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Big data can help prepare nurses and improve patient outcomes by improving quality, safety, and outcomes

Original Article

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Abstract: **Objectives:** Big data has revolutionized nursing and health care and raised concerns. This research aims to help nurses understand big data sets to provide better patient care.

Methods: This study used big data in nursing to improve patient care. Big data in nursing has sparked a global revolution and raised concerns, but few studies have focused on helping nurses understand big data to provide the best patient care. This systematic review was conducted based on PRISMA guidelines. PubMed, MEDLINE, CINAHL, Google Scholar, and ResearchGate were used for 2010–2020 studies.

Results: The most common use of big data in nursing was investigated in eight papers between 2015 and 2018. All research showed improvements in patient outcomes and healthcare delivery when big data was used in the medical-surgical, emergency department, critical care unit, community, systems biology, and leadership applications. Big data is not taught to nurses.

Conclusions: Big data applications in nursing and health care improve early intervention and decision-making. Big data provides a comprehensive view of a patient's status and social determinants of health, allowing treatment using all metaparadigms and avoiding a singular focus. Big data can help prepare nurses and improve patient outcomes by improving quality, safety, and outcomes.

Keywords: *big data • health • nursing • PRISMA • quality of care*

1. Introduction

Big data analysis can improve health care, reduce treatment costs, prevent preventable diseases, foresee epidemic outbreaks, and enhance life quality.[1–3] Huge amounts of data are generated by technology day after day. These data are almost always and everywhere accessible.[4] Data experts introduced big data by

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considering all data streams.[2] Big data refers to enormous data that flow from multiple sources, including clinical data, clinical support decision systems, health systems, and information technology, with the goal of achieving a seamless flow of big data at the population level.[5,6]

Big data lack a clear definition among data experts and researchers.[7] A good definition of big data in nursing will advance the research and practice and will improve care.[1] Structured health care data capture helps develop accurate, reliable, valid, and foundational patient-centered care information across systems and institutions.[3,8]

Big data influences how nurses learn, practice, research, and make policy recommendations. Nursing must maximize big data to support human health and well-being. Nurse practitioners, specialists, and educators often lack the skills to use big data effectively.[9]

Nurses and other health care professionals must understand large data sets. Nurses must collect and analyze data in today's knowledge-based society.[10,11] In light of the evolution of nursing in the context of big data, big data centers for nursing science, advanced professional nursing databases, and a knowledge system structure are needed.[9] Big data can predict blueprints and patterns shared by thousands of people and evaluate multiple data sources collected by nurses and other health care professionals.[12]

2. Methods

This systematic review followed PRISMA guidelines.[13]

2.1. Eligibility criteria

This systematic review analyzed big data nursing care research articles and included articles published during 2010–2020. Academic journal articles in English were also analyzed.

2.2. Information sources

Two researchers searched Medline, CINAHL, EMBASE, EBSCOhost, and PsycINFO. Google Scholar and ResearchGate were also used as search sources. MeSH key terms and the Boolean operator were used to search for big data concepts. The initial and final literature searches were carried out on March 1 and April 1, 2020, respectively.

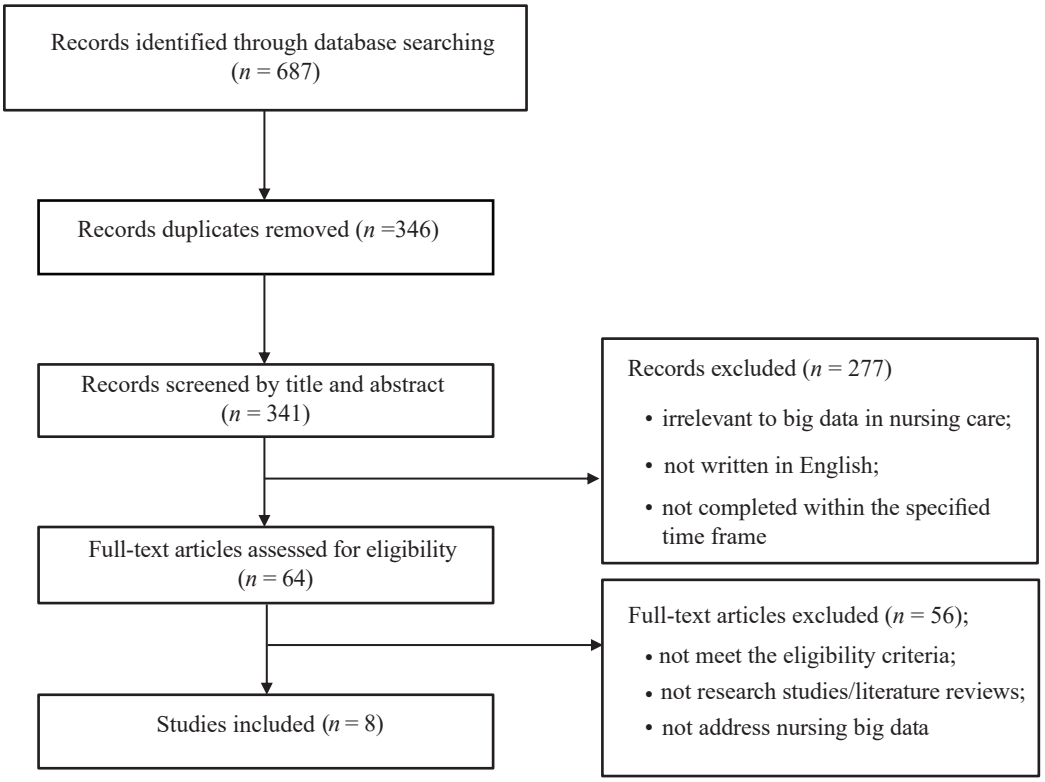

Figure 1. PRISMA Flowchart.

2.3. Search strategy

The search was performeded between March and April 2020. “Big data”, “health”, “health care”, “health domain”, and “nursing” were the key terms used for searching. Then, terms under each category were integrated. Searches produced 687 articles that were published after 2010. After a long consensus-building discussion, researchers screened articles by titles and abstracts for inclusion. Full texts of potential studies were evaluated for eligibility. A total of 346 articles were excluded as they were duplicate publications and non-eligible articles (not related to big data or health care, conference and editorial paper, not an academic journal, or duplication studies). Finally, 8 articles were included for review, which are presented in Figure 1.

2.4. Data collection process

The researchers reviewed key points of each article. Then, they discussed discrepancies and findings to identify trends and to draw inferences.

2.5. Data items

The researchers then examined the findings of the included studies, which are summarized in a review matrix (title, purpose, study type, study description, key findings, conclusion, and recommendation; Table 1).

2.6. Risk of bias in individual studies

Using EPHPP 11, study bias was determined. If scores differed, agreement was reached by consulting with all reviewers. Only 3 of 8 studies were bias-free. There were no quality-assessed studies (Table 2).

2.7. Synthesis of results

Reviewers synthesized and analyzed data; disagreements were resolved by consensus. Synthesis, finding consistency, and tables were produced.

3. Results

3.1. Study selection

A total of 8 articles were published between 2015 and 2018. All articles had big data and nursing care metrics.

3.2. Results of individual studies

Table 1 summarizes included studies. All categories have been identified through thematic synthesis.

3.3. Identification of commonly used big data by nursing

The 8 reviewed studies describe most common big data (data-driven) applications used in nursing. All the studies focused on medical-surgical, emergency room, critical unit, community, systems biology, and leadership use of big data to improve the health care delivery quality and patient outcomes. In the first study, medical-surgical and intensive care units were searched using “big data” from electronic health records to illustrate a nurse-sensitive patient outcome.[14]

In the second study, the importance of big data was conveyed to nurses, laying the groundwork for big data in nursing.[12] The third study used electronic health care data, machines, and devices, such as the cardiac monitor, as well as Facebook, Twitter, and genome data, to improve cardiovascular care.[17] The fourth study used big data and new technology to reduce readmissions, ER visits, and outpatient clinic visits; and this study shows a significant impact on resolving health care issues and reducing unnecessary readmissions, especially for chronic patients.[19]

Two studies in nursing research highlighted the use of big data. The first study examined 95 variables from randomized clinical trials and concluded that big data requires alternative nursing research methods.[20] The second study emphasized the participation of nurse scientists and clinicians in interdisciplinary collaborations to synthesize big data and systems biology in new clinical decision support applications to improve patient care.[16]

The remaining two studies examined the role of big data in nursing development, leadership, and decision-making. To our knowledge, this is the first study to combine electronic health data within nursing domains with social determinants of health data and population over a 3-year period to identify the role of nurse information with big data competencies.[18] The last study found that the effective use of big data by nurses could lead to new transformational leaders and successful advocacy for nurses in 21st-century health systems.[15]

4. Discussion

Big data can improve patient decision-making by detecting disease early. It reduces costs by enhancing nurses’ role in primary care and reducing readmissions of chronically ill patients. Reducing hospitalizations and improving the performance of nurses and patients by adopting patient-centered care improved care quality and effectiveness.

Study author	Title and year	Purpose	Additional description	Key findings	Recommendation\considerations
Janet Stifter, Yingwei Yao, Muhammad Kamran Lodhi, Karen Dunn Lopez, Ashfaq Khokhar, Diana J. Wilkie, Gail M. Keenan	Nurse Continuity and Hospital- Acquired Pressure Ulcer A Comparative Analysis Using an Electronic Health Record "Big Data" Set 2015	HANDS, an electronic nursing plan of care database, was used as the big data source.	The documentation system was used to collect data on nine units in four hospitals from 2005 to 2008. Two large community hospitals with medical-surgical and critical care units were included.	All nine study units had poor nurse continuity (index = 0.21–0.42 [1.0 = optimal]). Nutrition, mobility, perfusion, hydration, skin problems, and age were linked to HAPUs (p.001). HAPU development was not significantly associated with patient characteristics, nurse continuity, or interactions between the two. -High variation in nurse continuity between patient episodes in HANDS data, offering rich potential for future study on nursing	Nutrition, mobility, and perfusion are linked to HAPUs, but not nurse continuity. We found high variation in the degree of continuity between patient episodes in HANDS data, which offers rich potential for future study of nurse continuity and its effect on patient outcomes. This study used EHR big data containing nursing care plan documentation to examine a nurse-sensitive patient outcome. More research is needed, so hospital administrators can reorganize health care delivery systems to ensure safe, high-quality care for all hospitalized patients.
Patricia Flatley Brennan, Suzanne Bakken.	Nursing Needs Big Data and Big Data Needs Nursing 2015	To use data science to improve patient outcomes.	Explore emerging federal big data initiatives and nursing informatics research exemplars to determine where nursing is poised to join the big data revolution. We reflect on big data initiatives.	Existing methods for analyzing large data sets are necessary but insufficient for nursing to join the big data revolution. The nursing SPS guides an ethical, principled approach to big data and data science. Implications for basic and advanced clinical nurses, nurse scientists who collaborate with data scientists, and nurse data scientists.	Big data and data science could benefit nursing clinicians and researchers. Big data can be used to improve comparative effectiveness surveillance, opportunity monitoring, adverse event identification, and public health surveillance.
Kelly T. Gleason, and Cheryl R. Dennison Himmelfarb	Big Data: Contributions, Limitations, and Implications for CVNs 2017	Improve patient care and outcomes	Electronic health records, machine-generated data from cardiac monitors and ActiGraphs, social media including Facebook status updates and Twitter posts, and genome data are health care data sources. Big data analytics gives nurse scientists access to patient health data to answer clinical questions.	Big data improves patient care. No major cost increases. Electronic health records make nurse documentation easier to analyze.	Big data analytics can improve cardiovascular care. Big data allows researchers to study racial and ethnic minorities, among others. Nurses must continue to improve EHRs and mobile health technology. Nurses can include patient-reported outcomes in big data and use those data to develop an evidence base that helps patients and providers manage cardiovascular disease.
Monsen, Karen A.; Kelechi, Teresa J. McRae, Marion E. Mathiason, Michelle A. Martin, Karen S.	Data-driven discovery of novel patterns in archived clinical trial data 2018	To illustrate the approach by exploring a large research data set with 95 variables (demographics, temperature measures, anthropometrics, and standardized instruments measuring quality of life and self-efficacy) using the Omaha System.	2015–2017 annual deep dive study track work How will this understanding happen and how does nursing affect the trend of increasing access to data and information as sources improve in accuracy and timeliness? Develop professional curiosity, promote constructivist learning, and learn how to consider the context of care for patients. These data come from external systems that describe social determinants of health, such as a patient's environment, economic status, community, transportation infrastructure, food access, climate, and pollution levels. Nurses need basic skills, especially with data (analytics).	Reducing health disparities and improving providers' ability to meet demand Recognize the nurse's role in contextualized health care, which goes beyond EHR data. Develop a standard curriculum to teach nursing and interdisciplinary students to view, assess, and plan for the whole person (context). Obtain leadership buy-in to promote change to optimize collaborative care. This may involve expanding nursing activity, responsibility, and role. Strengthen nurse information skills for context-based collaborative care. Provide the nurse with big data manipulation and management, data science, data analytics, and visualization skills to enable collaborative eHealth.	Nursing is highly skilled in the science of care, the application of justified interventions to meet diagnostic needs, and the ability to record such care in system-designed tools like the EHR. There is much discussion about using medical and social determinants of health data to plan post-acute care for patients. Nurses understand the importance of considering the whole patient, but many lack the data science and analytics skills to turn oceans of data into continents of knowledge. Thought leaders will map the path to co-create eHealth. Reduce health and social care costs

Table 1. Continued

Study author	Title and year	Purpose	Additional description	Key findings	Recommendation\considerations
P.M. Procter and M.L. Wilson	eHealth, Nursing, and Big Data 2018	Explore the changing influence of big data, specifically population and social determinants of health data, on co-created eHealth in a nursing domain over the past 3 years.	2015–2017 annual deep dive study track How will this understanding happen and how does nursing affect the trend of increasing access to data and information as sources improve in accuracy and timeliness? Develop professional curiosity, promote constructivist learning, and learn how to consider the context of care for patients. This data comes from external systems that describe social determinants of health, such as a patient's environment, economic status, community, transportation infrastructure, food access, climate, and pollution levels. Nurses need basic skills, especially with data (analytics).	Reduce health inequalities and improve providers' ability to meet demand Acknowledge the nurse's professional curiosity in contextualized care that goes beyond EHR medical data. Prepare nursing and inter-disciplinary students in an academic setting to view, assess, and plan for the whole person in their population (context). Get leadership buy-in for change to optimize collaborative care; identify motivators. It may include a broader view of reimbursable nursing activity, responsibility, and role. Improve nurse information skills and context-based collaborative care. Give the nurse information on big data manipulation and management, data science, data analytics, and visualization so she can activate collaborative eHealth.	Nursing is highly skilled in the science of care, the application of justified interventions to meet diagnostic needs, and the ability to record such care in system-designed tools like the EHR. There is much discussion about using medical and social determinants of health data to plan post-acute care for patients. Nurses understand the importance of considering the whole patient, but many lack the data science and analytics skills to turn oceans of data into continents of knowledge. Thought leaders will map the path to co-create eHealth. Reduce health and social care costs
Sandra Founds	Big data and precision health require systems biology in nursing. 2017	To discuss systems biology, big data, and precision health from a nursing perspective.	This update discusses systems biology, big data, and precision health from a nursing perspective.	Expanding technology and data sources, viewed from the perspective of systems biology, create opportunities for nursing in the era of big data and precision health. Systems biology helps nurse scientists and clinicians model biological and behavioral components with big data. Nurse scientists and clinicians should collaborate to synthesize big data and systems biology in clinical decision support applications and to integrate databases and platforms. In the era of comics, big data, and precision health, nursing can lead in education, research, and practice by teaching and upholding ethical standards.	Systems biology can guide nurses and other clinicians in the acquisition, management, and modeling of multiomics data from people in health and illness in their environments. Nurses can help translate systems biology for precision health and advocate for patient engagement. Nursing research, education, and practice can incorporate systems biology to create and apply omics and big data to strengthen holistic precision health for all.
Sally Remus	CNEs and Big Data: Opportunities 2017	To connect CNE informatics competency and nursing knowledge development to big data.	Informatics competency and EBPs	CNEs with informatics skills can use Big data to develop nursing knowledge as eHealth project sponsors. Informatics-savvy CNEs are the new digital age transformational leaders who can advocate for nurses in 21st-century health systems. Transformational CNEs with informatics competency will position nurses and the nursing profession to achieve its future vision, where nurses are perceived as knowledge workers, providing leadership for safe, quality care and demonstrating nursing's unique contributions to fiscal health through clinically relevant, EBPs.	CNEs with informatics skills can write nursing's big data script. Harnessing big data will position nurses and the nursing profession to achieve its future vision, where nurses are seen as knowledge workers providing leadership for safe, quality care and demonstrating nursing's unique contributions to fiscal health through clinically relevant EBPs.

(*Continued*)

Study author	Title and year	Purpose	Additional description	Key findings	Recommendation\considerations
Sharon Hewner Suzanne S. Sullivan, Guan Yu.	Implementing best practice for transitional care using innovative technology and big data reduces ER visits and hospitalizations. 2018	To improve post-discharge utilization value by identifying high-risk patients who could benefit from rapid nurse outreach to assess social and behavioral determinants of health and reduce inpatient and ED visits.	The intervention was applied to chronically ill discharged patients before and after comparisons. Nurses give a phone alert. This project evaluated health-related outcomes and nursing care value in the year before and the year of intervention using binomial regression to account for rare events.	The nurse care coordinator reduced inpatient and emergency visits by 25% and increased outpatient visits by 27%.	Frontline nurses pose questions and identify opportunities to use big data to support EBP and solve health care problems. Coordination of care must go beyond single settings and include social factors. To influence health care policy and research, nurses must demonstrate the tangible and intangible value of nursing care.

Abbreviations: CNEs, chief nurse executives; EBPs, evidence-based practices; HANDS, Hands-on Automated Nursing Data System; CVN, Cardiovascular Nurse; EBPs, Evidence-Based Practice; ED, Emergency Department; CNEs, chief nurse executives; SPS, Social Policy Statement; HAPUs, Hospital-acquired pressure ulcers; HER, Electronic Health Record.

Table 1. Literature review matrix.

A total of 8 studies evaluated big data in nursing care, most of which showed a strong correlation between the effective use of big data and improved nursing and health care quality.

Brennan and Bakken's[12] study had implications for basic and advanced nursing practice and nurse scientists who work with data scientists using the Hands-on Automated Nursing Data System (HANDS). Second, Stifter et al.[14] found poor significance between nurse continuity and patient outcomes in the presence of HANDS HAPUs. Third, Gleason et al.'s[21] study showed that big data can be effectively employed to improve patient care, especially patients with cardiovascular diseases. Furthermore, big data can be used to evaluate nursing evidence-based practices (EBPs), as evidenced by Brennan and Bakken's[12] study, which showed that big data research can benefit from nursing theory, terminology, and discipline.

Two studies used big data to reduce health disparities and improve the ability of health providers to meet predictable demand,[11,18] as well as to assess nursing leadership and decision-making. The results showed that big data can create new transformational leaders for nurses to efficiently use 21st-century health systems.

By using new technology and big data, the nurse care coordinator can reduce inpatient and ER visits by 25% and increase outpatient visits by 27%.[19]

Big data can generate evidence-based knowledge that can help patients and health care providers manage cardiovascular diseases, hospital-acquired pressure ulcers, and peripheral venous insufficiency. This could be carried out using electronic health records, allowing nurses and other health professionals to analyze the existing data.[2,4,6] Numerous nurse informaticists use patient information and treat the patient as a whole, taking into account medical and social determinants of health, to create a thorough discharge plan for acute life patient care.[22] Bridging the information gap between data science analysis and nursing should be a priority.

This review found few studies on big data in nursing. As an emerging field of study with few studies, this review is valuable. The included studies revealed that nurses are not trained to use big data methods. This is a barrier to expanding the value of growing volume, variability, and complexity of data. Big data allows health care providers to generate statistically significant but clinically irrelevant findings from large samples. Broad access to patient data threatens data quality and variability.

5. Implications for future practice, policy, and research

Big data in health care can be used for the analysis of patients' physical and clinical data, which is too large to

Domain	Stifter et al.[14]	Brennan and Bakken[12]	Remus[15]	Founds[16]	Gleason and Dennison Himmelfarb[17]	Procter and Wilson[18]	Hewner et al.[19]	Monsen et al.[20]
Selection Bias	NA	NA	NA	NA	NA	NA	NA	NA
Study design	1	NA	NA	NA	NA	2	1	1
Control for confounders	NA	NA	NA	NA	NA	2	NA	NA
Blinding	NA	NA	NA	NA	NA	NA	NA	NA
Data collection methods	1	NA	NA	NA	NA	2	2	2
Withdrawals and drop-outs	NA	NA	NA	NA	NA	NA	NA	NA
Intervention integrity	NA	NA	NA	NA	NA	2	1	2
Analysis	NA	2	NA	NA	NA	NA	1	1

Note: 1 = strong, 2 = moderate, 3 = weak; EPHPP, Effective Public Health Practice Project; NA, not applicable.

Table 2. EPHPP quality assessment tool for quantitative studies (n = 8).

be analyzed by using conventional data analysis techniques. Future research should address problems when using large data sets. Big data improves health care quality, safety, and outcomes. This can be used to prepare the next generation of nurses and improve patient outcomes through connected health by applying a number of competencies to practical nurses, nurse educators, researchers, and policymakers. Second, using big data effectively, especially functional status, symptom prediction, and quality of life indicators, informs patient-centered care. Big data can improve nursing information systems by collecting, posting, and storing clinical documentation workflows, clinical decision system support tools, nursing documentation maps, and national standard terminologies, as well as data queries and reports. Nurse leaders should sponsor, support, and require clinical system builders and maintainers to integrate standard terminologies, key nursing data, and best practices.

Big data studies can influence health policy and research effectively. Health care organizations should adopt big data as it is essential for their success.

6. Conclusions

Big data can have an impact on nursing, and improvements in patient outcomes, quality, and safety can be achieved. As big data can strengthen the role of nurses in primary care and decrease readmissions of chronically sick patients, it lowers costs. Utilizing patient-centered care improves treatment quality and effectiveness by lowering hospitalizations and enhancing the performance of nurses and patients. Big data can also improve the EBPs of care.

Ethical approval

Ethical approval is not required for this study.

Conflicts of interest

All authors declare no conflicts of interest.

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