Capacity Planning in Paediatric Palliative and Hospice Care: An Italian Case

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Abstract: Although the growing demand for healthcare services has enhanced the occurrence of inefficiencies in care provision, healthcare systems should ensure safe, timely and equitable access to care. In particular, the long waiting lists, the lack of beds, and the shortage of healthcare workforce have highlighted the necessity to effectively manage and strategically plan the available resources. Capacity Planning (CP) contributes to determine what, when, where and how much product or service to deliver, with the goal of analysing and optimizing the use and allocation of human and material resources (e.g., physical spaces, equipment, beds, workforce) based on the demand. CP demonstrates to be extremely relevant for hospital units to schedule appointments, diagnostics, surgeries and admissions. Complex contexts and broader healthcare networks could benefit even more from this approach, helping to coordinate multiple care providers and aligning the available resources with the demand pace. The current research presents the implementation of CP in the context of Paediatric Palliative and Hospice Care (PPHC), delivered in an Italian facility. PPHC provides long-term, interdisciplinary and coordinated care between territorial, ambulatory and hospice services. It encompasses follow-up activities, parental training, end-of-life and respite care. In the Italian case analysed, the shortage of beds affects the quality of care delivered to these patients, in terms of accessibility to the service, effectiveness and timeliness of care. Hence, a CP analysis has been performed to pursue a twofold objective: a) to understand if the current capacity of the facility meets the demand for care; b) to improve productivity through an optimized allocation of resources, particularly the available beds and the healthcare workforce. The expected results involve a more effective use of resources, an increased bed occupancy rate and a reduction in rescheduled admissions due to inadequate planning. Optimizing capacity in this specific setting can serve as a pilot project for other similar contexts, aiming to improve patients' access to healthcare services, their quality of life and supporting the workforce involved in PPHC. This research offers new insights from both the academic and managerial point of view, providing evidence about the implementation of CP in complex healthcare settings.

Keyword: Hospice Care, Paediatric, Capacity Planning, Resource Planning and Management

1. Introduction and Theoretical Background

The healthcare system is currently under significant pressure to enhance productivity and performance while ensuring safe, timely and equitable access to care (Eriksson *et al.*, 2017; Youn, Geismar and Pinedo, 2022). With demand usually exceeding capacity, creating unmet demand, and optimization often lacking, the need to efficiently and effectively utilize scarce resources to maintain high levels of quality is evident (Humphreys *et al.*, 2022; van Hulzen *et al.*, 2022). In this challenging context, Capacity Planning (CP) emerges as a critical approach to optimize healthcare delivery. Healthcare capacity, generally defined as the upper limit of productivity (i.e. the output or number of patients treated in a given period) represents the best possible performance. However, the capacity utilized is often lower than this theoretical maximum due to resource limitations and operational inefficiencies (Burdett and Kozan, 2016; Humphreys *et al.*, 2022). Research highlights the impact of capacity strain on patient outcomes; in fact, periods of resource strain are correlated with higher patient mortality rates and compromised health outcomes. This consideration highlights the necessity of effective CP to mitigate risks (Eriksson *et al.*, 2017).

CP proves to be highly significant for hospital departments in scheduling appointments, diagnostics, surgeries, and admissions, resulting in numerous enhancements such as cost reduction, quality and productivity improvement, and risk mitigation (Youn, Geismar and Pinedo, 2022; Fei and Kang, 2023). In complex contexts and broader healthcare networks, CP can be particularly advantageous, as it helps coordinate multiple care providers and align available resources with the pace of demand (Youn, Geismar and Pinedo, 2022). The current research aims to implement CP in the complex context of Paediatric Palliative and Hospice Care (PPHC). PPHC support fragile children with life-limiting, severe and incurable diseases and their families enhancing their quality of life (Klick and Hauer, 2010; Feudtner *et al.*, 2013). Paediatric hospice offers an alternative residential structure

to hospital for patients with high care complexity (Benini *et al.*, 2024). This setting encounters numerous challenges, including a severe shortage of human and material resources, compounded by rising demand and clinical complexities. In Italy, only 15% of the demand for PPHC is currently being met, underscoring the urgent need for improvement (Benini *et al.*, 2024).

2. Methodology

This research aims to conduct a CP analysis within the context of PPHC in an Italian facility with two primary objectives:

1. To evaluate whether the current available capacity is adequate to meet the demand. If it is inadequate, the analysis will calculate the necessary level of capacity required to provide the appropriate level of care.
2. To improve productivity by optimizing the allocation of resources, with particular attention to the availability of beds.

This research is carried out in "Casa del Bambino", an Italian hospice selected because it is the regional and national referral centre as it provides all the services required by the Italian essential levels of care and is in extreme need due to a shortage of resources. In fact, the centre serves approximately 400 children, with only 4 beds available. This shortage has a significant impact on service accessibility, care effectiveness, and timeliness, compromising the overall quality of care provided. The hospice operates with a multidisciplinary team of 5 physicians, 24 nurses, 2 psychologists, and 1 physiotherapist, delivering continuous and coordinated care through various services, including territory care and hospice.

To address the two objectives of the study, the methodology is structured into the following steps:

a. Demand analysis: data from 2021 to 2023 were compared to assess changes in the need for PPHC. Several indicators such as number of patients and number of admissions were calculated.
b. Segmentation by type of admission: patients were grouped based on the type of care and assistance services they received. This allowed the assessment of specific metrics related to each category.
c. Trend analysis: temporal trends were identified by analysing the distribution of admissions over the years and by day of the week, providing insights into the patterns of care demand.
d. Capacity analysis: current and projected demands were compared with available capacity to assess whether adjustments are required and, if so, to quantify the extent of those adjustments.
e. Resource optimization: to address the second objective, simulations of alternative bed utilization scenarios will be performed, utilizing both historical and forecasted data. These simulations will help identify the most efficient scenarios for maximizing occupancy. Additionally, techniques such as linear programming will be applied to further refine the balance between demand and capacity

3. Preliminary Results

The comparison between different years revealed a significant increase in the demand for hospice services, attributable to the extended lifespan of children requiring PPHC (Cohen and Patel, 2014) and the growing knowledge and awareness of these services in the region. Specifically, the increase in patients in care from 2022 (282 patients) to 2023 (404 patients) was 43%. The number of patients with non-elective admissions has also increased, with the proportion of unplanned admissions rising from 20% of the total admissions in 2022 to 27% in 2023.

The segmentation of admissions according to the care and assistance services provided led to the identification of five different groups:

- Introductory: for newly admitted patients requiring comprehensive evaluation by the healthcare team.
- Parental Training: to educate parents on daily management and emergency responses for their child's care at home.
- Follow-up: for periodic clinical assessments and re-evaluations of the patient's condition.
- End-of-Life: to manage end-of-life phase.
- Aggravation: to offer an alternative to hospitalization during periods of clinical decline.
- Respite care: to provide temporary relief to families from the continuous care and management of their child.

These categories can be further divided into two main types: elective (Introductory, Parental Training, Follow-up) and non-elective (End-of-Life, Aggravation) admissions. Analysis of admission trends indicates significant variability throughout the year, with certain months, such as October, showing higher numbers of non-elective hospitalizations, while others, like July, exhibit lower volumes. Mondays consistently record the highest volume of both scheduled and unscheduled admissions. Due to the long admission process, this analysis suggests avoiding the scheduling of hospice admissions on Monday, to prevent staff overload.

Since bed capacity emerged as a bottleneck, the comparison between the current available capacity and demand was performed considering the number of beds. The preliminary findings indicate that the current available capacity is inadequate to meet the demand, revealing a need for at least 2 additional beds. Furthermore, to optimize bed capacity, priority should be given to unscheduled admissions that cannot be postponed. The analysis suggests assigning 1.5 (depending on the month) beds specifically for non-elective admissions to ensure urgent care readiness. However, these results will be validated through further analyses.

4. Conclusion

In conclusion, the need for effective CP in PPHC is highlighted by the increasing demand and limited resources available. By optimising resource allocation and, in the long term, expanding bed capacity to meet demand, it becomes possible to guarantee quality of care to all patients, enhance care pathways and improve patient outcomes.

Acknowledgments

The Authors gratefully acknowledge the financial support from the University of Padova and ULSS 2 Marca Trevigiana (VERB_CON_UNIIMPRESA21_01).

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