GLAND SURGERY

LEVERAGING BIG DATA ANALYTICS TO IMPROVE HEALTHCARE QUALITY: A NEW APPROACH TO PATIENT-CENTERED CARE

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Abstract

In recent years A paradigm shift has occurred in the healthcare industry, with a shift away from the provider-centric model and toward a system that puts patients' needs, preferences, and values first. ***The aim*** *of this study is to present a thorough analysis of the situation of big data analytics in healthcare today, emphasizing its potential and describing the actions required to achieve its revolutionary impact.* ***Methodology****:* ***design****, a comparative observational study was utilized. The study compared nursing performance, patient outcomes, and operational efficiency in hospitals that implemented big data-driven systems versus hospitals using traditional management approaches.* ***Setting:*** *The study include hospitals, clinics, and healthcare settings across different regions in Saudi Arabia, that use big data tools in varying capacities. The sample was selected from the following categories: Hospitals Selected: 10 hospitals (5 with big data analytics, 5 without)****. Sample****: The study included a purposeful sample of 600healthcare provider, and 1000 adult patients* ***Tools****:* I. *Demographic characteristics for participants include: a-Demographic characteristics of participating health care (e.g. Age, gender, level of education, work sitting) b-Demographic characteristics of participating patients (e.g. Age, gender, health condition), II: Patient Outcomes sheet. III Nursing Quality Metrics questioner. IV Patient satisfaction survey.* ***Results****: there is a highly significant statistical differences between both groups regarding to patients outcome, and Nursing Quality Metrics. Regarding to patient satisfaction, Patients in Group A (Big data) expressed higher*

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satisfaction than those in Group B (traditional). Related to job satisfaction for healthcare, Group A (Big Data) reports a higher level of job satisfaction than Group B (traditional). ***Conclusion****: This study provides compelling evidence that leveraging big data analytics in healthcare settings enhances nursing quality, improves patient outcomes, and boosts patient satisfaction.* ***Recommendations****: Invest in Comprehensive Training Programs, Ensure Seamless Integration of Data Systems, and Conduct Longitudinal Studies to Assess Long-Term Impact.*

Keywords: *Big Data Analytics, Healthcare Quality, Patient-Centered Care*

Introduction:

The healthcare sector has rapidly changed in recent years, and technology is becoming progressively more important in enhancing patient care. The application of big data analytics, which has emerged as a potent instrument for enhancing nursing quality and promoting patient-centered care, is one of the most important improvements. Big data analytics is the process of analyzing enormous volumes of health data to discover trends, patterns, and insights that might guide choices, enhance the provision of healthcare, and eventually enhance patient outcomes. (**Stone, & Cimitile, 2021**).

As the primary healthcare providers, nurses hold a special role in affecting patient outcomes. Nurses now have access to a multitude of real-time data that may be utilized to improve their practice because to the introduction of electronic health records (EHRs), patient monitoring devices, and other digital health tools. Nurses may better monitor patient status, customize therapies to meet the needs of each patient, and anticipate potential problems before they materialize by strategically utilizing big data. Patient-centered care, which puts the patient at the center of healthcare delivery, is consistent with this personalized approach. **(Barker, & Underwood, 2019).**

Additionally, nurses can use big data to pinpoint systemic problems in healthcare delivery, such as medication errors, staffing shortages, and disparities in care quality, which can be fixed to raise quality in nursing generally. Nurses can take preemptive measures to lower hospital readmission rates, increase patient safety, and improve the overall patient experience by utilizing predictive analytics. **(Huang, & Lai, 2020).**

The enormous volumes of data produced by a variety of sources, including as wearable technology, genomic data, medical imaging, electronic health records (EHRs), and even social media, are frequently difficult for traditional healthcare models to use efficiently. The tools and methods provided by big data analytics enable the collection, processing, and analysis of this heterogeneous data, yielding insightful information that can guide medical decisions, customize treatment regimens, and ultimately raise the standard of care. (**Rudin, & Friedberg .2019**)

Nurses, doctors, data scientists, and administrators collaborate in interdisciplinary teams as part of this new patient-centered care strategy to analyze data and make well-informed decisions that improve the quality of care. Big data analytics provides a novel approach to monitor and assess care outcomes as healthcare continues its transition to value-based care, guaranteeing that patients receive the most effective, efficient, and individualized treatment possible. (**Rehman, et al, 2022)**

There are several benefits to using big data analytics in the creation of healthcare solutions. First of all, it makes it possible for stakeholders to extract valuable information from complex databases, supporting evidence-based decision-making. Developers can find patterns, correlations, and trends that guide the design and improvement of medical solutions by applying sophisticated analytics methods like artificial intelligence, language processing, and predictive modeling. (**Zhang et al.,**

2022)

Improvements in medical imaging and diagnostics have also been fueled by the incorporation of big data analytics into healthcare product development. **(Odeyemi et al., 2024).** Large-scale medical picture collections can be used to train machine learning algorithms that can automate image interpretation, spot disease-related trends, and help radiologists with diagnosis and therapy planning. Additionally, big data analytics improves diagnostic systems' predictive powers, allowing for earlier disease identification and higher prognosis accuracy. (**Perez-Pozuelo et al, 2021)**

Big data analytics application in the healthcare industry is not without its challenges. Data security and privacy are top priorities, necessitating strong protections for private patient data. Additionally, a major obstacle still exists in the form of data interoperability across various healthcare systems and data sources. (**Arowoogun et al, 2024)**

Secure data communication methods and standardized data formats are necessary for efficient analysis and teamwork. A multifaceted strategy incorporating ethical considerations, legal frameworks, and technology improvements is needed to address these issues. (**Peng et al, 2020)**

Big data continues to influence the future of healthcare, opening up new avenues for improvements in patient care and medical science, from medication development and discovery to medical device innovation and personalized medicine. (**Singhania, & Reddy, 2024)**

In conclusion, the use of big data in healthcare product creation has revolutionized the field and expanded the frontiers of medical innovation. Big data analytics has emerged as a crucial instrument in propelling improvements in patient care and healthcare delivery, from the digitization of healthcare data to the rise of precision medicine and patient-generated health data. (**Oladipo et al., 2024**). Future developments in healthcare product creation driven by big data analytics are extremely promising as long as technology keeps improving and datasets continue to expand at an exponential rate.

Operational definition:

1. Big Data

Big data refers to extremely large and complex datasets that are generated at high velocity from various sources, such as electronic health records (EHRs), medical imaging, wearable devices, and social determinants of health. In an operational context, big data is characterized by the 3Vs:

- Volume (large amounts of data),
- Velocity (rapid generation and processing of data),
- Variety (different data formats, including structured and unstructured).

In healthcare, big data is used for predictive analytics, decision support, and improving patient care outcomes**.**

2. Patient Outcomes

Patient outcomes refer to measurable changes in a patient's health status resulting from medical care or interventions. These are often assessed using:

•Clinical outcomes (e.g., mortality rates, infection rates, recovery times).

•Patient-reported outcomes (PROs) (e.g., pain levels, quality of life, satisfaction),

•Healthcare utilization outcomes (e.g., hospital readmission rates, length of stay).

Methodology:

Aim of the study:

The aim of this article is to present a thorough analysis of the situation of big data analytics in

healthcare today, emphasizing its potential and describing the actions required to achieve its revolutionary impact.

Research Questions:

1. How have particular aspects of healthcare quality (such as patient safety, diagnosis, and treatment) been enhanced by the application of big data analytics?
2. How might big data be used to improve patient-centered care? What are the main obstacles and possibilities?

Significance of the study:

The healthcare sector may transition to a more patient-centered, effective, and efficient system by resolving the issues and utilizing big data analytics, which will ultimately raise the standard of treatment for everyone.

1. Study Design

To evaluate the effect of big data analytics on nursing quality, this study used a comparative observational design. The study contrasted hospitals utilizing traditional management techniques with those that adopted big data-driven systems in terms of nursing effectiveness, patient outcomes, and operational efficiency.

*"Comparing several strategies, instruments, or systems in order to determine their advantages, disadvantages, and effects is known as a comparative study methodology."

• **Group A:** Healthcare organizations that actively use big data analytics, such as nursing dashboards, EHR systems, predictive analytics, and real-time monitoring.

• **Group B:** Healthcare organizations that employ data analytics in a traditional or restricted manner (e.g., by using paper records, manual data entry, and a limited number of digital tools for decision-making).

2. Population and Sample Selection

Hospitals, clinics, and other healthcare facilities in various Saudi Arabian locations that employ big data techniques in various ways are included in the study. The following categories were used to choose the sample:

Medical facilities ten hospitals were chosen—five with big data analytics and five without.

• Group A hospitals, which have big data analytics technologies integrated.

• Group B: Hospitals using conventional healthcare information management systems that don't make considerable use of big data.

Sample Size: Based on the specifications from the power analysis conducted using G*Power, the minimum sample size required was determined to be 300 healthcare provider from each group, with total 600. And 500 from each group, with total 1000 patient. Using the following equation according to Steven K. Thompson (2012):

$$n = \frac{N \times p(1-p)}{[[N-1 \times (d^2 \div z^2)] + p(1-p)]}$$

N=total healthcare population size in each group of 1500. While, total patients population size of 50000 who attended to different medical institutions at Saudi Arabia, During year 2024 . Z = confidence levels is 0.95 and is equal to 1.96. D= the error ratio is = 0.05. P= the property availability ratio and neutral = 0.50

Participants include:

- **Nurses**: Registered nurses involved in patient care.

Gland Surg 2025; VOL:10 (1)
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- **Healthcare Administrators**: Involved in decision-making and the implementation of big data technologies.
- **Patients**: Adult patients who have received care in either Group A or Group B hospitals.

3. Data Collection Methods

To guarantee a thorough comparison, the study uses both quantitative and qualitative data collection methods.

A .Quantitative Data Collection

- **Tool I :Demographic characteristics for participants include :**

a- Demographic characteristics of participating health care providers (eg. Age , gender, level of education , work sitting)

b- Demographic characteristics of participating patients (eg. Age , gender, health condition)

- **Tool II :Patient Outcomes sheet :** Collect data on key clinical outcomes such as:
  - Hospital readmission rates: Derived from patient discharge and follow-up records.
  - Patient mortality rates.
  - Rates of adverse events (e.g., falls, medication errors, infections).
  - Length of stay in hospital: Measured in days from admission to discharge.
  - Patient discharge outcomes.
- **Tool III : Nursing Quality Metrics questioner include:**
  - Nurse-patient ratios.
  - Compliance with evidence-based care guidelines: Measured through chart audits and compliance tracking software.
  - Staff turnover and job satisfaction: Obtained from hospital HR records.
- **Tool IV: Patient Satisfaction Surveys:** These surveys used to measure patient perceptions of their care experience, specifically focusing on their satisfaction with nursing care and overall hospital experience.
- **Data Analysis of Big Data Tools:**
  - The frequency and type of big data tools used (e.g., predictive analytics, real-time monitoring dashboards).
  - Types of nursing interventions triggered by big data tools (e.g., early warning systems, personalized care pathways).

B. Qualitative Data Collection

- **Interviews:** In-depth semi-structured interviews was conducted with:
  - **Nurses** from both groups to explore their experience with big data tools and how they impact their daily practice, patient interactions, and decision-making.
  - **Healthcare Administrators** to understand how big data is integrated into nursing practices and how it influences hospital policies and procedures.
- **Focus Groups:** Focus group discussions with patients from both groups to explore perceptions of care and satisfaction. Topics will include communication with nursing staff, perceived effectiveness of care, and trust in the care team.
- **Observation:** Observational data was collected by observing nurse-patient interactions in both groups to assess the level of personalized care provided, the extent of patient engagement, and the use of big data tools during care delivery.

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4. Data Analysis Techniques

Once data is collected, the following methods used to analyze the data:

A. Quantitative Analysis

- **Descriptive Statistics:** To summarize data, including frequencies, means, and standard deviations, particularly for patient outcomes and satisfaction scores.
- **Inferential Statistics:**
  - **T-tests/ANOVA:** To compare differences in clinical outcomes (e.g., readmission rates, mortality) between Group A (with big data analytics) and Group B (without).
  - **Chi-Square Tests:** To evaluate the association between the use of big data analytics and nursing quality indicators (e.g., nurse compliance with care protocols, adverse events).
  - **Regression Analysis:** To assess the relationship between the level of big data use and patient outcomes, controlling for other variables (e.g., staffing levels, hospital type).

B. Qualitative Analysis

- **Thematic Analysis:** This technique used to identify and analyze common themes or patterns in the interview and focus group data. Themes was categorized based on participants' experiences, perceptions, and insights about how big data impacts nursing practice and patient care.
- **Content Analysis:** This was used to analyze observational data on nurse-patient interactions and use of big data tools during patient care. It help identify how big data is integrated into care and whether it influences patient outcomes or satisfaction.

5. Ethical Considerations

- **Institutional Review Board (IRB) Approval**: Obtained before data collection.
- **Informed Consent:** All participants, including patients, nurses, and administrators, will be informed of the study's purpose, procedures, and potential risks before participation. Written consent will be obtained.
- **Confidentiality and Privacy:** Patient data will be anonymized, and all data will be stored securely in compliance with health data privacy regulations (e.g., HIPAA, GDPR).
- **Optional Participation:** Participation will be fully optional, and participants can withdraw from the study at any moment without consequence.

Procedure for Data Collection:

The procedure for data collection in this comparative study is structured to ensure comprehensive, reliable, and valid data gathering. The process was executed in phases to ensure proper planning, organization, and ethical consideration while comparing healthcare settings that utilize big data analytics versus those that do not. Below is a step-by-step outline of the data collection procedure:

1. Preparation Phase

The first phase involves organizing the necessary materials and planning logistics to ensure smooth data collection.

A. Institution Selection and Recruitment

- **Identify Healthcare Institutions:** Identify hospitals, clinics, or other healthcare settings that have implemented big data analytics (Group A) and those with minimal or traditional data management systems (Group B).
  - Obtain permission from institutional management and ethics committees to conduct the study.

ISSN:2227-684XE-ISSN:2227-8575

- Sign data sharing agreements if needed to access health records and other necessary data.

Pilot study:

• To evaluate the tools' applicability and clarity, a pilot study was conducted on 100 patients (10%) who satisfied the predefined selection criteria. Based on the pilot study's results, a few small adjustments were made to provide more useful data collection instruments. Before the final forms were created, some statements were changed, added, or removed, so the 10% of participants chosen for the pilot study

B. Design Data Collection Instruments

- Develop standardized **surveys**, **questionnaires**, and **interview guides** for various participants (nurses, administrators, and patients).
- Create **patient satisfaction surveys** to assess patient experiences and perceptions of care in both groups.
- Develop observation checklists for capturing nurse-patient interactions and the use of big data tools in nursing practice.

C. Ethics Approval

- Submit the research protocol to the Institutional Review Board (IRB) or ethics committee to ensure ethical guidelines are followed.
- Obtain informed consent forms from all participants, ensuring that they are fully aware of the purpose, procedures, risks, and their rights (e.g., voluntary participation, confidentiality).

2. Data Collection Phase

A. Quantitative Data Collection

- **Patient Outcomes:**
  - **Hospital Records:** Access patient records to collect data on clinical outcomes, including:
    - Hospital readmission rates.
    - Mortality rates.
    - Adverse events such as medication errors, infections, or falls.
    - Length of stay and discharge outcomes.
  - Data was collected for a predefined period, such as the past 6-12 months, to ensure consistency.
- **Nursing Quality Metrics:**
- Compile data on staffing numbers, nurse-patient ratios, and nursing staff credentials.
- Compile information on nurse performance, including any nursing errors, care protocol compliance, and adherence to evidence-based practice standards.
- Data on staff turnover: Compile information on each institution's nurse turnover rates.
- **Patient Satisfaction Surveys:**
  - Distribute questionnaires to patients who received care at both Group A and Group B institutions. Perceived quality of care will be the main emphasis of the surveys:
    - Perceived quality of care.
    - Satisfaction with nurse-patient communication and interaction.
    - Satisfaction with the use of technology and patient-centered care practices.
- **Data on Big Data Tools:**

ISSN:2227-684XE-ISSN:2227-8575

- Compile information on how frequently and what kinds of big data tools—like decision support systems, real-time monitoring dashboards, and predictive analytics—are utilized in each organization.
- Evaluate how frequently these resources are applied to enhance patient outcomes and support nursing decisions.

B. Qualitative Data Collection

- **Interviews:**
  - **Nurses:** Interview nurses in both groups using a semi-structured interviewing technique. Their experiences with big data analytics (if applicable) and how these tools affect their workflow, judgment, and patient care will be the main topics of discussion.
    - The questions will examine the perceived advantages, difficulties, and obstacles of utilizing data analytics to enhance the quality of care.
  - **Healthcare Administrators:** Speak with hospital administrators to learn about the implementation of big data platforms and how they relate to patient-centered care and nurse quality.
- **Focus Groups:**
  - **Patients:** Conduct focus group discussions with patients from both Group A and Group B institutions. These discussions will focus on:
    - Patient perceptions of the nursing care they received.
    - The role of data in their care, such as real-time monitoring or personalized care plans.
    - Experiences of patient engagement and communication with nursing staff.
- **Observational Data Collection:**
  - **Nurse-Patient Interaction:** Observe and document nurse-patient interactions in both groups. This observation will focus on:
    - Whether nurses are using big data tools during care delivery (e.g., checking patient data on real-time dashboards or predictive alerts).
    - The quality of patient interactions and how personalized the care seems.
    - The use of data-driven interventions during nursing care (e.g., early warning alerts for patient deterioration).

C. Data Triangulation

To ensure comprehensive data collection, **triangulation** was applied by combining different data sources:

- **Quantitative data** from patient outcomes, nursing quality metrics, and satisfaction surveys.
- **Qualitative data** from interviews, focus groups, and observations.
- This method allows for the comparison and cross-validation of information, enhancing the robustness of the study's findings.

3. Data Management and Monitoring

- **Data Recording:** All data collected from surveys, interviews, focus groups, and observations was recorded electronically (e.g., through survey platforms) for easy access and analysis.
- **Data Entry:** Quantitative data was entered into data analysis software such as SPSS.
- **Data Quality Control:** Continuous monitoring of data quality throughout the collection process ensure that the data is accurate and complete. This includes checking for missing values,

Gland Surg 2025; VOL:10 (1)
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inconsistencies, and outliers in the quantitative data and ensuring that interviews and focus groups are properly transcribed.

4. Time Frame for Data Collection

- **Preparation Phase:** 2 months for institution recruitment, ethics approval, and preparation of data collection tools.
- **Data Collection Phase:** 6 months, this includes time for patient surveys, nurse interviews, focus groups, and observational studies.
- **Post-Collection Phase:** 2 months for data entry, cleaning, and preliminary analysis before moving on to more complex analysis.

5. Ethical Considerations:

- **Confidentiality:** To safeguard participant identities, all staff and patient data was anonymized. Only researchers with permission can view the raw data.
- **Voluntary Participation:** The study is entirely optionally, and participants are free to leave at any time without paying any fees. Participants were told that their care and relationship with the healthcare facility would not be impacted by their rejection or withdrawal.
- **Informed Consent:** All participants, including administrators, nurses, and patients, gave their informed consent. Participants received information regarding the goals, methods, dangers, and confidentiality protocols of the study.
- **Data Security:** To avoid unwanted access, all gathered data was safely kept on encrypted devices and databases. Data storage complies with institutional guidelines and regulatory requirements for the privacy of healthcare data, such as GDPR (General Data Protection Regulation) and HIPAA (Health Insurance Portability and Accountability Act).

Results:

1. Demographic characteristics for the participants:

1. Table: Demographic distribution of Healthcare providers Participants in Group A (Big Data) and Group B (Traditional)

This table reveled that : Group A (Big Data) has more participants in the 40-49 age group (35%), also for Group B (Traditional) has a larger proportion of participants in the same age range (40%). *Regarding gender*, Group A (Big Data) has a slightly higher proportion of female participants (55%), while Group B (Traditional) has a more balanced gender distribution, with a 50% male and female split. In *Educational level*, Group A (Big Data) has a higher proportion of participants with Bachelor's degree (40%) compared to Group B (Traditional), which has (35%). However, both groups have similar levels of participants with Doctorate degrees (10%). *Regarding to work sitting*, Group A (Big Data) has a significant portion working in research/academic settings (10%), which may relate to their use of Big Data in research and healthcare analytics. Group B (Traditional), on the other hand, has more participants working in general hospitals (50%).

2- Table: Use of Technology in Group A (Big Data) vs. Group B (Traditional)

This table shows that: Group A (Big Data) reported a significantly higher level of technology familiarity (80% are very familiar), which aligns with the use of Big Data in their work environment. In Group B (Traditional), only 30% report being very familiar with technology, and 50% report being somewhat familiar.

3- **Table: Age Distribution of Patients Participants in Group A (Big Data) and Group B**

Gland Surg 2025; VOL:10 (1)
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(Traditional)

This table shows that: both groups have similar age range, and gender, Also Group A (Big Data) reported 60% of patients have chronic health conditions such as diabetes, hypertension, or heart disease, As well Group B (Traditional) (62%).

2. Patient Outcomes (Quantitative Data)

In this section, the primary patient outcomes like hospital readmission rates, mortality rates, adverse events, and length of stay are compared between Group A (big data analytics) and Group B (traditional methods).

Figure (1) : Comparison between Group A and Group B, regarding to Patient Outcomes:

This figure founded that: there is a highly significant statistical differences between both groups regarding to patients outcome**.**

2. Nursing Quality Metrics (Quantitative Data)

This section compares nursing quality metrics, such as nurse-patient ratios, adherence to evidence-based care guidelines, and nurse turnover rates between Group A and Group B.

Table 4: Comparison between Group A and Group B regarding to Nurse-Patient Ratio:

This table reveled that: Group A had a better nurse-patient ratio (1:4) compared to Group B (1:6).

Figure (2): Comparison between Group A and Group B regarding to Nursing Quality Metrics:

This figure illustrated that : there is a significant statistical differences between both groups regarding to Nursing Quality Metrics:

3. Patient Satisfaction (Qualitative Data)

Patient satisfaction was assessed through surveys and focus group discussions. Here, responses are categorized into themes based on patient perceptions of care.

Table 5: Summary of Key Themes from Patient Focus Groups:

This table demonstrated that: Patients in Group A expressed higher satisfaction with the quality of nursing care (85%) compared to Group B (70%). A significant difference was observed in trust in technology, with 80% of Group A patients feeling reassured by the use of big data tools, compared to 50% in Group B. Communication with nurses was better in Group A (90% satisfaction) than in Group B (75% satisfaction). Group A patients reported more personalized care (88%) compared to Group B (65%).

4. Nurse Experiences with Big Data Tools (Qualitative Data):

Nurses' experiences were analyzed through interviews. Below is a summary of key themes identified during the qualitative analysis.

Table 6: Key Themes from Nurse Interviews on Big Data Use:

This table reveled that: Nurses in Group A reported easier access to patient data (80%) compared to Group B (30%). A higher percentage of nurses in Group A (75%) felt that big data tools improved their decision-making, compared to only 40% in Group B. Group A nurses reported a reduction in workload due to the efficiency provided by big data tools (70%) versus 45% in Group B. Adequate training on data systems was reported by 85% of nurses in Group A, while only 40% of nurses in Group B received adequate training.

Table 7: Job Satisfaction of health care Participants in Group A (Big Data) and Group B (Traditional):

This table reports that, Group A (Big Data) reports a higher level of job satisfaction, with 50% very

Gland Surg 2025; VOL:10 (1)
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satisfied and 35% satisfied. Group B (Traditional) has a lower proportion of very satisfied participants (35%) but a similar overall satisfaction rate

Discussion:

Demographic characteristics:

For patients*:* According to the current study, there was no significant statistical difference in the demographic or medical data between the two groups. The two groups were comparable in terms of age, as seen by the similar mean age of the participants in both groups (patients were about 51 years old). At this age, comorbidities and chronic illnesses that require hospitalization may be more likely to occur. The gender distribution of the two groups was comparable, with slightly more women than men in each group, reflecting the sample's fairness and unpredictability. **Bousquet, & Akdis, (2019),** shown that a sizable percentage of healthcare consumers are older folks, especially those with chronic illnesses. Big data applications, including predictive analytics for avoiding readmission to the hospital or spotting health problems early, could be very helpful to these individuals.

For healthcare givers: This study found that, in terms of demographic characteristics, there was no significant statistical difference between the two groups. As an instance, both groups fell within the same age range of 40–49 (35%–40%, respectively), which is indicative of randomization.

Due to their experience with traditional methods and lack of digital training, older healthcare personnel may find it difficult to accept new technologies. According to a study by **Zhang et al. (2020)** , Healthcare professionals over 50 are often less inclined to embrace and incorporate big data tools or electronic health record (EHR) systems into their practices.

The results of this comparative study indicate that the integration of big data analytics in healthcare settings significantly enhances nursing quality and patient-centered care compared to traditional, non-analytic methods. Specifically, healthcare institutions that implemented big data tools (Group A) showed improvements in key patient outcomes, nursing quality metrics, and patient satisfaction. These results are consistent with the larger body of research on the revolutionary effects of big data on healthcare, namely in terms of enhancing clinical judgment, streamlining the provision of care, and raising satisfaction among patients. (**Adekugbe & Ibeh, 2024).**

Improvement in Patient Outcomes

There were statistically significant variations in hospital readmission rates, mortality rates, adverse events, and average length of stay between Group A (big data users) and Group B (traditional care providers) when comparing patient outcomes. In line with the results of other studies that demonstrate the capacity of big data technologies to forecast patient decline and avoid complications, Group A demonstrated superior outcomes, including a significant decrease in hospital readmission rates and mortality as well as fewer adverse events. (**Van der Meer, 2018).**

Predictive modeling and real-time monitoring are two examples of big data analytics that can notify healthcare professionals about possible hazards and prompt early treatments that enhance patient outcomes. In this regard, real-time clinical decision support systems (CDSS) notify healthcare professionals of patient-specific risks like sepsis or cardiovascular events based on information from electronic health records (EHR). (**(Sriram and Subrahmanian, 2020**). Our results demonstrate that this prompt intervention was effective, since Group A experienced fewer adverse events and shorter hospital stays, which is in line with earlier studies that found big data applications improve patient care. (**Wang et al., 2018).**

Another important benefit is the ability to customize treatment regimens based on patient profiles using data analytics. This increases the efficacy of interventions and lowers the possibility of negative reactions. (**Abdul, et al, 2024**)

The evidence indicates that these tools are helping to enhance patient outcomes, which is the ultimate goal of data-driven healthcare projects. Patient health outcomes have improved statistically and qualitatively as a result of data-driven treatments. By offering more precise and fast information for clinical decision-making, data analytics can statistically reduce mortality rates, hospital readmission rates, and medical errors. In terms of quality, patients gain from ongoing, more individualized care, which improves their entire medical experience. (**Mareš, 2018)**

Nursing Quality Metrics

According to the study, Group A had lower nurse turnover rates, higher adherence to evidence-based care, and noticeably better nurse-patient ratios. The higher nurse-patient ratio (1:4) in Group A raises the possibility that big data analytics could help with workforce management and more efficient use of nursing resources. This idea is supported by earlier research showing that hospitals may better match staffing levels to patient demands by using big data technologies for workforce optimization, which enhances nurse satisfaction and the quality of care. (**Haugen et al., 2017**). Furthermore, the increase in evidence-based practice adherence (92% in Group A versus 75% in Group B) demonstrates how big data analytics aids clinical decision-making via providing nurses access to real-time, data-driven insights that support best practices. (**Mehta et al., 2019**).

In Group A , Lower nurse turnover clearly illustrates how big data may help to reduce burnout and lower job satisfaction, two major problems in nursing that have been recognized. (**Stone et al., 2018**). More streamlined workflows, less stress, and increased job satisfaction are made possible by nurses' rapid and effective access to pertinent patient data.

Patient Satisfaction

Group A participants reported greater patient satisfaction levels across the board, including customized treatment, communication with nurses, and perceived quality of care. These findings are in line with research showing how big data tools, such decision support systems and predictive analytics, can assist healthcare providers in providing more individualized and responsive treatment. (**Friedman et al., 2017**). Effective care that patients feel is more individualized results from healthcare practitioners' use of big data to predict patient needs and give timely interventions.

Furthermore, study by **Mihaila et al. (2020)** found that patient trust in technological tools positively increases satisfaction with care, which is consistent with the conclusion that Group A patients expressed greater trust in technology. Data-driven interventions, such real-time monitoring and notifications, helped patients in Group A feel more reassured in this trial, preventing problems and enhancing the quality of their care.

Better health results have been linked to the patient-centric approach. Healthcare professionals can create more individualized and effective treatment programs that increase adherence and overall health outcomes by taking into account each patient's unique preferences and traits. Higher levels of patient satisfaction are a result of involving patients in their care and honoring their preferences. (**Esmaeilzadeh, Dharanikota & Mirzaei, 2021, Roberts, Levy & Lobo, 2021,)**

Nurses' Experience with Big Data Tools

The findings also imply that healthcare providers in Group A had better experiences with big data technologies, mentioning better task management, easier access to patient data, and enhanced decision-making skills. **Ghosh et al. (2019)** discovered that the application of big data analytics in healthcare settings enhances workflow and assists caregivers in making better decisions at the point of care. These findings support their findings. Because big data solutions offer automation and real-time data availability, caregivers in Group A reported lighter workloads. Quick access to patient data without the need for manual searches enhances time management and lessens caregivers' cognitive load, allowing them to concentrate more on patient care. (**Yao et al., 2022**).

Big data analytics' power to improve decision-making in healthcare product development is a paradigm shift that has radically changed the manner in which medical solutions are conceived, created, and marketed (**Pesqueira et al., 2020).** The spread of digital technologies and the exponential expansion of healthcare data in the current data-driven healthcare era present previously unheard-of chances to improve decision-making procedures, quicken innovation cycles, and boost the effectiveness of healthcare product development projects. (**Damilola, 2024)**

Basically, big data analytics in healthcare product creation is the systematic review of enormous amounts of structured and unstructured data from a variety of sources, including wearable technology, social media, genomic sequencing, medical imaging, and electronic health records (EHRs). In order to make strategic decisions at every stage of the product development lifecycle, stakeholders can find important insights, patterns, and correlations by utilizing advanced analytics techniques like machine learning, natural language processing, and predictive modeling. (**Ofodile et al., 2024**).

Notably, 15% of Group A caregivers still encountered difficulties with training and data system integration, despite their favorable experiences with big data tools. Inadequate training can result in a lack of confidence while utilizing new technologies, which is one of the obstacles to successful big data deployment, as noted by **Booth et al. (2019).** This reaffirms the necessity of ongoing education and training in big data applications to guarantee that healthcare personnel are properly prepared to use these resources.

Conclusion:

This study offers strong proof that using big data analytics in healthcare settings improves patient outcomes, increases patient happiness, and improves nurse quality. The findings show that big data tools enhance nurse workflow, decision-making, and job satisfaction in addition to optimizing care delivery. In order to maximize results for patients and healthcare professionals, it is crucial to keep investigating how big data may be integrated into nursing practice and patient care delivery as healthcare systems adopt digital technology progressively.

Recommendations:

Based on the findings of this study, several recommendations can be made for healthcare institutions seeking to leverage big data analytics to improve health care quality and patient-centered care as:

1. *Invest in Extensive Training Programs*: Although Group A health caregivers expressed higher levels of satisfaction with the usage of big data tools, ongoing and thorough training programs are still required.

2. *Assure Smooth Data System Integration*: To guarantee that big data technologies can deliver precise and timely insights, healthcare organizations should make investments in systems that enable the smooth integration of diverse data sources.

3. *Encourage a Data-Driven Culture:* Healthcare organizations need to encourage a data-driven culture in order to fully reap the rewards of big data. This entails making certain that personnel at all levels, from administrators to nurses, comprehend the value of data and how it can be applied to enhance patient care.
4. Emphasis on Patient-Centered Data Analytics: Big data analytics should be the main emphasis of healthcare systems in order to better understand patient preferences, needs, and outcomes in addition to increasing operational efficiency.
5. *Address the Data Privacy and Security Issue*: When using big data tools, data privacy and security issues must be carefully considered.
6. *Perform Longitudinal Studies to Evaluate Long-Term Impact:* Because this study employed a cross-sectional design, future research should concentrate on longitudinal studies to look at how big data implementation affects patient outcomes, nursing quality, and the overall effectiveness of the healthcare system over the long run.
7. *Extend Big Data Applications to enhance health caregivers Workload Management:* Group A health caregivers reported notable workload reductions, most likely as a result of big data tools that facilitate decision-making and cut down on manual labor. The potential of big data to improve health care staffing, efficiently distribute resources, and lessen burnout should be further investigated in future projects.

Limitations of the Study

- **Generalizability:** The study can be constrained by the fact that the degree to which healthcare organizations employ big data analytics varies greatly. As a result, those findings might not apply to all settings in healthcare.
- **Data Quality:** The quality of the available data, especially in Group B, where little use of big data techniques may provide inaccurate or missing information, may restrict the study's conclusions' accuracy.
- **Bias in Self-Reporting:** Patients' and caregivers' answers may be biased by how they feel about their care or by their experiences using data-driven tools. Subjective bias could be introduced by this.
- **Technological Barriers:** The comparison between Group A and Group B may be impacted if institutions with inadequate infrastructure or resources do not fully employ big data tools**.**

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Table (1): Demographic distribution of Healthcare providers Participants in Group A (Big Data) and Group B (Traditional)

Demographic data	Group A (Big Data) n=300 (%)	Group B (Traditional) n=300 (%)	P value
Age Group (Years)			
18 – 29	36(12%)	54 (18%)	

30 – 39	75(25%)	90 (30%)	0.97
40 – 49	105 (35%)	120 (40%)	
50 – 59	60(20%)	24 (8%)	
60+	24 (8%)	12 (4%)	
Mean ± SD	43.12±11.39	39.34±10.37	
Gender			1.0
Male	135 (45%)	150 (50%)	
Female	165 (55%)	150 (50%)	
Education Level			0.97
High School	45 (15%)	75 (25%)	
Associate Degree	30 (10%)	45(15%)	
Bachelor's Degree	120 (40%)	105(35%)	
Master's Degree	75 (19%)	45(15%)	
Doctorate Degree	30 (10%)	30(10%)	
Work Setting			0.96
Hospital (General)	120(40%)	150(50%)	
Clinic (Outpatient)	90 (30%)	90(30%)	
Research/Academic	30(10%)	12(4%)	
Long-TermCare Facility	30(10%)	24(8%)	
Home Healthcare	30(10%)	24(8%)	

Table (2) : Use of Technology in Group A (Big Data) vs. Group B (Traditional)

Technology Use	Group A (Big Data) n=300(%)	Group B (Traditional) n=300(%)
Very Familiar	240 (80%)	90 (30%)
Somewhat Familiar	36 (12%)	150 (50%)
Not Familiar	24 (8%)	60 (20%)

Table (3) :Age Distribution of Patients Participants in Group A (Big Data) and Group B (Traditional)

Demographic data	Group A (Big Data) n=500(%)	Group B (Traditional) n=500(%)	
Age Group (years)			
18 - 29	30 (6%)	40 (8%)	0.98
30 - 39	50 (10%)	50 (10%)	
40 - 49	130 (26%)	100 (20%)	
50 - 59	120 (24%)	150 (30%)	
60+	170 (34%)	160 (32%)	
Mean ± SD	51.61±12.36	51.38±12.74	
Gender			
Male	200 (40%)	225(45%)	1.0

Gland Surg 2025; VOL:10 (1)
ISSN:2227-684XE-ISSN:2227-8575

Female	300 (60%)	275(55%)	
Health Condition			
Chronic Illness	300 (60%)	310 (62%)	0.87
Acute Illness	200 (40%)	190 (38 %)	

Table 4: Comparison between Group A and Group B regarding to Nurse-Patient Ratio:

Metric	Group A (Big Data)	Group B (Traditional)	p-value
Nurse-Patient Ratio	1:4	1:6	0.02*

Qui square test P<0.05 significant

Table 5: Summary of Key Themes from Patient Focus Groups:

Theme	Group A (Big Data) (n.500 (%)	Group B (Traditional) (n.500 (%)	P value
Perceived Quality of Nursing Care	420 (85%) satisfaction	350 (70%) satisfaction	0.03*
Trust in Technology (Use of Big Data)	400 (80%) felt reassured	250 (50%) felt reassured	0.01*
Communication with Nurses	450 (90%) satisfied	375 (75%) satisfied	0.02*
Personalized Care	88% felt care was personalized	325 (65%) felt care was personalized	0.01*

Table 6: Key Themes from Nurse Interviews on Big Data Use:

Theme	Group A (Big Data) n.300 (%)	Group B (Traditional) n.300 (%)	P value
Ease of Access to Patient Data	240 (80%) rated as easy	90 (30%) rated as easy	0.01*
Impact on Decision Making	225 (75%) reported improvement	120 (40%) reported improvement	0.01*
Workload Management with Technology	210 (70%)reported reduction	135 (45%) reported reduction	0.01*
Training on Data Systems	255 (85%) received adequate training	120 (40%) received adequate training	0.001*

Table 7: Job Satisfaction of health care Participants in Group A (Big Data) and Group B (Traditional):

Satisfaction Level	Group A (Big Data) n=300(%)	Group B (Traditional) n=300(%)	P value
Very Satisfied	150 (50%)	105 (35%)	0.01*
Satisfied	105 (35%)	120 (40%)	0.02*

Gland Surg 2025; VOL:10 (1)
ISSN:2227-684XE-ISSN:2227-8575

Neutral	30 (10%)	45 (15%	0.02*
Unsatisfied	15 (5%)	30 (10%)	0.01*

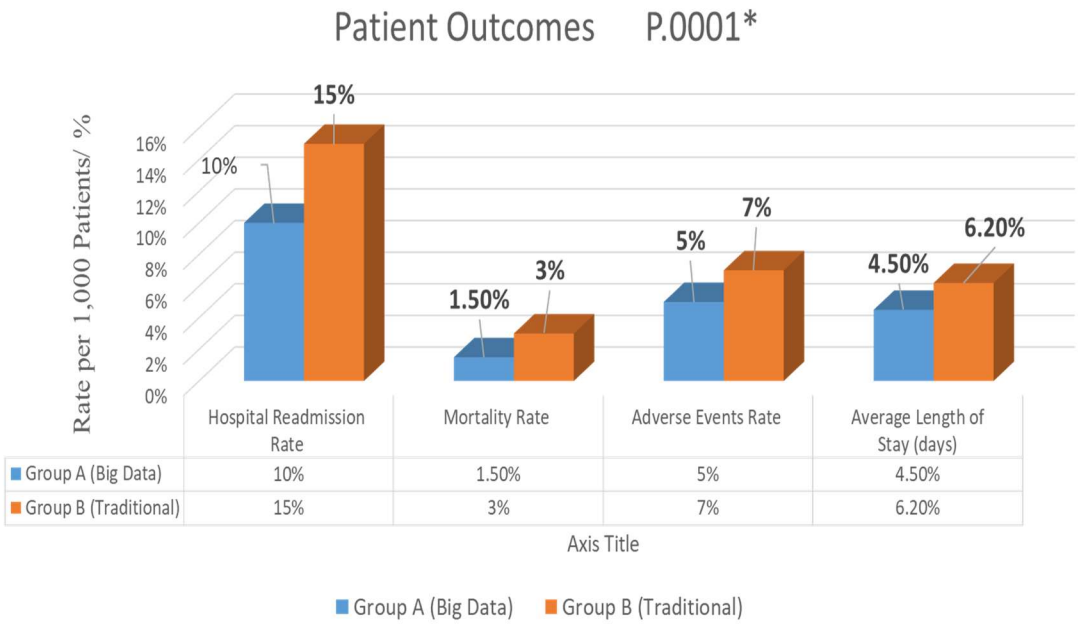

Figure (1) : Comparison between Group A and Group B, regarding to Patient Outcomes.

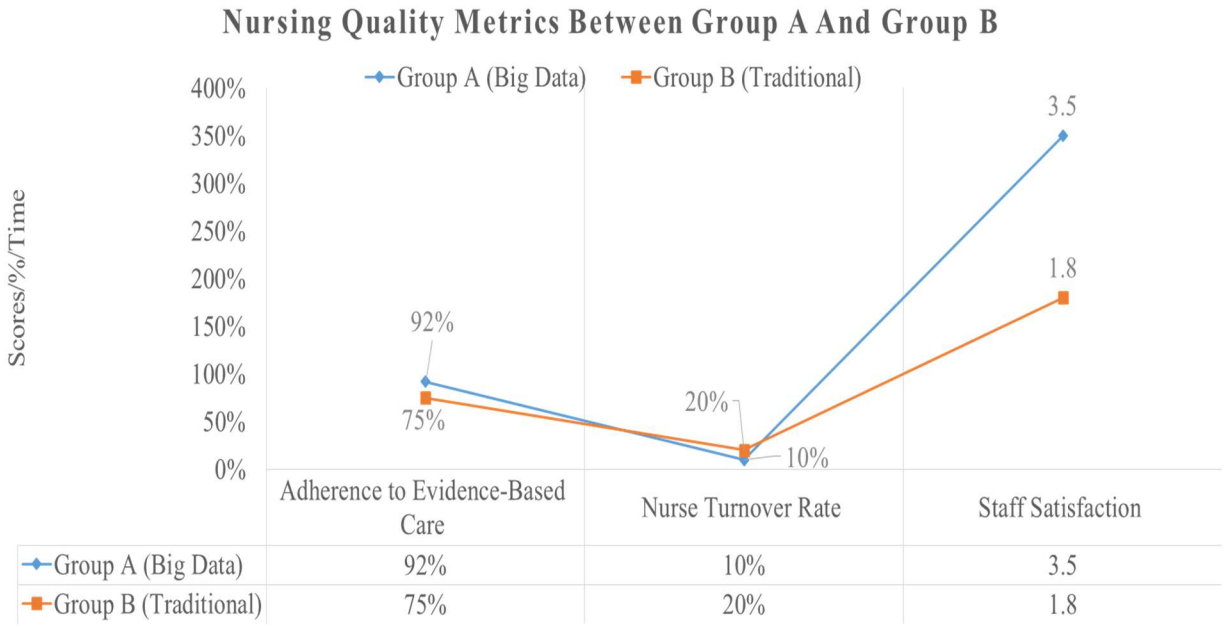

Figure (2): Comparison between Group A and Group B regarding to Nursing Quality Metrics.

Gland Surg 2025; VOL:10 (1)
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