

Business Intelligence as a Clinical Governance Intervention: A Longitudinal Quasi-Experimental Study Protocol in Long-Term Care

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Study protocol

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Abstract

Background

Long-term care (LTC) systems are subject to increasing demand due to population ageing, multimorbidity, and the sustained complexity of care. This has elevated the need for transparent and effective decision-making. While healthcare organizations routinely generate large volumes of clinical and administrative data, utilization of these data remains fragmented and insufficient to fully support integrated clinical governance. Business Intelligence (BI) has been identified as one potential strategy to address this gap; nonetheless, empirical evidence regarding its effectiveness as a structured organizational intervention, particularly with respect to nursing-sensitive outcomes, is limited.

Methods

This study protocol outlines a single-center, quasi-experimental longitudinal study using a one-group pretest–posttest design with repeated measures over 12 months following BI implementation. The intervention comprises a structured BI system integrating indicators of structure, process, outcome, and value, combined with data literacy training, monthly indicator-driven clinical governance meetings, and continuous monitoring of key performance indicators.

The primary outcome is the Nursing Practice Environment (NPE). Secondary outcomes include missed nursing care, functional gain (Δ FIM), and well-being index (WHO-5). Data will be collected through repeated nurse-level questionnaires and aggregated institutional data.

Longitudinal analyses will be conducted using Linear Mixed Models or Generalized Estimating Equations, with adjustment for temporal and contextual factors. Interrupted time series analyses will be applied where appropriate. Mediation models will explore the role of NPE and missed care in linking BI implementation to patient outcomes.

Discussion

This study conceptualizes BI as a complex organizational intervention that enables data-driven clinical governance. By integrating organizational, process, and outcome indicators within a longitudinal framework, this study aims to generate robust evidence on the mechanisms by which data visibility influences care quality and system performance in LTC. The findings are expected to inform scalable strategies for strengthening healthcare governance and accountability.

Background

Healthcare systems, particularly in Long-Term Care (LTC) settings, face increasing challenges related to population ageing, multimorbidity, and sustained demand for complex, resource-intensive care. Within this context, nursing management plays a central role in ensuring quality of care, patient safety, and

organizational sustainability, as managerial decisions have cumulative and often irreversible effects on care trajectories and outcomes (Liu & Castle, 2024; World Health Organization, 2021).

Decision-making in nursing management is inherently complex, requiring the integration of clinical, organizational, and ethical considerations under conditions of uncertainty and resource constraints. Evidence suggests that inadequate organizational conditions—particularly related to staffing, leadership, and work environment—are associated with poorer outcomes, including increased adverse events, reduced quality of care, and higher levels of professional burnout (Aiken, 2002; Aiken et al., 2017; Lake et al., 2019). In LTC settings, where patients present high levels of functional dependency and prolonged exposure to care systems, these organizational factors assume heightened importance as determinants of both clinical and ethical quality.

One of the most consistent indicators of organizational strain in nursing systems is missed nursing care, defined as required care that is delayed or omitted. This phenomenon is widely recognized as a system-level indicator rather than an individual failure, reflecting misalignment between care demands and available resources (Kalisch, Landstrom, & Hinshaw, 2009; Lake et al., 2019; White et al., 2020). Missed care has been associated with adverse patient outcomes, including functional decline and safety incidents, reinforcing its relevance as a key process indicator in health services research.

Despite the increasing availability of clinical and administrative data within healthcare organizations, decision-making processes remain frequently fragmented and insufficiently supported by integrated information systems. This fragmentation limits the capacity of nurse managers to identify patterns, anticipate risks, and make timely, evidence-informed decisions (Damschroder et al., 2022; Skivington et al., 2021). Consequently, there is a growing need for structured approaches that transform data into actionable knowledge within clinical governance systems.

In this context, Business Intelligence (BI) has emerged as a promising strategy to enhance organizational decision-making by integrating large volumes of data into coherent and interpretable formats. BI systems enable the visualization of key performance indicators, facilitate monitoring of care processes and outcomes, and support predictive analysis, thereby contributing to improved transparency and accountability in healthcare management.

From a health services perspective, BI can be conceptualized not only as a technological tool but as an organizational infrastructure that supports clinical governance, enabling alignment between structure, processes, and outcomes, as proposed in the Donabedian model (Donabedian, 1988). By making organizational dynamics visible—such as staffing adequacy, care delivery patterns, and outcome variability—BI has the potential to reduce information asymmetries and support more consistent and equitable decision-making.

Within nursing, the Nursing Practice Environment (NPE) has been identified as a central organizational construct linking structural conditions to care processes and patient outcomes (Lake, 2002; Lake et al., 2019; Braga, 2024; Braga et al., 2026; Braga et al., 2025). Improvements in NPE have been associated

with reductions in missed care, better patient outcomes, and enhanced workforce sustainability, positioning it as a key mediator in organizational interventions targeting quality improvement.

Although the theoretical and technological potential of BI in healthcare is increasingly recognized, empirical evidence regarding its impact on nursing-sensitive organizational and clinical outcomes remains limited, particularly in LTC settings. Existing studies tend to focus on isolated technological implementations or descriptive analytics, with fewer investigations examining BI as a structured, theory-informed organizational intervention integrated into clinical governance processes.

This study addresses this gap by proposing and evaluating a structured implementation of a BI system as a complex organizational intervention, grounded in contemporary frameworks for implementation and health services research. The intervention is designed to integrate indicators of structure, process, and outcomes, while supporting data-informed decision-making within nursing management.

The primary aim of this study is to evaluate the effect of BI implementation on the Nursing Practice Environment, while secondary objectives include assessing its impact on missed nursing care and care-sensitive outcomes, namely functional gain (Δ FIM) and well-being (WHO-5). By doing so, the study seeks to contribute to the evidence base on data-driven clinical governance and to inform the development of sustainable, ethically grounded management practices in long-term care settings (Jakobsen et al., 2024).

Methods

Study design

This study adopts a quasi-experimental, non-randomized, single-center longitudinal design, with a pre-implementation phase (M0) and a 12-month post-implementation follow-up period (M1–M12), corresponding to a one-group pretest–posttest design with repeated measures (Grove et al., 2017; Polit & Beck, 2021).

The implementation of Business Intelligence (BI) is considered the intervention point, allowing comparison of outcome levels and temporal trends between pre- and post-intervention periods. Where methodologically appropriate, segmented regression and interrupted time series (ITS) approaches will be used to assess changes in level and slope over time (Bernal et al., 2017; Wagner et al., 2002).

The study is conducted in accordance with the Medical Research Council (MRC) framework for complex interventions, which recognizes the dynamic interaction between intervention components, context, and outcomes (Craig et al., 2008; Skivington et al., 2021).

Given the absence of randomization and a control group, findings will be interpreted as temporal associations consistent with intervention effects, without claiming definitive causal inference (Shadish, Cook, & Campbell, 2002; Polit & Beck, 2021).

The study protocol will be reported following the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) statement for non-randomized evaluations (Des Jarlais et al., 2004; Fuller et al., 2014).

Setting

The study will be conducted in a Long-Term Care (LTC) unit with a capacity of 30 beds, providing care for patients with significant functional dependency and rehabilitation needs. The length of stay is typically up to 90 days, although extensions may be granted based on clinical evaluation and patient-specific requirements.

Care is delivered on a continuous basis (24 hours per day, 7 days per week) by a nursing team operating within a shift-based system. This organizational context is characterized by a high level of clinical complexity, reflecting the multifaceted needs of patients, as well as by prolonged care trajectories that require sustained coordination across time. In addition, the effective delivery of care is highly dependent on organizational alignment and interprofessional collaboration, given the intensity and continuity of required interventions.

At baseline, the unit does not have a structured Business Intelligence (BI) system or integrated digital dashboards to support clinical governance. Although clinical and administrative data are routinely collected, they remain fragmented across different information systems and are not systematically integrated into decision-making processes. This fragmentation represents a common barrier to evidence-informed management and reflects broader challenges in the implementation of data-driven governance in healthcare settings (Damschroder et al., 2022; Skivington et al., 2021).

Participants

All nurses working in the unit during the study period will be eligible, following an exhaustive sampling strategy consistent with pragmatic quasi-experimental designs in organizational settings (Burns & Grove, 2017; Polit & Beck, 2021).

Recruitment will occur through institutional communication, including email and team briefings, ensuring transparency regarding study objectives and procedures.

To minimize hierarchical influence, recruitment will be conducted by a researcher not directly involved in line management. Participation will be voluntary, with a minimum reflection period prior to consent, in line with ethical guidelines (CIOMS, 2016; Emanuel, 2000).

Participation rates, non-response, and attrition will be documented and reported according to TREND recommendations (Des Jarlais et al., 2004).

Intervention

The intervention consists of the structured implementation of a Business Intelligence (BI) system conceptualized as a complex organizational intervention. Its primary aim is to transform fragmented clinical and administrative data into integrated, actionable information capable of supporting clinical governance and decision-making processes.

The intervention is operationalized through the development of digital dashboards that integrate data from clinical, administrative, and organizational sources. These dashboards are structured according to the Donabedian framework, encompassing indicators of structure, process, outcome (Donabedian, 1988; Zhang et al., 2022). Structural indicators include staffing-related variables such as nursing hours per shift, skill mix, and planned staffing levels. Process indicators include the Nursing Practice Environment (NPE) and missed nursing care, while outcome indicators include functional gain (Δ FIM) and adverse events. Value is operationalized through patient-reported well-being using the WHO-5 index.

To ensure effective use of the system, the implementation is preceded by a structured data literacy training session aimed at enhancing professionals' ability to interpret and apply indicators in clinical decision-making. Particular emphasis is placed on promoting a non-punitive data culture, consistent with principles of just culture (Reason, 2000).

Following this initial phase, the intervention incorporates monthly clinical governance meetings in which indicators are systematically reviewed. These meetings are designed to support collective interpretation of data, identification of deviations, and formulation of corrective actions. This cyclical process aligns with continuous quality improvement principles and supports organizational learning.

Throughout the study period, dashboards are updated monthly and made available through a secure internal platform, enabling continuous monitoring of key performance indicators (KPIs) and facilitating timely access to relevant data.

Intervention fidelity will be assessed using objective indicators, including the number of meetings conducted, attendance rates, frequency of dashboard access, and the number of documented data-driven decisions. Predefined thresholds (≥ 10 meetings, $\geq 70\%$ attendance, and at least one corrective action every three months) will be used to ensure adequate exposure to the intervention (Skivington et al., 2021).

Outcomes

The evaluation of the intervention is structured around a set of outcomes that reflect organizational, process, and patient-level dimensions, in alignment with established health services research frameworks. Particular emphasis is placed on nursing-sensitive indicators that capture the relationship between organizational conditions and care quality.

The primary outcome of the study is the evolution of the *Nursing Practice Environment (NPE)* over time. The NPE is widely recognized as a central organizational construct that reflects the conditions under which nursing care is delivered, including leadership, staffing adequacy, professional autonomy, and interprofessional relationships (Lake, 2002; Lake et al., 2019; Braga, 2024; Braga et al., 2025; Braga et al., 2026). It has been consistently associated with both professional outcomes and patient safety indicators and is therefore conceptualized in this study as a key mediator linking organizational structures to care processes and outcomes.

In addition to the primary outcome, several secondary outcomes are included to capture complementary dimensions of care delivery and effectiveness. One of these is the level of *missed nursing care*, defined as necessary care that is delayed or omitted. This indicator is understood as a sensitive marker of organizational strain and system-level dysfunction, reflecting the misalignment between care demands and available resources (Kalisch, Landstrom, & Hinshaw, 2009). Monitoring changes in missed care over time allows for the assessment of whether improvements in organizational conditions translate into safer and more complete care delivery.

Patient-centered outcomes are also incorporated through the assessment of functional *gain*, measured using the Functional Independence Measure (FIM), and subjective *well-being*, assessed using the WHO-5 index. Functional gain reflects changes in patients' ability to perform activities of daily living and is a widely used indicator of effectiveness in rehabilitation and long-term care contexts (Mitchell et al., 1998). The WHO-5 index captures perceived well-being and complements clinical indicators by incorporating a patient-reported dimension of value (Topp et al., 2015).

To adequately represent the multilevel nature of the intervention, outcomes are analyzed across two complementary levels. At the individual level, repeated measurements of NPE and missed nursing care are collected for each nurse, allowing the assessment of within-person changes over time. At the organizational level, outcomes such as functional gain and well-being are aggregated on a monthly basis, reflecting unit-level performance. This dual analytical structure enables the examination of both intra-individual variation and broader organizational trends, in line with methodological recommendations for longitudinal and hierarchical data in health research (Verbeke, 1997; Twisk, 2013).

Overall, the selection and operationalization of outcomes are designed to capture the hypothesized pathways through which the intervention may exert its effects, namely by improving organizational conditions, reducing process failures, and ultimately enhancing patient outcomes.

Data collection

Data collection is structured to capture both individual-level and organizational-level dimensions of the intervention, reflecting the multilevel nature of the study design. Two complementary sources of data will be used: primary data obtained directly from nursing professionals and secondary data extracted from institutional records.

Primary data will be collected through repeated administration of anonymous questionnaires to nurses working in the unit. These questionnaires will include validated instruments assessing the Nursing Practice Environment (NPE) and missed nursing care, as well as contextual variables related to staffing and perceived work conditions. Data collection will occur at regular intervals throughout the study period, with frequency adapted to the characteristics of each variable in order to balance temporal sensitivity with the risk of response fatigue. The use of anonymous, self-administered instruments is intended to minimize social desirability bias and encourage accurate reporting of organizational conditions and care processes.

Secondary data will be obtained from institutional information systems and will include aggregated indicators related to patient outcomes and service performance. These data encompass measures such as functional status at admission and discharge, allowing calculation of functional gain (Δ FIM), as well as well-being indicators derived from the WHO-5 index. Data extraction will be conducted in a standardized manner and at the level of the unit-month, ensuring consistency across time points and minimizing the risk of measurement error associated with manual data handling.

The integration of primary and secondary data sources enables triangulation of information and strengthens the validity of the study by linking subjective assessments of the work environment with objective indicators of care delivery and outcomes. Furthermore, the temporal alignment of data collection across sources supports the analysis of longitudinal relationships between organizational conditions, care processes, and patient outcomes.

Statistical analysis

The statistical analysis is designed to account for the longitudinal and hierarchical structure of the data, as well as the quasi-experimental nature of the study. Analytical strategies will focus on estimating temporal changes in outcomes following the implementation of the intervention, while controlling for potential confounding factors and accounting for within-subject and within-unit correlations.

Descriptive analyses will be conducted as an initial step to characterize the distribution of variables across time points. Continuous variables will be summarized using means and standard deviations or medians and interquartile ranges, depending on distributional properties, while categorical variables will be described using absolute and relative frequencies (Polit & Beck, 2021). Graphical representations, including time-series plots and trend lines, will be used to support preliminary inspection of temporal patterns and potential structural changes.

To examine longitudinal changes in the primary and secondary outcomes, Linear Mixed Models (LMM) or Generalized Estimating Equations (GEE) will be employed, depending on the distribution and correlation structure of the data (Verbeke, 1997; Liang & Zeger, 1986; Hardin & Hilbe, 2012). These approaches allow for appropriate handling of repeated measures and enable the estimation of both fixed effects of time and random effects at the individual level. Time will be treated as the primary independent variable, and models will be adjusted for relevant contextual covariates, including staffing

levels, occupancy rates, and other organizational factors that may vary over the study period (Shadish, Cook, & Campbell, 2002).

For outcomes with sufficient pre-intervention data points, interrupted time series (ITS) analysis using segmented regression will be applied to estimate changes in level and slope associated with the intervention (Bernal et al., 2017; Wagner et al., 2002). This approach strengthens causal inference in quasi-experimental designs by distinguishing intervention effects from underlying temporal trends. Autocorrelation of residuals will be assessed, and appropriate correlation structures (e.g., AR(1)) will be incorporated where necessary.

Missing data will be examined to determine underlying patterns, including missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR). For longitudinal models, estimation will be conducted using restricted maximum likelihood (REML), which provides robust estimates under MAR assumptions (Twisk, 2013; Verbeke, 1997). Sensitivity analyses will be performed when missing data exceed predefined thresholds, including multiple imputation procedures and scenario-based analyses to assess the potential impact of non-random missingness.

To further explore the mechanisms underlying the intervention, mediation analyses will be conducted using longitudinal models with temporal ordering. Specifically, the analysis will examine whether changes in the Nursing Practice Environment precede reductions in missed nursing care, which in turn are associated with improvements in patient outcomes. Indirect effects will be estimated using bootstrap methods with 95% confidence intervals, providing robust inference for mediation in complex models (MacKinnon, 2017; Hayes & Little, 2022).

Statistical inference will prioritize estimation of effect sizes and corresponding confidence intervals, rather than exclusive reliance on p-values, in line with contemporary recommendations emphasizing magnitude and precision of effects (Wasserstein & Lazar, 2016; Cumming, 2014). This approach supports a more meaningful interpretation of findings in applied health services research contexts.

Bias control

The quasi-experimental design entails inherent risks of bias and confounding, particularly in the absence of randomization and a control group (Shadish, Cook, & Campbell, 2002; Polit & Beck, 2021). To mitigate these risks, several methodological strategies have been implemented.

Selection bias is minimized through the adoption of an exhaustive sampling strategy, including all eligible nurses in the unit. Participation rates and attrition will be monitored over time to assess potential instability in the sample.

To reduce social desirability bias, particularly in self-reported measures such as NPE and missed nursing care, data will be collected anonymously using electronic questionnaires. The separation between the

research team and direct supervision structures further reduces the likelihood of response distortion (Podsakoff et al., 2003).

Measurement bias is addressed through the use of validated instruments and standardized calculation procedures for key variables. Secondary data will be extracted directly from institutional systems, minimizing manual error and enhancing data reliability.

The potential influence of the Hawthorne effect will be mitigated by the longitudinal nature of the intervention, allowing differentiation between short-term reactive changes and sustained patterns over time (Bernal et al., 2017).

Temporal confounding will be addressed through longitudinal modelling, incorporating time as a central variable and adjusting for relevant contextual covariates, such as staffing levels, occupancy rates, and organizational changes. These strategies are consistent with recommendations for quasi-experimental studies in health services research (Shadish et al., 2002).

Finally, intervention fidelity will be systematically monitored to distinguish between lack of effect and insufficient implementation intensity, in line with the MRC framework for complex interventions (Skivington et al., 2021).

Ethics and dissemination

This study is conducted in accordance with internationally recognized ethical principles for research involving human participants, including those outlined in the Declaration of Helsinki and the guidelines of the Council for International Organizations of Medical Sciences (CIOMS) (World Medical Association, 2013; CIOMS, 2016; Edge & Groves, 2017). Ethical approval was obtained from the Ethics Committee of the Hospitaller Sisters Institute (Belas), which confirmed that the study design complies with fundamental principles of human dignity, autonomy, proportionality, and risk minimization.

Participation in the study is voluntary, and all eligible nursing professionals will receive comprehensive information regarding the objectives of the research, the nature of the organizational intervention, the procedures involved in data collection, and their rights as participants. Informed consent will be obtained prior to participation, either electronically or in written form, ensuring that individuals are able to make a free and informed decision. Participants will be explicitly informed that their decision to participate or decline will have no impact on their professional evaluation or employment conditions, and that they may withdraw from the study at any time without any adverse consequences (Emanuel, 2000; Polit & Beck, 2021). Given the organizational context in which the study is conducted, particular attention is given to minimizing potential hierarchical influence. Recruitment procedures are therefore designed to ensure autonomy, including the involvement of a researcher external to direct supervision and the avoidance of individualized follow-up that could be perceived as coercive.

All data handling procedures are fully compliant with the General Data Protection Regulation (GDPR). Primary data will be collected anonymously, without the inclusion of direct or indirect identifiers, thereby ensuring that individual participants cannot be traced. Secondary data will be extracted exclusively in aggregated form from institutional records, under formal data use agreements, and will not allow identification at the individual level. No reversible pseudonymization procedures will be applied, and the adopted approach effectively eliminates the risk of re-identification, classifying the study as minimal risk according to international ethical standards (CIOMS, 2016; Polit & Beck, 2021; Edge & Groves, 2017).

Data will be stored on secure institutional servers using encrypted systems, with access restricted to authorized members of the research team through individual authentication credentials. All access will be logged to ensure accountability. Data will be retained for a period of two years, in accordance with institutional policies, after which secure destruction procedures will be implemented. These measures are consistent with best practices in research data security and confidentiality.

The study does not involve direct clinical intervention or manipulation of patient care and is therefore considered to present minimal risk to participants. At the same time, it is expected to generate meaningful benefits at the organizational level by contributing to improvements in clinical governance, patient safety, and decision-making processes. These anticipated benefits are consistent with the ethical principles of beneficence and non-maleficence (Beauchamp & Childress, 2019).

The findings of this study will be disseminated through publication in peer-reviewed scientific journals, presentations at academic and professional conferences, and feedback sessions within the participating institution. Reporting will follow the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) Statement to ensure transparency and methodological rigor (Des Jarlais et al., 2004; Fuller et al., 2014). In line with principles of scientific integrity, all results will be reported in full, regardless of their direction or statistical significance, thereby avoiding selective reporting and contributing to the credibility and reproducibility of health services research (Makhoul et al., 2018).

Discussion

Principal contribution

This study protocol addresses a critical gap in health services research by proposing and evaluating **Business Intelligence (BI) as a structured organizational intervention within** nursing clinical governance. While BI has been widely discussed as a technological solution, its role as an integrated mechanism linking organizational structures, care processes, and outcomes remains insufficiently explored in empirical research.

By combining data integration, structured decision-making processes, and continuous monitoring, this study advances the conceptualization of BI as a governance-enabling infrastructure, aligned with the Donabedian model of quality (Donabedian, 1988) and contemporary frameworks for complex interventions (Skivington et al., 2021).

Implications for health services research

This study contributes to health services research by advancing the understanding of how data infrastructures can be operationalized as mechanisms of clinical governance within real-world healthcare settings. While the availability of clinical and administrative data has increased substantially in recent years, the translation of these data into actionable knowledge remains a persistent challenge. By conceptualizing Business Intelligence (BI) as a structured organizational intervention, rather than a purely technological solution, this study addresses an important gap in the literature concerning the integration of data systems into decision-making processes.

A key contribution lies in the explicit articulation of the mechanisms through which BI may influence organizational performance and care quality. By linking structural conditions, care processes, and patient outcomes within a longitudinal framework, the study aligns with established models in health services research, particularly the structure–process–outcome paradigm (Donabedian, 1988), while extending it through the incorporation of real-time data visibility and feedback loops. This approach allows for a more dynamic understanding of how organizational environments evolve over time and how these changes relate to measurable outcomes.

Methodologically, the study reinforces the importance of theory-informed designs in evaluating complex interventions. The integration of the Medical Research Council (MRC) framework and the Consolidated Framework for Implementation Research (CFIR) provides a comprehensive structure for examining not only whether an intervention is effective, but also how and under what conditions it produces its effects (Skivington et al., 2021; Damschroder et al., 2022). This emphasis on mechanisms and context responds to a recognized limitation in health services research, where interventions are often evaluated without sufficient attention to implementation processes and organizational dynamics.

The longitudinal design with repeated measures further strengthens the contribution of the study by enabling the analysis of temporal patterns and sustained changes, rather than relying on cross-sectional or short-term evaluations. This is particularly relevant in organizational research, where the effects of interventions often emerge gradually and are influenced by cumulative processes (Twisk, 2013). The inclusion of multilevel data—combining nurse-level perceptions and unit-level outcomes—also enhances analytical depth by capturing both individual and organizational dimensions of change.

In addition, the study contributes to the growing field of data-driven health systems by providing empirical evidence on how integrated information systems can support more transparent, consistent, and accountable decision-making (Rosenberg et al., 2022). By examining outcomes such as the Nursing Practice Environment and missed nursing care, the study bridges the gap between data analytics and frontline care processes, offering insights into how organizational conditions can be monitored and improved using routinely collected data.

Overall, this work supports a shift in health services research from viewing data as a passive resource to understanding it as an active component of governance and system performance. By demonstrating

how BI can be embedded within clinical and managerial practices, the study provides a foundation for future research on scalable, sustainable, and context-sensitive approaches to improving healthcare quality and organizational effectiveness.

Implications for clinical governance and long-term care

The findings of this study have important implications for the development and strengthening of clinical governance in long-term care (LTC) settings, where decision-making processes are inherently complex and carry cumulative consequences for patient outcomes, workforce sustainability, and ethical quality of care (Braga, 2024; Braga et al., 2025). In these contexts, the prolonged duration of care trajectories and the high levels of patient dependency amplify the impact of organizational decisions, making the availability of timely, integrated, and reliable information a critical determinant of both effectiveness and accountability.

By introducing Business Intelligence (BI) as a structured component of clinical governance, this study supports a shift from fragmented and reactive decision-making toward a more systematic and proactive model. The integration of indicators related to staffing, care processes, and patient outcomes within a unified framework enables a more comprehensive understanding of organizational performance, facilitating early identification of risks and more timely corrective actions. This capacity is particularly relevant in LTC settings, where delays in recognizing system-level dysfunctions—such as staffing inadequacy or missed nursing care—may result in progressive deterioration of patient conditions.

The study also highlights the role of data visibility as a mechanism for enhancing transparency and accountability in clinical governance. By making organizational processes and outcomes more explicit, BI systems can support shared understanding among healthcare professionals and managers, reducing informational asymmetries and strengthening collective responsibility for care quality. This is consistent with contemporary perspectives on governance that emphasize the importance of distributed decision-making and continuous monitoring of performance indicators.

Furthermore, the focus on the Nursing Practice Environment (NPE) as a central outcome reinforces the importance of organizational conditions as a key leverage point for improving care quality in LTC. Evidence has consistently shown that favorable practice environments are associated with lower levels of missed nursing care, improved patient outcomes, and better retention of nursing staff (Aiken et al., 2017; Lake et al., 2019). By systematically monitoring and acting upon indicators related to the work environment, BI may contribute to more sustainable workforce models and to the creation of conditions that support safe and effective care delivery.

In addition, the incorporation of patient-centered outcomes, such as functional gain and well-being, extends the scope of clinical governance beyond traditional safety metrics, aligning it with broader concepts of value in healthcare (Zhang et al., 2022). This is particularly relevant in LTC, where the goals of care often include maintenance of functional capacity and quality of life, rather than solely clinical stabilization.

Overall, this study suggests that embedding BI within clinical governance structures can enhance the capacity of LTC organizations to respond to complexity, support continuous quality improvement, and align decision-making processes with both clinical and ethical imperatives. By operationalizing the link between data, organizational conditions, and outcomes, the study provides a framework that may inform the development of more resilient and accountable care systems in long-term care settings (Braga. et al., 2026).

Implications for nursing management

This study reinforces the central role of nurse managers as key actors within clinical governance systems, particularly in their capacity to translate complex data into actionable and context-sensitive decisions. In contemporary healthcare environments, characterized by increasing informational complexity and operational demands, the ability to interpret and mobilize data effectively has become a critical managerial competency. By providing structured access to integrated and longitudinally organized information, Business Intelligence (BI) has the potential to support a shift toward more consistent and evidence-informed leadership practices.

In this context, BI contributes to reducing reliance on intuition, fragmented data sources, or retrospective interpretations, which often characterize decision-making in resource-constrained environments. Instead, it enables nurse managers to engage with real-time indicators that reflect organizational conditions, care processes, and outcomes, thereby enhancing the precision and responsiveness of managerial decisions. This increased visibility supports not only more effective prioritization of actions but also strengthens accountability mechanisms, as decisions can be explicitly linked to observable data and monitored over time.

These contributions are consistent with existing literature emphasizing the importance of organizational environments in shaping both professional outcomes and patient care quality (Aiken, 2002; Russell & Fawcett, 2005). By situating the Nursing Practice Environment (NPE) as the primary outcome, the study further highlights its role as a central mediator between structural conditions and clinical results. Improvements in NPE are therefore understood not merely as organizational achievements, but as critical pathways through which nursing management can influence care quality, workforce sustainability, and patient outcomes (Lake, 2002; Lake et al., 2019; White et al., 2020).

Mechanisms of action

The proposed intervention is underpinned by a set of interrelated mechanisms that together explain how the implementation of Business Intelligence (BI) may lead to improvements in organizational performance and care quality. These mechanisms operate at informational, decision-making, and behavioral levels, reflecting the multifaceted nature of complex interventions in healthcare systems.

At the informational level, BI enhances the visibility and accessibility of key indicators related to staffing, care processes, and patient outcomes. By integrating previously fragmented data sources into a coherent and interpretable format, the system reduces informational asymmetries and enables a more

comprehensive understanding of organizational dynamics. This increased transparency constitutes a necessary condition for informed decision-making, particularly in environments characterized by high complexity and uncertainty.

Building on this informational foundation, the intervention influences the decision-making process by structuring the interpretation and prioritization of available data. The use of regular, indicator-driven clinical governance meetings provides a formalized space for collective reflection, enabling nurse managers and teams to identify patterns, detect deviations, and define appropriate corrective actions. This structured approach supports more consistent and deliberate decision-making processes, reducing variability and enhancing alignment with organizational goals.

At the behavioral level, the intervention promotes organizational learning and adaptive responses. Through repeated cycles of data review, decision-making, and action, the organization develops increased capacity to respond to emerging challenges and to refine its practices over time. This dynamic process aligns with principles of continuous quality improvement and fosters a culture in which data are actively used to guide practice rather than passively reported.

Together, these mechanisms are expected to produce improvements in the Nursing Practice Environment, reductions in missed nursing care, and enhancements in patient outcomes, including functional gain and well-being (Δ FIM and WHO-5). This explanatory model is consistent with contemporary approaches to evaluating complex interventions, which emphasize the interaction between intervention components, contextual conditions, and outcome trajectories (Skivington et al., 2021).

Strengths and limitations

This study presents several methodological and conceptual strengths. First, it adopts a theory-informed approach, integrating the Medical Research Council (MRC) framework for complex interventions (Skivington et al., 2021) and the Consolidated Framework for Implementation Research (CFIR) (Damschroder et al., 2022), which enhances the robustness of intervention design, implementation, and evaluation.

Second, the use of a longitudinal design with repeated measures allows for the assessment of temporal trends and potential sustained effects, addressing limitations commonly associated with cross-sectional analyses in health services research (Twisk, 2013; Verbeke, 1997).

Third, the study incorporates a multilevel analytical structure, combining nurse-level and unit-level data, enabling a more comprehensive understanding of the relationship between organizational conditions, care processes, and patient outcomes.

Fourth, the explicit inclusion of intervention fidelity indicators strengthens internal validity by allowing differentiation between absence of effect and implementation failure, in line with recommendations for evaluating complex interventions (Skivington et al., 2021).

Finally, the protocol addresses an important gap by operationalizing Business Intelligence (BI) as an organizational intervention, rather than solely as a technological tool, contributing to the advancement of data-driven clinical governance research.

Despite these strengths, several limitations should be acknowledged. The single-center design may limit external validity and generalizability of findings to other settings with different organizational structures or resources.

The absence of a control group restricts the ability to establish causal relationships, and findings will therefore be interpreted as temporal associations consistent with intervention effects, in accordance with quasi-experimental methodological principles (Shadish, Cook, & Campbell, 2002; Polit & Beck, 2021).

Variability in staff engagement and data literacy levels may influence exposure to the intervention and its effectiveness. Although training is included, differential uptake cannot be fully controlled.

Additionally, the possibility of a Hawthorne effect—where participants modify behavior due to awareness of being observed—cannot be excluded. However, the longitudinal nature of the intervention is expected to mitigate short-term reactive effects (Bernal et al., 2017).

Finally, although multiple strategies are implemented to control for temporal confounding, unmeasured contextual factors (e.g., concurrent organizational changes) may still influence outcomes.

Implications for practice and future research

If demonstrated to be effective, this intervention has the potential to inform the development of scalable and sustainable models of data-driven clinical governance, particularly within long-term care (LTC) settings (Braga. et al., 2026). By operationalizing the integration of organizational, process, and outcome indicators into routine decision-making, the study provides a framework that can be adapted to support more systematic, transparent, and responsive management practices. In practical terms, this approach may enable healthcare organizations to move beyond reactive and fragmented decision-making processes toward more anticipatory and coordinated strategies, grounded in continuous monitoring and interpretation of relevant data.

The implications for practice are particularly relevant in LTC environments, where organizational constraints, workforce challenges, and patient complexity require adaptive and context-sensitive management approaches. Embedding Business Intelligence (BI) within existing governance structures may facilitate more efficient allocation of resources, earlier identification of system-level risks, and more consistent alignment between care delivery and organizational priorities. In addition, by making performance indicators visible and actionable, BI may contribute to fostering a culture of accountability and shared responsibility among healthcare professionals.

From a research perspective, this study provides a foundation for further investigation into the implementation and impact of data-driven interventions in healthcare systems.

Replication in multi-center studies will be essential to assess external validity and to determine whether the observed effects can be generalized across different organizational contexts. Longitudinal follow-up beyond the initial implementation period will also be necessary to evaluate the sustainability of observed changes and to understand how organizational learning processes evolve over time.

Future research should also address the economic dimension of such interventions, including cost-effectiveness analyses that consider both implementation costs and potential gains in efficiency, safety, and patient outcomes. In addition, examining the transferability of the model across diverse healthcare systems and regulatory environments will be critical to understanding its broader applicability.

Finally, greater attention should be given to the role of organizational culture and leadership in shaping the adoption and effectiveness of BI systems. As highlighted in implementation science, the success of complex interventions depends not only on their technical design but also on contextual factors that influence how they are interpreted, enacted, and sustained in practice (Damschroder et al., 2022). Exploring these dimensions will contribute to a more comprehensive understanding of how data-driven governance models can be effectively embedded in real-world healthcare settings.

Conclusion

This study protocol proposes an innovative approach to integrating Business Intelligence into nursing clinical governance, positioning it as a structured mechanism to enhance decision-making, improve organizational environments, and optimize patient outcomes.

By bridging the gap between data availability and actionable knowledge, the study contributes to advancing evidence-informed, transparent, and value-oriented healthcare systems, particularly in the context of long-term care.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Hospitaller Sisters Institute, Belas (Approval reference: CE-01/2026). The study will be conducted in accordance with the ethical principles of the Declaration of Helsinki and the International Ethical Guidelines for Health-related Research Involving Humans (CIOMS). Participation will be voluntary, and informed consent will be obtained from all participating nurses prior to data collection.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

VB conceptualized the study, developed the methodology, drafted the manuscript, and coordinated the overall study design. AR contributed to methodological development, critical revision of the manuscript, and supervision of the scientific content. RB contributed to study design, implementation planning, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analysed during the current study will not be publicly available due to institutional and ethical restrictions related to organizational and workforce data but will be available from the corresponding author on reasonable request and with permission of the participating institution.

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