coordination across care settings are recognised as major contributors to bed blocking and prolonged stay (Hollande et al., 2016; Rojas Garcia et al., 2018).

Other forms of delay, including consultation waiting times, medical imaging, theatre access, and administrative issues, contributed a smaller but still relevant proportion of inappropriate days. Although these categories did not carry the same overall weight as long term care and rehabilitation delays, they remain operationally important because they represent bottlenecks that are at least partly modifiable at hospital level. In practice, the cumulative effect of these smaller delays may still be substantial, especially in a setting already operating under high bed occupancy.

COVID 19 related delays also remained visible in the data, despite the study taking place well beyond the peak pandemic period. This finding suggests that infection prevention protocols and residual organisational responses to the pandemic may continue to affect patient flow even after the emergency phase has passed. The literature has reported mixed findings on the extent to which COVID 19 worsened delayed discharge patterns, but it is plausible that in a small and densely populated healthcare system, infection control processes may have remained more cautious for longer (Guilcher et al., 2023; Hinde et al., 2021; Vinci et al., 2024). In this context, some of the observed delays may have reflected an effort to minimise cross infection risk within a highly pressured acute environment.

Overall, the results suggest that delayed discharge in this setting is best understood as a combined product of external capacity constraints and internal process inefficiencies. The shortage of long-term care and rehabilitation places appears to be the dominant structural issue. However, the findings also indicate that delays are amplified by the timing and organisation of discharge related reviews, consultations, and decision making. This distinction is important because it implies that not all causes of delayed discharge require the same type of intervention. Some depend on system wide investment, while others may be improved through local operational redesign.

4.3. Financial Implications

The costing exercise showed that delayed discharge carries a substantial financial burden. Based on the observed data and annual extrapolation, inappropriate hospital days in the two study units were associated with an estimated yearly cost of more than €2.5 million. While this figure should be interpreted with caution, it nevertheless provides a useful estimate of the scale of avoidable expenditure associated with prolonged acute bed occupancy.

The largest share of this cost was attributable to delays in long term care and rehabilitation placement. This reflects the high number of inappropriate days generated by patients who remained in hospital despite no longer requiring acute care. From a health service perspective, this is particularly important because acute beds represent one of the most expensive resources in the

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system. When such beds are used to accommodate patients awaiting downstream placement, the result is not only direct financial inefficiency but also reduced admission capacity and added pressure on emergency and elective care pathways.

The cost associated with delays in geriatrician review, social worker review, and consultation processes is also noteworthy. Unlike external bed shortages, these delays may be more amenable to internal service redesign. Faster referral systems, better prioritisation of discharge related reviews, and improved workforce allocation could potentially reduce a meaningful proportion of avoidable bed days without requiring large scale infrastructure expansion.

The cost estimates related to COVID 19 should be interpreted more cautiously, given the changing nature of infection control policies and the possibility that such delays may not remain stable over time. Nevertheless, their presence in the data illustrates how system shocks can continue to shape operational efficiency after the acute crisis phase has passed.

An additional issue of practical importance concerns patients who remained in hospital for intravenous antibiotic administration alone. Although this was not classified as a central delayed discharge category within the AEP structure, the number of such cases suggests that community based intravenous treatment pathways may have further potential to reduce unnecessary inpatient stay. This is particularly relevant in systems seeking lower cost alternatives to prolonged acute admission for clinically stable patients.

4.4. Contribution of the Study

This study adds to the literature by examining delayed discharge within a small, highly centralised healthcare system. Most previous studies have focused on larger and less centralised systems, particularly in the United Kingdom, Canada, and the United States (Landeiro et al., 2019; Guilcher et al., 2023). By contrast, the present study provides evidence from a setting where patient redistribution options are limited and pressure on one major acute hospital has system wide consequences.

The study also contributes by combining operational measurement with financial estimation. By linking specific causes of delay to both inappropriate hospital days and associated costs, it provides evidence that is directly relevant to hospital managers and policymakers. In particular, it highlights the extent to which delayed discharge in small systems may be shaped by an interaction between demographic pressure, constrained post-acute capacity, and internal process inefficiencies.

5. Limitations

This study has several limitations that should be considered when interpreting the findings.

First, the study was conducted in a single acute general hospital within a small European state. Although this setting provides an important case study of delayed discharge in a centralised system, the findings may not be directly generalisable to larger or more decentralised healthcare systems. The results reflect the specific infrastructure, referral pathways, and operational practices of one institution.

Second, the study focused only on selected units and excluded specialised ward areas and paediatric services. The findings should therefore not be assumed to represent delayed discharge patterns across the whole hospital. Relatedly, the inclusion criterion of length of stay greater than seven days was appropriate for identifying patients at higher risk of delay, but it also means that the sample was intentionally weighted towards longer stay admissions and does not reflect the full inpatient population.

Third, the study used quota sampling rather than random sampling. While this approach was practical and appropriate for the study aim, it limits the strength of general statistical inference. The results should therefore be interpreted as analytically informative rather than fully representative at hospital or national level.

Fourth, the study did not include a direct measure of patient medical complexity or severity of comorbidity in the statistical analysis. This was a deliberate decision due to the difficulty of isolating

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the effect of individual conditions in a sample with high multimorbidity. However, the absence of this variable means that some part of prolonged stay may have reflected genuine clinical complexity rather than discharge inefficiency alone.

Fifth, the study relied on manual review of paper based medical records. Although the use of an intermediary helped protect anonymity, the quality of the analysis depended on the completeness and clarity of the recorded notes. In some cases, the AEP criteria alone were not sufficient to capture the complexity of the delay, which is why supplementary fields for comments and undetected delays were introduced.

Finally, the continued presence of COVID 19 related operational measures during the study period may limit the stability of some findings over time. As infection control protocols evolve, the contribution of these delays may decrease or change in character.

Future research should build on these findings by including larger samples, additional specialties, and where possible, measures of clinical acuity and patient complexity. Multi site studies would also help determine the extent to which these patterns apply across other hospitals and healthcare systems. In addition, qualitative work involving patients, families, and healthcare professionals could provide a fuller understanding of the human and organisational impact of delayed discharge.

6. Conclusions

This study supports the use of inappropriate hospital days as a practical operational indicator of delayed discharge in acute hospital care. The findings show that delayed discharge was common in the study sample and was driven mainly by waiting times for long term care and rehabilitation placement, together with slower internal processes related to professional review and discharge coordination.

The burden of delay was concentrated among older patients and those admitted under medicine, reflecting the combined effect of population ageing, multimorbidity, and pressure on downstream care services. The analysis also showed that the likelihood of inactivity increased as the hospital stay progressed, suggesting that discharge planning and transfer arrangements may not always be initiated early enough.

From a management perspective, the findings point to two broad priorities. The first is the need to strengthen post acute capacity, particularly in long term care and rehabilitation. The second is the need to improve internal discharge processes, especially those involving referral, flagging, review, and multidisciplinary coordination. Addressing only one of these dimensions is unlikely to resolve the problem fully.

The costing exercise further showed that delayed discharge is not only a patient flow issue, but also a significant financial issue. Even with the limitations of annual extrapolation, the estimated cost burden was substantial and suggests that avoidable acute bed occupancy represents an important area for service improvement.

In conclusion, delayed discharge in this setting appears to be driven by an interaction between external capacity limitations and internal operational inefficiencies. In small and centralised healthcare systems, where flexibility is inherently limited, these delays can have particularly wide system effects. Interventions aimed at improving discharge planning, accelerating review processes, expanding community and post-acute alternatives, and strengthening digital coordination may therefore offer meaningful benefits for both efficiency and patient care.

7. Recommendations

Based on the findings of this study, a number of practical recommendations emerge. First, discharge planning should begin earlier in the admission pathway, particularly for older patients admitted under medicine who are likely to require long term care, rehabilitation, or community support on discharge.

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Second, the flagging and review process should be streamlined. Greater use of integrated electronic referral and discharge planning systems may reduce delays associated with paper-based communication and improve the timeliness of geriatrician, social worker, and discharge facilitation review.

Third, workforce allocation should be examined in the areas most closely linked to discharge progression, particularly within medicine, geriatrics, and social support functions. Better alignment between staffing patterns and discharge related workload may help reduce unnecessary waiting time.

Fourth, investment in long term care, rehabilitation, and community-based alternatives is essential. Without stronger downstream capacity, acute hospitals are likely to continue absorbing patients who no longer require acute treatment.

Fifth, community administration of intravenous antibiotic therapy should be further explored and expanded where clinically appropriate, in order to avoid prolonged admission for treatment that could be delivered safely outside the acute setting.

Finally, future research should examine delayed discharge across a wider range of specialties and should incorporate measures of patient complexity, as well as qualitative perspectives from patients, relatives, and staff.

Table A1. Causes of inappropriate days in relation to patients' gender, age group and medical speciality.

	Total (% of total) of inappropriate days	**Gender (Frequency (% of total))**		**Age Range (years) (Frequency (% of total))**								**Speciality (Frequency (% of total))**				
		Male	Female	<25	26-35	36-45	46-55	56-65	66-75	76-85	>85	Medical	Surgical	Orthopaedic	Urology	Vascular
Awaiting long-term care	**1140 (45.4)**	23 (65.7)	12 (34.3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (5.7)	8 (22.8)	8 (22.8)	17 (51.3)	31 (88.5)	3 (8.5)	0 (0)	0 (0)	1 (3)
Awaiting rehabilitation	**365 (14.5)**	12 (50)	12 (50)	0 (0)	0 (0)	0 (0)	1 (4.1)	0 (0)	2 (8.2)	13 (45.1)	8 (32.8)	11 (41.3)	5 (20.8)	1 (4.1)	6 (12.3)	1 (4.1)
Awaiting DFT review	**30 (1.16)**	4 (50)	4 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (25)	2 (25)	4 (50)	8 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Awaiting social worker review	**115 (4.59)**	13 (46.4)	15 (53.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	6 (21.4)	10 (35.8)	12 (42.8)	24 (85.7)	3 (10.7)	0 (0)	1 (3.6)	0 (0)
Awaiting geriatrician review	**122 (4.89)**	19 (55.8)	15 (44.2)	0 (0)	0 (0)	0 (5)	1 (2.94)	0 (0)	4 (11.7)	12 (35.2)	17 (50.3)	25 (73.5)	3 (8.8)	0 (0)	5 (14.7)	1 (3)
Awaiting consultation	**154 (6.13)**	23 (52.2)	21 (47.8)	0 (0)	1 (2.2)	1 (2.2)	6 (14.2)	6 (14.2)	13 (29.5)	12 (26.4)	5 (11.3)	36 (81.8)	4 (9.4)	1 (2.2)	3 (6.6)	0 (0)
Awaiting theatre	**7 (0.28)**	8 (72.7)	3 (27.3)	0 (0)	0 (0)	0 (0)	2 (18)	1 (9)	3 (27.3)	5 (55.7)	0 (0)	1 (9)	5 (45.7)	0 (0)	2 (18)	3 (27.3)

Awaiting relocation	**25 (0.85)**	2 (50)	2 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	3 (75)	4 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Awaiting Medical Imaging	**175 (6.93)**	27 (50.9)	26 (49.1)	0 (0)	1 (1.8)	2 (3.6)	6 (11.3)	8 (14.4)	15 (28.3)	17 (32)	4 (7.2)	28 (52.8)	14 (26.4)	5 (9.4)	3 (5.6)	3 (5.6)
Awaiting relatives meeting	**14 (0.16)**	2 (50)	2 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (50)	1 (25)	1 (25)	4 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Management red-tape	**29 (1.13)**	4 (100)	0 (0)	0 (0)	0 (0)	1 (25)	1 (25)	2 (50)	0 (0)	0 (0)	0 (0)	3 (75)	1 (25)	0 (0)	0 (0)	0 (0)
Awaiting oncology transfer	**11 (0.43)**	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	1 (50)	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)
COVID-19 related delays	**240 (9.56)**	11 (42.3)	15 (57.7)	0 (0)	0 (0)	2 (7.6)	1 (3.8)	4 (15.2)	9 (34.6)	4 (15.2)	6 (23.6)	18 (69.2)	4 (15.2)	1 (3.8)	0 (0)	3 (11.8)
Awaiting speech Language Pathologist review	**28 (1.10)**	7 (70)	3 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (10)	3 (30)	6 (60)	9 (90)	0 (0)	1 (10)	0 (0)	0 (0)
Awaiting dietitian review	**44 (1.72)**	3 (42.8)	4 (57.2)	0 (0)	0 (0)	1 (14.3)	0 (0)	0 (0)	1 (14.3)	3 (42.8)	2 (28.5)	7 (100)	0 (0)	0 (0)	0 (0)	0 (0)

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References

Anieting, A. E. M. J. K. (2017). Comparison of quota sampling and snowball sampling. *Indian Scholar, 3*(3), 33–36.

Aruldas, V. (1999). Appropriateness Evaluation Protocol: An application in a multi-speciality hospital. *Vikalpa: The Journal for Decision Makers, 24*(3), 23–32.

Azzopardi, N., Calleja, N., Buttigieg, S. C., & Merkur, S. (2017). Malta health systems review. *Health Systems in Transition, 19*(1), 1–137.

Bauer, M. W., & Becker, S. (2014). The unexpected winner of the crisis: The European Commission's strengthened role in economic governance. *Journal of European Integration, 36*(3), 213–229.

Berger, G., Epstein, D., Rozen, M., Miskin, A., Halberthal, M., & Mekel, M. (2020). Delayed discharges from a tertiary teaching hospital in Israel: Incidence, implications and solutions. *Israel Journal of Health Policy Research, 9*, Article 66.

Chavan, P., & Kulkarni, C. (2017). Role of non-parametric tests in management and social science. *Quest International Multidisciplinary Research Journal, 9*(6), 38–53.

Clinical Performance Unit. (2021). *Hospital activity report 2020*. Mater Dei Hospital.

Clinical Performance Unit. (2022). *Hospital activity report 2021*. Mater Dei Hospital.

El-Eid, G. R., Kaddoum, R., Tamim, H., & Hitti, E. A. (2015). Improving hospital discharge time: A successful implementation of Six Sigma methodology. *BMJ Quality Improvement Reports, 4*(1), u209961.w3939.

Eurostat. (2021). Healthcare resource statistics – beds. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare_resources_statistics_-_beds (accessed on 12 December 2023).

Feigal, J., Park, B., Bramante, C., Nordgaard, C., Menk, J., & Song, J. (2014). Homelessness and discharge delays from an urban safety net hospital. *Public Health, 128*(11), 1033–1035.

Fowler, P. H., Craig, J., Fredendall, L. D., & Damali, U. (2008). Perioperative workflow: Barriers to efficiency, risks, and satisfaction. *AORN Journal, 87*(1), 187–208.

Green, M. A., Darling, D., Minton, J., & Pickett, K. E. (2017). Could the rise in mortality rates since 2015 be explained by changes in delayed discharges of NHS patients? *Journal of Epidemiology and Community Health, 71*(11), 1064–1071.

Guilcher, S. J. T., Bai, Y. Q., Wadchis, W. P., Bronskill, S. E., & Kuluski, K. (2023). Impact of the COVID-19 pandemic on alternative level of care hospitalisations in Ontario, Canada: An interrupted time series study. *CMAJ Open, 11*(4), E673–E681.

Ha, N. T., Hendrie, D., & Morrin, R. (2014). Impact of population ageing on hospitalisation costs for cardiovascular disease: A population-based study. *BMC Health Services Research, 14*, Article 554.

Harvey, S. A. (2018). Observe before you leap: Why observation provides critical insights. *Global Health: Science and Practice, 6*(2), 299–316.

Hendy, P., Patel, J. H., Kordbacheh, T., Laskar, N., & Harbord, M. (2012). In-depth analysis of delays to patient discharge. *Clinical Medicine, 12*(4), 320–323.

Hinde, S., Bojke, L., Richardson, G., Birks, Y., Whittaker, W., Wilberforce, M., & Clegg, A. (2021). Delayed transfers of care for older people: A wider perspective. *Age and Ageing, 50*(4), 1073–1076. https://doi.org/10.1093/ageing/afab035

Hollande, D. E., Pacyna, J. E., Gillard, K. L., & Carter, L. C. (2016). Tracking discharge delays: Critical first step toward mitigating inefficiencies. *Journal of Nursing Care Quality, 31*(1), 17–23.

Jasinarachchi, K. H., Ibrahim, I. R., Keegan, B. C., Mathialagan, R., McGourty, J. C., Phillips, J. R. N., & Myint, P. K. (2009). Delayed transfer of care from NHS secondary care to primary care in England. *BMC Geriatrics, 9*, Article 4.

Landeiro, F., Roberts, K., Gray, A. M., & Leal, J. (2019). Delayed hospital discharges of older patients: A systematic review. *The Gerontologist, 59*(2), e86–e97.

Lenzi, J., Mongardi, M., Rucci, P., Di Ruscio, E., Vizioli, M., Randazzo, C., Toschi, E., Carradori, T., & Fantini, M. P. (2014). Factors associated with delayed hospital discharge. *BMC Health Services Research, 14*, Article 128.

Majeed, M. U., Williams, D. T., Pollock, R., Amir, F., Liam, M., Foong, K. S., & Whitaker, C. J. (2012). Delay in discharge and unnecessary hospital bed occupancy. *BMC Health Services Research, 12*, Article 410.

 doi:10.20944/preprints202605.0673.v1

Mann, S. (2016). Delayed discharges within community hospitals: Qualitative study. *Journal of Integrated Care, 24*(6), 260–270.

Marmot, M., Allen, J., Bell, R., Bloomer, E., & Goldblatt, P. (2012). WHO European review of social determinants of health. *The Lancet, 380*(9846), 1011–1029.

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Sage Publications.

Mendoza Giraldo, D., Navarro, A., Sanchez-Quijano, A., Villegas, A., Asencio, R., & Lissen, E. (2012). Impact of delayed discharge in internal medicine. *Revista Clínica Española, 212*(5), 229–234.

Micallef, A., Buttigieg, S. C., Tomaselli, G., & Garg, L. (2020). Defining delayed discharges of inpatients and their impact in acute hospital care: A scoping review. *International Journal of Health Policy and Management, 11*(2), 103.

Mustafa, S. S., Keating, L., Heffernan, C., et al. (2016). Social determinants of delayed discharge in acute care. *International Journal of Health Planning and Management, 31*(4), e365–e374.

Philp, I., Mills, K. A., Thanvi, B., Ghosh, K., & Long, J. F. (2013). Reducing hospital bed use by frail older people. *International Journal of Integrated Care, 13*, e048.

Rojas-García, A., Turner, S., Pizzo, E., Hudson, E., Thomas, J., & Raine, R. (2018). Impact and experiences of delayed discharge: A mixed-studies systematic review. *Health Expectations, 21*(1), 41–56. https://doi.org/10.1111/hex.12619

Sant, J., Abela, G. P., & Farrugia, D. (2015). Delayed discharges and unplanned admissions from the day care unit at Mater Dei Hospital, Malta. *Malta Medical Journal, 27*(2), 26–30.

Sarfo, P., Achampong, G., & Kusi, E. (2017). Length of hospital stay on medical wards. *International Journal of Business Innovation and Technology, 4*(2), 1–13.

Thwaites, R., Glasby, J., Le Mesurier, N., & Littlechild, R. (2017). Inappropriate admissions review in NHS. *Health & Social Care in the Community, 25*(1), 1–10.

United Nations. (2017). Ageing. Available online: https://www.un.org/en/sections/issues-depth/ageing/ (accessed on 12 December 2023).

van den Ende, E., Schouten, B., Pladet, L., Merten, H., van Galen, L., Marinova, M., Schinkel, M., Boerman, A. W., Nannan Panday, R., Rustemeijer, C., Dulaimy, M., Bell, D., & Nanayakkara, P. W. (2023). Leaving the hospital on time: Hospital bed utilization and reasons for discharge delay in the Netherlands. *International Journal for Quality in Health Care, 35*(2), mzad022. https://doi.org/10.1093/intqhc/mzad022

Van der Heede, K., Van de Voorde, C., & Vleugels, A. (2019). The implications of an ageing population for hospital care in Europe. *Health Policy, 123*(5), 456–463.

Vinci, A., Furia, G., Cammalleri, V., Colamesta, V., Chierchini, P., Corrado, O., Mammarella, A., Ingravalle, F., Bardhi, D., Malerba, R. M., et al. (2024). Burden of delayed discharge on acute hospital medical wards: A retrospective ecological study in Rome, Italy. *PLOS ONE, 19*(1), e0294785. https://doi.org/10.1371/journal.pone.0294785

World Health Organization. (2015). *World report on ageing and health*. World Health Organization.