Leveraging Electronic Health Record Data for Whole-person Knowledge Discovery

A Dissertation
SUBMITTED TO THE FACULTY OF
THE UNIVERSITY OF MINNESOTA
BY

Grace Gao

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Adviser: Karen A. Monsen, PhD, RN, FAAN
Co-adviser: Madeleine Kerr, PhD, RN

April 2018

Acknowledgements

My heart-felt thanks go to my advisors Professor Karen Monsen, Professor Madeleine Kerr and my committee members Professor Ruth Lindquist, Professor Chih-Lin Chi. Professor Monsen provided the opportunity for me to work with the EHR nursing data from a senior living community. Her guidance is instrumental and critical in the completion of my research project. Professors Kerr, Lindquist, and Chi also consistently offer timely feedback and support for my dissertation. My success in this PhD research is inseparable from their countless work and efforts.

The Robert Wood Johnson Foundation Future of Nursing Scholar program and the School of Nursing at the University of Minnesota have provided generous financial support, leadership development, and academic advice throughout my PhD program. I would like to extend my deepest gratitude and appreciation to both institutions, especially Susan Hassmiller, Julie Fairman, Heather Kelley, Amanda Bastelica from the Robert Wood Johnson Foundation Future of Nursing Scholar program, and Professor Jayne Fulkerson from the School of Nursing at the University of Minnesota.

I also like to acknowledge and thank my family for their loving support to me in this rewarding and challenging journey of my academic pursuit. My loving appreciations go to my husband, Alex, my son, Victor, and my daughter, Michelle.

The best part of my journey is to get to know my God and grow my faith stronger and stronger through His provisions, protection, and blessings…

Dedications

This work is dedicated to my family and my profession.

Abstract

This dissertation presents strengths data capture in electronic health record (EHR) documentation, risk assessment and management using a strengths-based data capture model, and a strengths-based research study within a wellbeing context using de-identified EHR data and a data-driven model. It starts with the description of the current state of documentation of problems and strengths in the EHRs. There exists a gap of strengths data in EHRs that predominantly follow problem-based infrastructure in the healthcare information system, and there are also emerging new data sources that include strengths data in EHRs. Following this trend, this dissertation examines the potential of leveraging the use of a proposed Strengths-based Data Capture Model in health risk assessment and management. This model adds a whole-person perspective including the purposeful use of strengths data as health assets in data capture, aggregation, and person-driven application throughout the process of risk assessment and management. It concludes by a strengths-based research in older adults using a data-driven model to aid data-mining discovery of associations among older adults' strengths, problems, planned nursing interventions, and baseline Knowledge, Behavior, and Status scores using EHR data captured by the Omaha System. By integrating strengths-based documentation, data capture model, and research, this dissertation introduces a cutting-edge data capture model, and creates a platform for continued research and application of a strength-based ontology in clinical practice and electronic system of documentation.

Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

Advancements in information technologies have brought many changes in the clinical documentation process and health information systems (Kuhn, Basch, Barr, & Yackel, 2015). Clinical documentation in electronic health records (EHRs) embedded in health information systems is moving beyond a typical scenario that involves healthcare team members to track and communicate notes about a patient (Kuhn et al., 2015). Accompanied by the integration of healthcare information systems, devices, and mobile devices using existing technology and technology yet to be built, clinical documentation continues to be leveraged as a means for better care qualities and outcomes (Kuhn et al., 2015). Such documentation chronicles a patient's health journey and story as a significant source of the documentation in their records (Slack et al., 2012; Bachman, 2003). In EHRs, among other things, reside joint patient–provider decision making, team collaboration, and care process management (Cusack et al., 2013) that could result in better care based on presentation of clinically relevant data particularly for patients with chronic or complex conditions (Kuhn et al., 2015). What data are captured to describe a patient's health story and experience plays a pivotal role in narrating that story to facilitate health care delivery and management, maximize healthcare outcomes, and minimize healthcare costs.

A patient's health and care story is often situated in the broader social landscape where healthcare takes place. The unprecedented increase in the aging population and in older adults aged 65 and over (The U.S. Department of Health and Human Services, 2016; Colby & Ortman, 2014) brings along the concomitant increase in the prevalence of

chronic illness and associated costs in healthcare (Gerteis et al., 2014; Institute of Medicine [IOM], 2012). As a growing number of the population lives longer with chronic diseases, living well with chronic illness is becoming a growing focus in the healthcare arena (IOM, 2012; HHS, 2016). Living well as conceptualized by the Institute of Medicine (IOM) is related to all dimensions of physical, mental, and social wellbeing (IOM, 2012). However, the predominant infrastructure in EHRs is constructed upon a problem-based framework (Kuhn et al., 2015; Fung, McDonald, & Srinivasan, 2010; Campbell, 1998; Dick & Steen, 1991) that concentrates on problems and the deficits and negative aspects of an individual's health, and omits strengths and the positive aspects along an individual's health spectrum. This information structure presents a data gap in the capture of strengths and wellbeing. Leveraging the use of a person's strengths to living well is an innovative approach to promote health and wellbeing in clinical practice and documentation (Monsen, Holland, Fung-Houger, & Vanderboom, 2014; Monsen, Peters, Schlesner, Catherine, & Holland, 2015). Such an innovative approach adds a person-centered, strength-based ontology to depict a patient's health and care that requires adequate data capture in clinical practice and documentation.

A strengths-based approach takes on a whole person perspective and represents a new way of thinking in nursing care (Gottlieb, 2013). It focuses on leveraging the use of the positive, the potential, and what is working to address problems and deficits to capitalize and mobilize strengths to support health (Gottlieb, 2013). This whole-person approach in patient care presents a novel way to support healthy aging and healthy living in chronic illness management (Monsen et al., 2015) and complements the dominant problem-based paradigm in EHRs.

A strengths-based perspective requires new sets of structures to be articulated and a new language to communicate (Gottlieb, 2013). Such a strengths-based ontology encourages and enables data representation over a full spectrum of health and illness in the health journey that facilitate individuals with chronic conditions to live well (Monsen et al, 2014; Monsen et al., 2015; Gao, Kerr, Lindquist, & Monsen, 2016). A whole-person based nursing approach that was once embedded in the nursing process of individual care, in contrast to the problem-oriented medical practice, is receiving a refined application in this dissertation as it is realigned with the goal of living well for individuals with chronic illness (Institute of Medicine, 2012; The U.S. Department of Health and Human Services, 2016). By describing current EHR documentation related to strengths, a strengths-based data capture model, and strengths-based research, this dissertation provides new aspects of data attributes for constructing information and knowledge of health data that pioneers a new trail following whole-person oriented nursing practice and documentation.

This PhD dissertation, therefore, compiles three manuscripts on the topic of strengths related to clinical documentation, data capture, and a research study using a data-driven model. The first manuscript presents a critical review and examination of the current state of EHR documentation pertaining to problems and strengths. This review identifies the problem-based framework as the predominant infrastructure in EHRs that leads to a gap in data capture to build a whole-person account of a person's health and care of health. This review also illuminates emerging strengths data sources and research findings of strengths data capture as a complement to problem-based documentation in EHRs.

Following a scan of the current state of clinical documentation of patient problems and strengths in the first manuscript, the second manuscript illustrates a strength-based data capture model for risk assessment and risk management in clinical documentation. This model explores the potential of an innovative perspective that encourages and enables use of whole-person data including strengths at the individual level and, in aggregate, at the population level for the development of strengths-based population health metrics that will promote evaluation of person-centered, data-driven care, outcomes and value.

A third manuscript is a research study that further explores associations among older adults' strengths, problems, planned nursing interventions, and baseline Knowledge, Behavior, and Status (KBS) captured by the standardized terminology, the Omaha System, using de-identified EHR data and a data driven model. Limited research has been found in this area. This study provides new nursing knowledge related to whole-person based nursing practice in improving chronic care management within a wellbeing context, a quality of life indicator. This research discovered some associations among group characteristics based on strengths and problems, planned interventions, and baseline KBS status. The results of this study offer a new insight and potential in the use of a strengths-based ontology to facilitate the nursing process and discourse, and inform person-centered care practice and whole-person documentation. This research contributes cutting-edge knowledge of older adults' strengths to nursing care and lays the groundwork for future studies in an area that fosters individuals' strengths to support a well-lived health experience in chronic illness management of the aging population.

This PhD dissertation is concluded by a chapter of synthesis and interpretation of overall findings that integrate content of all manuscripts to illustrate a unifying theme, discuss the new contribution of the full set of findings to the body of science, and explain the importance of the manuscripts in relation to the main topic. In addition, direction for future research and implications of results for nursing practice are identified.

Chapter 2 Special Content – Documentation of Patient Problems and Strengths in Electronic Health Records

(Published on Internal Medicine: Open Access, 6: 221doi:10.4172/2165-8048.1000221 @ https://www.omicsonline.org/open-access/documentation-of-patient-problems-and-strengths-in-electronic-health-records-2165-8048-1000221.php?aid=75099 on June 23, 2016.

Abstract

Background: A whole-person representation captures not only patient problems but also patient strengths. To better understand and inform practice of person-centered care and documentation using a whole-person representation, a critical review of literature was conducted of the current state of patient problems and strengths documentation in electronic health records.

Methods: The informatics model of Data, Information, Knowledge and Wisdom is employed to develop this critical review. Two scientific databases were used to conduct a systematic search: CINAHL and Ovid Medline with the following search terms: strength*, problem*, whole person, wellbeing or well-being, electronic health record*, personal health record*, EHR*, and PHR*. 602 articles were returned. All articles were screened through review of titles, abstracts, or full texts. 24 articles were selected for this review.

Results: Four themes have emerged from this critical review. They are individual or cross-institutional use of problem-oriented EHRs, extension of problem-based EHRs with other integration, patient-centered integration of the problem-oriented EHR build, and construction of a whole-person representation to include strengths in the EHR documentation. The vast majority of articles focus on problem-based diagnoses and practices. Early reports of strengths documentation were found using a standardized interface terminology and ontology, the Omaha System. Results of two studies demonstrated the feasibility of using the Omaha System for whole-person documentation to capture perception of both problems and strengths.

Conclusion: Clinical information in EHRs is typically structured by problem-based diagnoses; however, there is emerging documentation of formalized strengths attributes using the Omaha System, which may promote a holistic approach to clinical practice and documentation using a person-centered, strength-based ontology.

1. Introduction

Electronic health records (EHR) document a patient's health history and encounters in clinical care and are strategically sought after as a vehicle for effective health management and efficient health service delivery to individuals and populations alike. Professional, industrial, and governmental recommendations and policy mandates drive the focus on EHR attributes.[1,2] The U.S. Centers for Medicare and Medicaid Services has created criteria for EHRs to meet the Meaningful Use guidelines and incentives.[2] Certification of EHR systems with defined sets of requirements for functionalities and features is also available from professional and industrial organizations.

The commonly accepted clinical information ontology to describe a patient in EHRs is based on a problem-oriented system thinking and design following the pioneer work of Dr. Lawrence Weed in the field of medical informatics.[3,4] Dr. Weed proposed a method of organizing the problem list as the center of medical records to create a system of patient care solutions.[5] Since its conception in the late 1960s, the problem list has received both professional and governmental recommendations and policy mandates as a standard in patient care records.[6-9] The Institute of Medicine (IOM) recommends use of a problem list for care providers. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires a summary list, which is interchangeable with a problem list, as an element of a complete medical record. One of the core measures in the Medicare & Medicaid EHR Incentive Program is to maintain an up-to-date problem list of current and active diagnoses.

As a result, contemporary EHRs incorporate the problem-list as the center to build problem-oriented information structure in EHRs. The American Health Information Management Association (AHIMA) defines the problem list as "a compilation of clinically relevant physical and diagnostic concerns, procedures, and psychosocial and cultural issues that may affect the health status and care of patients".[10] Such a definition by AHIMA captures a comprehensive representation of a patient's physical, psychosocial, and cultural issues based on problems. Such a problem-driven framework supplies clinical narration with "pertinent negatives" and "obscuring the more clinically relevant details."[11]

To effectively, efficiently, and safely manage the health and illness of individuals and populations, a call to nursing in recent years to lead the change of healthcare transformation has been made from IOM.[12] A reemerging nursing care model in the healthcare landscape is incorporating a strength-based nursing approach that was once carried out in the nursing process of patient care into the opposite end of the problem-oriented medical practice. Leveraging the use of patient's strengths dated back to the tradition of a holistic nursing diagnosis as documented in a nursing care planning process. A nursing diagnosis of a whole person is not merely problem-based but rather encompasses the "positive energy" of strengths under all problems.[13] The positive outcomes in patient care by finding and using a patient's strengths were demonstrated in the example described in the Nursing Ground Rounds.[14]

More contemporary studies also support leveraging the use of strengths in patient care. A study conducted by Rotegård, Fagermoen, & Ruland recognizes cancer patients' own strengths as a crucial factor to help them get through their illness and encourages

nurses to place a greater focus on bringing forth and supporting patients' personal strengths in their care.[15] A qualitative study done by the same authors investigated nurses' perceptions and experiences of patients' strengths and potentials in oncology care, and their findings reveal three core dimensions of strengths.[16] They are cognitive, emotional, and physical strengths. The study results indicate that nurses want to better utilize patients' strengths and need the clinical and organizational support for this type of care practice. Studies also suggest that patients want their strengths and inner resources to be utilized by care providers.[15,17]

As contemporary healthcare consumers drive the paradigm shift of healthcare toward a whole-person, person-centered approach in patient care, getting and describing patient stories requires a full representation using a person-centered ontology including consumer health vocabulary and language with a focus on both problems and strengths. Unconventional ways are explored beyond conventional medical routines with further recognition of meanings embedded in patients' situations through the practice of narrative medicine.[18] This proposed practice encourages not only a care provider's expanded capacities to perceive but also the increased capacities to capture and represent what is perceived, so that what might remain out of awareness becomes available to enhance and enrich the patients' experiences and their stories, symbolized by the metaphor of the activated cellular membrane for an effective clinician and patient contact.

The lack of clinical representation of patient values, health goals, and action plans in an EHR hinders health care providers from offering respectful, ongoing self-management support to patients.[19] Both strengths and vulnerabilities of individuals and populations need to be considered and made visible when taking a patient-centric

approach in health care.[20] Patient-centered care involves all the coordinated systems that cover medical, behavioral and social domains. Similar efforts to improve the patient experience in quality improvement and cost maintenance and reduction by using integrated care strategies have also been demonstrated in health systems around the global setting.[21]

2. Purpose

Effective health management of individuals and populations calls for a holistic, person-centered approach in clinical care and documentation. A whole-person representation captures not only patient problems but also patient strengths.[22] Strengths are an integral part of well-being that involves physical, mental, and social dimensions.[23] To better understand and inform practice of person-centered care using whole-person documentation, a critical review was conducted of the current state of patient problems and strengths documentation in EHRs.

3. Scope

As the contemporary healthcare trend shifts toward patient-driven care, patient-focused health journey is taking on the center stage of healthcare management and services that extend traditional health care delivery models with an increased level of information flow, customization, collaboration, patient choice and responsibility.[24] Their accounted experiences should be captured by a patient ontology and reflected in health information systems documented in EHRs. This critical review illustrates the representation of a patient ontology in EHRs using the data, information, knowledge, and wisdom (DIKW) framework originated from information and computer sciences and adopted by the international nursing informatics community.[25] The early version of this

framework conveyed concepts of data, information, and knowledge as described by Graves and Corcoran.[26] This framework was further expanded to include wisdom by American Nurses Association,[27] and theorized with philosophical underpinnings by Matney et al.[25]

DIKW starts with data and the four components in this framework "build upon each other" with increased complexity as it ascends upward from the data concept.[25] In a conceptual description, the relationships as depicted in this DIKW informatics model are as follows: data are used to name, collect, and organize; information is used to organize and interpret data; knowledge is used to interpret, integrate, and understand information; and wisdom is used to understand and apply knowledge to practice with compassion.[25] As denoted by this model, data are the basic building blocks of an information system. Information gives meanings based on data. Knowledge is then further integrated and synthesized using available information gathered through data. And finally wisdom is acquired by knowledge built upon information through data.

A whole-person representation that captures the complete patient health experience and story includes the full spectrum of health from problems to strengths. To develop and use a person-centered ontology to capture patient experiences and stories from reality needs a whole-person representation using data elements to capture both patient problems and strengths. Adequate data representation is necessary to derive meaningful information which can further be used to generate knowledge and offer wisdom of practice based on generated and discovered knowledge. This progressive and cycling process in EHRs records a patient health experience and narrates a patient health story. DIKW framework can be leveraged to structure and capture a patient-centered

health experience and create a person-centered ontology to express and document this health story. The scope of this critical review is, therefore, to uncover patient problems and strengths documentation in EHRs in the context of DIKW framework for organizing and expressing a patient-centered ontology.

4. Search Strategies and Results

Two search strategies were employed to conduct this critical review search. One strategy was to perform literature search in scientific database and the other one was to review reference lists from selected articles to gather additional results. Two scientific databases were used to conduct this systematic search: CINAHL and Ovid Medline. Since the database PubMed overlaps with the database Ovid Medline in this academic setting where the systematic search was conducted, PubMed was used only for limited advance search. The following search terms were used: strength*, problem*, whole person, wellbeing or well-being, electronic health record*, personal health record*, EHR*, and PHR*. Two search limits were applied: English language and year=2000 to current (March, 2016). 602 articles were returned with different combinations of designated search terms.

Both inclusion and exclusion criteria were set for this literature search. The inclusion criteria were to include literature and studies if it was related to utilization and documentation of patient strengths and/or patient problems in EHRs and/or PHRs. The exclusion criteria were to exclude literature and studies if it was written in a language other than English or published before 2000. All articles were screened through review of titles, abstracts, or full texts. Twenty-four articles were selected for this review.

The following diagram adapted from PRISMA 2009 Flow Diagram[28] depicts the search process and results in Figure 1:

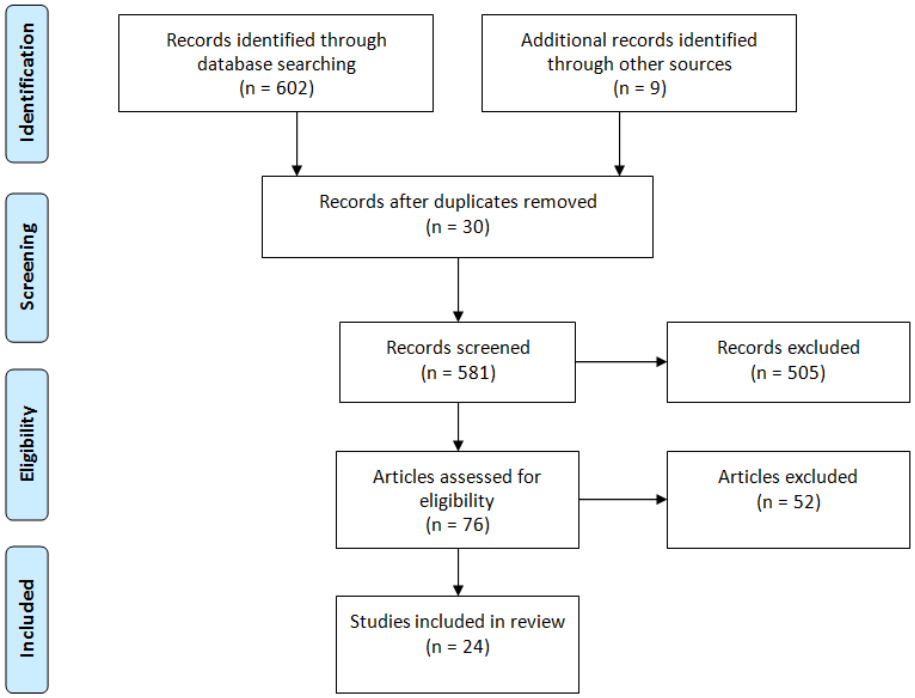


Figure 1. Search Process & Results

5. Findings/Results

As described in Figure 1 above, twenty-four articles were selected for this critical review. The characteristics of selected articles are described in Table 1 below.

Time Period	# of Articles	Journals	Setting	Country of Origin
2000 to 2005	3	Peer-review journals; professional conference proceedings	Clinic; hospital; health system	U.S., Norway
2006 to 2010	7	Peer-review journals; professional conference proceedings	Clinic; hospital; health system	U.S., Belgium, Canada, Taiwan, Germany, Malaysia
2011 to March, 2016	14	Peer-review journals; professional conference	Clinic; hospital; health system; residential facility	U.S., Japan

Time Period	# of Articles	Journals	Setting	Country of Origin
		proceedings		

Table 1. Selected Article Characteristics

Four themes have emerged from this critical review. They are individual or cross-institutional use of problem-oriented EHRs, extension of problem-based EHRs with other integration, patient-centered integration of the problem-oriented EHR build, and construction of a whole-person representation to include strengths in the EHR documentation.

The vast majority of articles under this review reveal that clinical documentation is framed under a problem-oriented approach and focus on problem-oriented clinical documentation in EHRs since the early years of EHR development and implementation during this review period. This problem-oriented EHR approach is also evident in the global setting. Under this broad representation, studies differ in the focus and scope around this medical/health informatics framework. There appears later on during this review period a contemporary trend that moves toward the extension of a problem-oriented EHR with the integration of a person-centric architecture and ontology into EHR systems. New meanings are also given to accompany the shifting trend toward person-centered care by introducing a strength-based model in the whole-person patient care and documentation. Table 2 below lists these themes and studies corresponding to these themes.

Reference #	Theme
1; 29; 30; 31; 32; 33; 34; 35; 36; 37; 38; 39; 40; 41; 42	Problem-based EHRs in an individual institution or cross-institutions
43; 44	Extension of problem-based EHRs
19; 45; 46	Patient-centered integration of problem-based EHRs

Reference #	Theme
22; 47; 48; 49	Whole-person representation in EHRs with the inclusion of strengths documentation

Table 2. Themes and Studies

5.1. Problem-Based EHRs in an Individual Institution or across Institutions

Under this critical review, the majority of articles (15 articles) address computerized problem lists as the central foundation of electronic medical records (EMR) and EHRs in an individual institution or across institutions. These articles acknowledge problem lists as a key part of EHRs. Studies are carried out to explore different issues around problem-lists in a problem-oriented EHR system. Issues falling into the category of EHR systems in one institution or across institutions in this critical review include building a framework/model for problem-orientated patient records,[29,30] developing EHRs based on a problem-oriented system,[31] investigating representations of standardized terminologies for problem lists,[1,32,33] designing methods to automate or generate patient-specific health problem lists,[34-36] creating ways to improve the use of the problem list by healthcare teams to improve compliance to governmental policy mandates such as the Meaningful Use requirement for problem lists in EHRs,[37,38] examining the use of problem lists within other clinical contexts,[39,40] exploring clinician attitudes toward the use of electronic problem lists.[41,42]

This review also suggests that standardized terminologies such as the Systematized Nomenclature of Medicine (SNOMED), the International Statistical Classification of Diseases and Related Health Problems (ICD) are used to capture the problem list and studies are conducted to evaluate and cross-compare standardized terminologies for their representation of problem lists and the associated

implementation.[1,32,33] Studies are often performed to automate, generate, implement, improve, expand, and evaluate problem lists in EHR pertaining to clinical care qualities and outcomes.[34-38] The development of EHRs is closely associated with the health care policy-making and policy execution such as the Meaningful Use.[37,38] Problem-based EHRs have also been implemented nationally in the international setting such as in Norway, Belgium, Japan and Canada.[29-31, 35]

Bayegan & Nytro proposed a two-layer framework for the construction of problem-orientated patient records to facilitate better patient care by mostly referring to record systems from Norwegian primary care patient record systems.[29] This framework has a knowledge-based model to capture physicians' way of thinking and working, evaluate information use and needs and a relevance model to provide relevant support for content and usage in the system. The authors develop and merge three ontologies for this framework. They are a process ontology for the primary care workflow, a patient record ontology for the rendition of the patient record content, and an information ontology connecting the process ontology and the patient record ontology. This framework supports better utilization of information in the patient record to support continuity of care, eliminate redundant and confusing information, and offer easy review of and better access to its content. However, this proposed framework has not been applied and tested, and so its applicability is not fully established. In addition, this framework is based on patient record systems in Norwegian primary care service, and so the generalized usability is in question in the EHR of a healthcare system in other setting.

De Clercq measured the agreement between a problem-oriented conceptual model and the ways this model was implemented in 17 Belgian general practitioners' (GPs)

electronic patient records systems.[30] This study used an original discriminating method to assess the implementation of the problem-oriented conceptual model. This model has six concepts including Health Care Element, Health Approach, Contact, Subcontact, Service, and Health Agent. Two evaluators evaluated each implementation and assigned the final result with a success or failure score within the scope of the official Belgian accreditation procedure for GPs' electronic patient records within almost all Belgian GPs' 17 software systems. The study results suggest that the problem-oriented conceptual model was successfully implemented within 65% of the software systems. The study concludes that a problem-oriented conceptual model can be successfully implemented and its quality can be assessed in many operational EHR systems. The results also have an international implication in the improvement of semantic interoperability between patient information systems. However, since this problem-oriented conceptual model is specific to the Belgian general practice, it may not fully applicable in other health systems in different countries. The methodology used to evaluate the implementation may also require further examination for its appropriateness for EHR systems in other settings.

Steindel conducted a comparison of approximately 5,000 terms in the July 2009 Clinical Observations Recording and Encoding (CORE) Problem List subset of SNOMED–Clinical Terms (SNOMED CT) to terms in ICD-10-Clinical Modification/Procedure Coding System (ICD-10-CM/PCS).[1] Results showed that 6% of the CORE Problem List terms were not found in ICD-10-CM/PCS; 69.1 % had equivalent ICD-10-CM/PCS terms; 13% of terms could be used with acceptable partial clinical precision; and 11.9% of terms required rule-based mapping. This study results suggest that ICD-10-CM/PCS meets the intended design goal of increased clinical

precision but studies are needed to precisely define the depth of coverage. As the author states, site-specific clinical needs may determine the selection of a certain set of standardized terminology. This study offers certain general guidance, and yet its institution-specific guidance is lacking.

Wasserman & Wang investigated the representation of the standardized terminology SNOMED CT for problem lists within a computerized physician order entry (CPOE) system in the EHR implemented at the 820-bed Cedars-Sinai Medical Center.[32] The authors evaluated the breadth of SNOMED CT terms and concepts for the coding of diagnosis and problem lists by clinicians for each patient admitted into the hospital during a four-month period. The study results showed that the majority of diagnosis/problem list terms about 88.4% were found in SNOMED CT with 98.5% concept coverage after taking into considerations of other missing terms. This study suggests that SNOMED CT is a relatively complete standardized terminology that could be utilized as a vocabulary to construct the clinical problem list. As this study describes, the clinical representation of patient problems were derived from both structured and unstructured texts through a data extraction process. Hospital-specific terms and other terms not represented in SNOMED CT were also taken into considerations. This process indicates that a standardized terminology such as SNOMED CT is constantly evolving as well as problem lists that need to be represented by a standardized terminology. It demonstrates the need for a patient-centric problem list. However, this study does not discuss the integrity of collected data and thus it may affect the accuracy of terms evaluated for this coverage.

Fung and Xu commented that SNOMED CT is becoming an internationally recognized health terminology standard for encoding clinical information in EHRs.[33] They conducted a study to evaluate the coverage of its CORE Problem List Subset and its growth pattern using the eight problem list datasets from the CORE Project that covered about 18 million patients mostly in the U.S. institutions. They did a "leave-one-out" analysis of the eight current CORE Subset datasets to evaluate frequently used terms and the corresponding usage of the covered terms. A retrospective experiment was done to study the growth pattern and examined the relationship through linear regression between the size of the starting subset and the coverage of frequently used terms in the incoming dataset. The study results indicate that in the left-out dataset, the CORE Subset covered 80.3% of the frequently used terms with 83.7% term usage of the covered terms. A significant positive correlation was also demonstrated between the CORE Subset's size and the coverage of the frequently used terms in an incoming dataset that implies a slower growth of the CORE Subset as it gets bigger. The study concludes that the CORE Problem List Subset is a useful resource for the SNOMED CT implementation in EHRs with good coverage of frequently used terms and a high proportion of term usage. However, this study may possess data selection bias. It considers only the most frequently used local terms with 95% term usage that can be mapped to SNOMED CT.

Wright et al. developed 6-step, replicable, automatic methods and knowledge base for inferring patient problems targeted at 17 conditions by developing and validating a set of 17 rules using structured data based on both clinical and billing information such as medications, laboratory results, billing codes, and vital signs.[34] This study was conducted by performing association rule mining on coded EHR data from a sample of 100000

patient records at the Brigham and Women's Hospital in Boston, Massachusetts. Results validation using 100000 randomly selected patient records indicated a better overall performance using the inference rules than using either the problem list or billing data alone. These rules can be applied to clinical decision support, care improvement, augmentation of the problem list, and patient identification for cohort research. However, this study also poses certain limitations in data selection for problems. The problems are based on a gold standard that selects problems documented in clinical data which may imply some misclassifications and thus it would influence the analysis results. In addition, some problems also have a selection bias according to association strength between labs and medications.

Poissant et al. suggest that health problem lists are a key component of EHRs and are useful for best clinical practices and optimal patient safety.[35] They conducted a study to assess the accuracy of a novel approach to create an inter-institutional automated health problem list in an EHR generated from three integrated sources of information for ambulatory patients in the Canadian province of Quebec with 7.5 million residents who have access to a public health insurance program. These three sources were diagnostic codes from medical services claims, therapeutic indications from electronic prescriptions, and single-indication drugs. Data were collected from 121 general practitioners and medical services provided for 22248 of their patients. Results suggest that automation of an inter-institutional problem list added over half of all validated problems to the health problem list and could provide timely access to accurate and relevant health problem information with accelerated uptake and use in the EHR. This study is performed in a

national health system in Canada, and so its generalizability to other settings remains a question.

Wang et al. mentioned that problem lists are essential to EHRs.[36] The authors developed and implemented a problem list dictionary and search algorithm, and they also evaluated its use in several EHR systems by assessing overall coding rates of a sample of 10000 problem entries from each system at an integrated delivery network, Partners HealthCare System in Boston. Results suggest that the overall coding rate varied significantly between different EHR implementations between 63% and 79%. Three most frequent reasons for uncoded entries were related to user interface failures which accounted for 44% to 45%, insufficient dictionary coverage from 20% to 32%, and non-problem entries between 10% and 12%. When entries were coded, they were always appropriate at 99%. This study suggests that the problem list dictionary and search algorithm demonstrates a good coding rate, but the specific user interface implementation influences the variation in problem coding rates. On the other hand, this study was carried out in an integrated health delivery network, so the lack of consistent coding by clinicians using different EMRs may affect data collection and thus results.

Bakel et al. pointed out that the problem list in EHRs is a considered incentive criterion for the Meaningful Use and theses authors conducted a quasi-experimental, time series quality improvement study to investigate the use of a series of interventions on the outcome of 80% of medical and psychiatric inpatients with a problem added to the problem list before discharge in the Children's Hospital Colorado.[37] The study results suggest that significant increases happened with inpatient problem list usage by both medical and psychiatric teams after initiation of these series of interventions in this study

and the outcomes met the quality improvement goal designated by the Meaningful Use for greater than 80% of inpatients to have a problem list at discharge. This study also encounters some limitations. A data selection bias is shown due to lack of accuracy verification about the problem list. The intervention is conducted at one site and so its generalizability to other locations is not fully established.

Pacheco, Thompson, & Kho originally developed and validated an algorithm to identify type 2 diabetes cases in the EHR to support clinical research and it was reapplied to identify problem list gaps by examining the problem lists the algorithm identified and determining the absence or presence of a structured code for diabetes within the Northwestern Medicine Enterprise Data Warehouse from 36 source systems.[38] The study findings suggest that a corresponding structured code was present in the problem list for over half of patients identified by the algorithm, which failed to meet the threshold of Meaningful Use guidelines for a patient's problem list. The authors conclude that the application of such algorithms in EHR could fill gaps in the problem list omissions and help meet Meaningful Use requirements. However, since this study was done by using an Enterprise Data Warehouse, the generalizability of the study findings is limited beyond this setting. A significant proportion of data used from this Enterprise Data Warehouse is captured as structured elements, and hence the processing of unstructured data elements needs to be considered for the application of such algorithms in this study to other settings.

Banerjee, Gambler, & Fogleman carried out a two-step study to evaluate how often obesity presented on the problem list and whether the addition of obesity to the problem list would affect the frequency for it to be addressed in a patient's future visits at

an urban family medicine residency office.[39] After the first step of assessment to determine how often obesity appeared on the problem list, a randomized controlled trial of patient records was pursued after the intervention of adding obesity to the problem list to evaluate whether this intervention would affect the rate of addressing obesity in a patient's future visits. The results show a significant relationship between the addition of obesity to the problem list and addressing obesity at future visits by providers. The study implies that this intervention has the potential to change provider behavior with the automatic assistance in EMR. However, this study is performed at one site and it can limit the generalizability of its findings. The study also uses the encounter form diagnosis as an indication for addressing obesity and it lacks a specific description as to how the issue is addressed by provider.

Van Vleck et al. indicated that the generation of a patient history summary in the EHR was commonly created based on the patient problem list.[40] In their study, the authors studied the use of problem lists within other clinical context by analyzing the structure and content of the Past Medical History (PMH) sections in a collection of 7673 initial visit notes obtained from the Columbia University Medical Center Milstein Hospitalist Service for inpatient admissions of all types from late 2006 through early 2007. Their study results demonstrate that physicians tended to describe several semantic types of information in addition to problems when documenting patients' history. Related concepts were also grouped in a single line in the PMH. On the other hand, traditional problem lists were captured by a simple list of coded terms. Content analysis reaffirmed the value of more complex representations with valuable data and guidelines for automated generation of a clinical summary. However, the data source in this study

comes from the initial visit notes upon admission from a hospitalist service, and so there is a lack of differentiation by diagnosis and specialty for a more complex representation of clinical summary generation.

Wright, Maloney, & Feblowitz did an ethnographic study of healthcare providers' attitudes towards the problem list using grounded theory methods from April 2009 to January 2010 among academic and community outpatient medical practices in the Greater Boston area.[41] The study results indicate that healthcare providers' attitudes towards the problem list varied and were categorized into nine themes. These nine themes were workflow, ownership and responsibility, relevance, uses, content, presentation, accuracy, alternatives, support/education with one cross-cutting theme of culture. This study concludes that there were significant variations of clinician attitudes towards and use of the electronic patient problem list, which requires clearer guidance and best practices for problem list utilization. However, this study is also done in one health system, and so the transferability of its findings to other settings is limited.

Holmes et al. conducted an observational cross-sectional qualitative study to explore hospital practitioner opinions towards the problem list and the logic that drives their decisions in their clinical situations at two major Boston teaching hospitals.[42] Data were collected through in-person interviews and an online questionnaire. Vignettes of clinical scenarios were used to frame questions about practitioners' preferred actions towards the problem list. Data analysis results agree with prior research that practitioners demonstrated different opinions about the problem list management, but this study results also indicate a common approach among the majority of practitioners. In addition, basic demographic characteristics of providers did not strongly affect their attitudes towards

the problem list. The results also indicate that defined problem list policies and EHR tools are needed to formulate a common approach to guide the creation of accurate problem lists over time. This study also shows some limitations with the sample selection. The sample is convenient and limited to practitioners at two affiliated, academic medical centers, and so the sample lacks representativeness to produce generalizable results.

Problem oriented EHR systems are adopted and implemented internationally. Uto et al. described that problem-oriented EHR systems are recommended in the clinical guideline in Japan.[31] In their article, the authors described a system function that allowed all professionals to document and share the patients' clinical information including patient problems chronologically as an identical record in a hospital information system. This system function is implemented in an EHR system in Japan and its applicability is limited to the settings in other locations.

5.2. Extension of Problem-Based EHRs

Two articles under this review discuss the expansion of a problem-based EHR system by integrating other area of care activity. Englebright, Aldrich, & Taylor described incorporating basic nursing care for hospitalized adult patients through the implementation of a 170-bed community hospital EHR located in the central US.[43] The results of this effort integrate the use of a standardized terminology, the Clinical Care Classification (CCC), into the hospital EHR to capture 9 basic nursing care activities with 1 additional basic nursing care activity identified following the pilot implementation in the EHR. The results of this project show how to define the concept of basic nursing care and distinguish it from the interdisciplinary, problem-focused plan of care. This project also indicates that the use of EHR can facilitate communication and documentation of

basic nursing care elements and improve nursing process. However, this project attempts to define basic nursing care for adult patients in a hospital setting, and so the definition was limited to the adult population in this setting. Moreover, the testing of this project was conducted in an EHR at a single hospital, and thus the generalizability of its results is also limited.

Rosenberg described in her article the adoption and implementation of Jean Watson's Theory of Caring in the EHR for clinical nursing staff to document the patient experience using a language specific to nurse caring relations and its many meanings in a Chicago-based eight-hospital healthcare system.[44] The development of this new nursing clinical context in documentation occurred during an extensive clinical documentation system upgrade in the EHR. During this project, available standardized nursing terminologies including NANDA, NIC and NOC were reviewed. When a documentation terminology does not exist within the current taxonomies to document the patient experience that incorporates the context of an applied theory in nursing care, the author encourages nurse leaders to take an active role in developing new terminology when needed to capture the expression of the patient experience. The development of this system-wide documentation terminology for nurses to capture the patient experience using a theoretical framework is institution-specific, and so its generalizability and relevance to other institutions needs to be reevaluated for their own settings.

5.3. Patient-Centered Integration of EHRs

Three articles in this review consider patient-centered integration of an EHR system. Almunawar et al. recognize the need to include patients as partners in care.[45] They propose a novel, holistic representation of health data by reorganizing and

extending EMRs with Web 2.0 features for a patient health record with the additional incorporation of personal and social dimensions. They name this new representation electronic health object (EHO) to increase patient interactivity in health care systems. The EHO includes three objects. They are medical objects, social objects, and personal objects that work together to facilitate interactivity. Individually, social objects build clinic social networks for patients to share their health experiences; personal objects create a personal space to strengthen patients in generating personal health habits; and medical objects allow patients to view their medical records. This framework addresses the emerging need for interactivity among patients and providers by preserving and extending existing EHR data and empowers patients to be active partners of health care services in health care processes. This article describes implementing EHO with Clinic 2.0. However, no specific discussion is made about testing and its related results. So the applicability of this model is still at a conceptualized stage. This platform also raises privacy and security concern related to sensitive personal and health information.

Li et al. suggest that a more patient-centered approach to EHR is emerging around the globe accompanied by increased patient access and personal use of EHRs.[46] This trend makes patient empowerment an important issue of EHRs. In this study, the authors synthesized comprehensive, empirically-based conceptual models of EHR for personal use by reviewing prior papers or case-studies for EHR systems used or designed for nation-wide use. They identified 3 models, including the inexpensive data media model, the internet patient portal model, and the personal portable device model with their own recognized strengths and weaknesses. They also synthesized a new behavior of personal use of EHRs, which is referred as Business (Provider) to Customer (Patient) and

Customer (Patient) to another Business (Provider) with last process as optional (B2C(2B)). This model allows patients to access their provider EHR and to share it with another provider if they choose. The authors believe this model looks promising according to their study. Since this study reviews papers designed for nation-wide use, it may limit its generalizability of its findings to other different settings.

A drive to patient-centered care has also emerged in other areas of EHRs. Chunchu & Mauksch conducted a one-year, experimental, prospective cohort study to evaluate an EHR-based patient centered care plan (PCCP) in improving collaborative self-management planning in a family medicine residency clinic.[19] Results suggest that PCCP facilitates patient engagement in support of chronic illnesses self-management in goal setting and action planning. The authors state that "EHR design that stores patient values, health goals, and action plans may strengthen continuity and quality of care between patients and primary care team members" (p.199). However, this study encounters several challenges that reduced the sample size and hindered a robust assessment of the patient experience, and thus it may affect the full optimization of PCCP and study findings.

5.4. Whole-Person Representation Including Strengths

Four studies in this review explore the inclusion of strengths in nursing care documentation. In their study, Monsen et al. looked at the feasibility of using a standardized terminology, the Omaha System, for documenting wellbeing in EHRs using strengths indicators and signs/symptoms data from 5 seniors living facilities in a residential community.[22] Using concept mapping techniques, this study mapped the Omaha System to the Wellbeing Model constructed for nursing documentation in a

strength-based wellbeing assessment located in the EHR. The feasibility was also assessed of using the Omaha System to describe strengths and needs of the senior population based on this assessment. The study results suggest that problem concepts with more signs/symptoms had fewer strengths and the ratio of strengths indicators to signs/symptoms was 6:1 with a range between 2.8 and 9.6. This study concludes that the Wellbeing Model and the Omaha System have potential to capture a whole-person perspective to document strengths and wellbeing for a senior population in community. However, this study also described the challenge of accessing the wellbeing data in the EHR during the software development for this study and it may exert some impact on the study results.

Another retrospective secondary analysis study done by Monsen et al. examined the feasibility of using the Omaha System to classify strengths of older adults with chronic illness by mapping 421 codified strengths phrases to the Omaha System concepts from existing narratives of 32 older adults with 12 to 15 comorbid conditions.[47] Exploratory analysis in this study demonstrated unique strengths profiles for 30 of 32 patients and showed the feasibility of using the Omaha System to describe strengths of patients with chronic illness. The study concludes that there is a potential to capture the perception of both problems and strengths by using the Omaha System as a whole-person assessment tool for nursing care and documentation. However, this explorative analysis is based on a limited sample dataset to detect patterns in strengths data, and therefore the representativeness and generalizability of the findings is limited.

Rotegaard & Ruland conducted two studies to explore the representation of patients' strengths and perspectives which they developed for a health assets conceptual

model in a standardized nursing vocabulary, the International Classification of Nursing Practice (ICNP).[48,49] They cross-mapped the core concepts of this health assets conceptual model that has a focus of care for wellness outcomes to ICNP Version 1.0/1.1 in their first study and the concepts of this health assets conceptual model to ICNP Version 2.0 in their second study.

Their first study found that most of the health asset terms in the conceptual model were captured in ICNP on a global level. However, a complete set of health asset terms is needed in ICNP to provide optimal support of nursing care and patient self-care.[49] The second study found that ICNP captured 33 of 76 health assets concepts/terms with several other health assets categories and subcategories embedded in the descriptors of other ICNP concepts/terms.[48] The study also detected a lack of a number of positive statements in some ICNP terms to represent the health assets approach and a patient's strength perspective. The authors conclude that the inclusion of additional health assets concepts in ICNP would reflect and support patient-centered nursing care. However, the proposed heath assets model is a conceptual model that needs to be tested in practice and mappings to ICNP need to be further validated.

6. Discussion

As indicated in the findings, from the early stage on during the time period of this review, the majority of studies demonstrate that the four components of data, information, knowledge, and wisdom depicted in the DIKW informatics model are structured on a problem-oriented basis to document a patient health encounter. Data used for naming and organizing to further build information for a patient health story appear to unfold around patient problems. Likewise, knowledge developed from interpretation, integration, and

understanding of information as well as wisdom used to understand and apply knowledge to practice with compassion by providers follow the same problem-based encounters and events, which ultimately are employed to construct a problem-focused plot and resolution with providers as the persona of narration in this patient health story.

Under this problem-based representation of a patient health experience, these articles reveal a few recurring topics in literature around problem lists in EHRs. Problem lists as the central component of modern EHRs are finding various ways in their standardized representation, automation, generation, implementation, improvement, and evaluation to support continued sequences of care and better patient care solutions in a patient health journey.[1,32-36] In the EHRs, standardized terminologies such as SNOMED and ICD are used as structured vocabulary to describe a patient's problems.[1,32,33] Mappings to such standardized problem vocabulary are studied to facilitate automated interpretation of problem data, information exchange among providers and administrative sources. These various ways demonstrate that problem-oriented records are aimed to enable better knowledge management, and so methods and strategies in research are utilized to move in that direction.

However, even though a problem list should cover any concept from a comprehensive spectrum of issues as recommended by AHIMA,[10] the studies from this review suggest a medical and clinical representation of a patient's problems as captured by the standardized terminologies in SNOMED and ICD.[1,32,33] Within this scope, it appears that there is no universal representation of diverse problem lists. The development and implementation of problem lists are carried out by individual institutions or cross-institutions. Problem-lists are enterprise-specific in US, which agrees

with what is reported in literature that the content and utilization of the problem list vary from institutions and providers.[1,50] Therefore, at the data level, no consistency is established, and consequently, diverse information is documented in the EHR and knowledge management is operationalized based on an enterprise-selection of problem list sets. Even though efforts are pursued to move beyond a singular representation pertaining to an enterprise and rules are developed purposefully to generate to a more universal setting as reported in the studies under this review, [30,32-35] work in this area appears to be disjointed and lack of coordination as suggested in literature.[4]

In addition, using terminologies with partial or inadequate coverage as suggested in several studies[32-38] limits a complete representation of data and information pertaining to the expression of a patient's health encounter. The inconsistency across enterprises and a lack of a full data representation in an individual institution or across institutions around the problem list point toward inadequate knowledge database and management with regard to a full description of a patient health experience. As a result, structuring EHRs around a problem list poses its own problems and efforts are sought to expand beyond a problem list as what is revealed in the later period of this review.

Toward the middle part of the time period covered in this review, two articles suggest an expansion of data naming and organizing beyond a problem-based representation by incorporating other areas of care into a problem-based EHR.[43,44] Both articles describe the extension of a problem-oriented EHR with added contents and functions to communicate and document nursing care elements by creating a system-wide documentation terminology to record and express their patient experiences. These projects expand the knowledge database for the documentation of a patient encounter in

supplement of a problem-based EHR. As a result, the patient story has evolved to include more perspectives as more providers become narrators of a patient story.

During the latter time period of this review, three articles demonstrate a patient-centered, patient-specific integration to name and organize concepts into a problem-oriented EHR system.[19,45,46] This trend occurs to merge all the themes around patient-centered care management and delivery around EHRs. These articles examine a holistic representation of a patient health experience and encourage a patient to be the persona of their health story through patient empowerment, engagement, and partnership with providers to record their own health occurrence.

During and close to the same latter timeframe under this review, four articles recount a new emerging wave of migration from a problem-based EHR system to a whole-person representation of problems and strengths in EHR documentation.[22,47-49] Early reports of strengths documentation were found using two standardized interface terminologies, the Omaha System, and ICNP. Results of two studies demonstrate the feasibility of using the Omaha System for whole-person documentation to capture perception of both problems and strengths based on a wellbeing model[22,47] while two other studies examine mappings of strength concepts from a heath assets model to the standardized terminology, ICNP.[48,49] Findings illuminate the merits of a strength-based approach in chronic illness management and wellbeing.

Based on the final emerging trend generated from the themes of this review, there is a potential to achieve the person-centered goal by creating a person-centered ontology from an integrative perspective with the use of standardized terms to capture both needs-focused and strengths-based care and documentation. Formalized strengths attributes

using a whole-person approach is a novel development in standardized terminologies.[22,47] Utilizing a strength-based ontology may equip individuals with personalized strengths, potentially leading to better individual health management and population wellbeing. This patient-centered, strength-based ontology can build the four components of data, information, knowledge, and wisdom in the DIKW informatics model around a whole-person representation with a robust and improved knowledge management system that includes both problems and strengths for optimal patient care and outcomes. As Cimino points out, "clinicians should recognize that current EHRs are illuminating the opportunities for the next generation of systems that will support clinicians as active partners across the spectrum of healthcare settings and tasks" (p.992).[11] The next generation of EHR systems looks promising for optimal care and documentation by using a patient-centered, strength-based ontology to support the expression of a patient health story of perpetual self-becoming constructed and narrated from a patient's persona of strengths.

7. Implications

This critical review of literature has implications for theoretical, research and ethical practice in nursing. Based on this review, clinical information in EHRs is typically structured by problem-based diagnoses; however, this emerging documentation of formalized strengths attributes captured by the Omaha System may promote a holistic approach to clinical practice and documentation using a person-centered, strength-based ontology. This strength-based model utilized to develop a person-centered, strength-based ontology offers an innovative approach to nursing care and this area of research has the potential to make significant theoretical and conceptual contributions to the discipline

of nursing. Further nursing research in this area needs to be developed to test and evaluate this emerging patient care and documentation model so that new knowledge of patient care in nursing can be generated and the theoretic and conceptual roles this model plays can be validated in constructing and narrating a patient health story.

As mentioned before, limited research has been found using the Omaha System for whole-person documentation to capture perception of both problems and strengths based on a wellbeing model in the senior living community. No study has been performed to evaluate the effects of this strength-based model on patient wellbeing and patient outcomes. Further studies are warranted to better understand how a strength-based nursing care model could affect an individual's wellbeing, quality of life, and health management. Therefore, one potential area of study is to examine the patient wellbeing and health outcomes in the senior living setting using this strength-based nursing care model to provide illuminating results among strengths, problems, and health outcomes. Findings generated from this area of study could shed light for the results of a strength-based approach in patient care and health management.

When developing and implementing this research, the ethical principle of respect for an individual freedom and autonomy can be used to guide this research process. The ethical principle of respect for autonomy and individual freedom endows a patient the right to receive a full representation of a patient's complete health experience with the patient in the center of care. In the meantime, this ethical principle also supports a patient's right to make informed decision, voluntary participation and to withdraw from the study. Following the same ethical principle, another area to consider is to protect a patient's privacy, confidentiality, and security of the sensitive health information related

to their care and documentation. In addition, the guiding ethical principle of beneficence also applies to this area of research. The research in this area could potentially offer a better health management and delivery solution with demonstration of a direct linkage to better individual health outcome and wellbeing. In return, the research results in this area could be used to help policymakers make informed decisions to benefit both individual and public health.

Using the DIKW informatics model to construct a person-centered, strength-based ontology to capture and document a whole-person health story includes the recordings of health, illness, strengths and problems with a healthy theme leading toward a meaningful and fulfilling ending. To build such a person-centered, strength-based ontology in EHRs requires the integration of both medical problem-oriented practice and nursing strength-based approach in patient care management and delivery. Such ontology encourages the patient to be the true hero or heroine of their health story and enables the full expression of its narration.

References

1. Steindel SJ. A comparison between a SNOMED CT Problem List and the ICD-10-CM/PCS HIPAA Code Sets. *Perspect Health Inf Manag*. 2012;9:1b.
2. HealthIT.gov. EHR Incentives & Certification. https://www.healthit.gov/providers-professionals/how-attain-meaningful-use. (accessed 25 May 2016).
3. Kaplan DM. Clear writing, clear thinking and the disappearing art of the problem list. *J Hosp Med.* 2007 Jul;2(4):199-202.
4. Rothschild AS, Dietrich L, Ball MJ, Wurtz H, Farish-Hunt H, Cortes-Comerer N. Leveraging systems thinking to design patient-centered clinical documentation systems. *International Journal of Medical Informatics.* 2005;74: 395-398.
5. Weed LL. Medical records that guide and teach. *New Engl J Med.* 1968;278:652e7.
6. Fung KW, McDonald C and Srinivasan S. The UMLS-CORE project: A study of the problem list terminologies used in large healthcare institutions. *J Am Med Inform Assoc*. 2010;17(6):675–680.
7. Dick RS, Steen EB, eds. *The Computer-Based Record: An Essential Technology for Health Care.* Institute of Medicine, National Academy of Sciences. 1991.
8. Campbell JR. Strategies for problem list implementation in a complex clinical enterprise. *Proc AMIA Symp*. 1998:285-9.
9. HealthIt.gov. Maintain problem lists. https://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures/patient-problem-list (accessed 10 May 2016).
10. AHIMA Best Practices for Problem Lists in an EHR Work Group: Best practices for problem lists in an EHR. *J AHIMA* 2008;79(1):73–77.

11. Cimino, JJ. Improving the electronic health record: getting what we wished for. *JAMA.* 2013; 309(10):991-2.
12. IOM. *The Future of Nursing: Leading Change, Advancing Health.* Washington, DC: National Academies Press. 2010.
13. Popkess SA. Diganosing your patient's strengths. *Nursing.* 1981;11(7):34-7.
14. Wiley L. (ed.). Nursing grand rounds: finding--and using--your patient's strengths. *Nursing.* 1979; 9(3):40-5.
15. Rotegård AK, Fagermoen MS, Ruland CM. Cancer patients' experiences of their personal strengths through illness and recovery. *Cancer Nurs.* 2012 Jan-Feb;35(1):E8-E17.
16. Rotegård AK, Ruland CM, & Fagermoen MS. Nurse perceptions and experiences of patient health assets in oncology care: a qualitative study. *Research and Theory for Nursing Practice: An International Journal*. 2011;25(4): 284-301.
17. Petera C, Raucha A, Ciezaa A, Geyha S. Stress, internal resources and functioning in a person with spinal cord disease. *Neuro Rehabilitation*. 2012;30:119–130.
18. Charon R. At the membranes of care: stories in narrative medicine. *Academic Medicine.* 2012;87(3):342–347.
19. Chunchu K & Mauksch L. Patient Centered Care Plan in the EHR: Improving Collaboration and Engagement. *Families, Systems, & Health.* 2012;30(3):199–209.
20. Kotoulas S, Sedlazek W, Lopez V, Sbodio M, Stephenson M, Tommasi P, Aonghusa PA. Enabling person-centric care using linked data technologies. *Studies in Health Technology and Informatics.* 2014;205:692-6.

21. Tsasis P, Evans J M, Forrest D, Jones RK. (2013). Outcome mapping for health system integration. *Journal of Multidisciplinary Healthcare.* 2013;6:99-107.

22. Monsen KA, Peters J, Schlesner BS, Catherine EV, Holland, DE. The gap in big data: Getting to wellbeing, strength, and a whole-person perspective. *GAHMJ.* 2015;4(3):31-39.

23. Kreitzer MJ. Spirituality and well-being: focusing on what matters. *West J Nurs Res.* 2012;34(6):707-711.

24. Swan M. Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. *Int J Environ Res Public Health.* 2009 Feb;6(2):492–525.

25. Matney S, Brewster PJ, Sward KA, Cloyes KG, Staggers N. Philosophical approaches to the nursing informatics data-information- knowledge-wisdom framework. *Advances in Nursing Science*. 2011;34 (1):6-18.

26. Graves JR, Corcoran S. The study of nursing informatics. *Image–the Journal of Nursing Scholarship.* 1989;21(4): 227-231.

27. American Nurses Association. *Nursing informatics: Scope and standards of practice.* Silver Spring, MD: Nursesbooks.org. 2008.

28. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med* 6(6): e1000097. doi:10.1371/journal.pmed1000097.

29. Bayegan E, Nytro O. A problem-oriented, knowledge-based patient record system. *Stud Health Technol Inform*. 2002;90:272-276.

30. De Clercq E. From a conceptual problem-oriented electronic patient record model to running systems: A nationwide assessment. *Int J Med Inform*. 2008 May;77(5):346-53.

31. Uto Y, Iwaanakuchi T, Muranaga F, Kumamoto I. Development of the electronic patient record system based on problem oriented system. *Stud Health Technol Inform*. 2013;192:1036.

32. Wasserman H, Wang J. An applied evaluation of SNOMED CT as a clinical vocabulary for the computerized diagnosis and problem list. *AMIA Annu Symp Proc.* 2003:699-703.

33. Fung KW, Xu J. An exploration of the properties of the CORE problem list subset and how it facilitates the implementation of SNOMED CT. *J Am Med Inform Assoc.* 2015 May;22(3):649-58.

34. Wright A, Pang J, Feblowitz, JC, Maloney, FL, Wilcox AR, Ramelson HZ, Schneider LI, Bates DW. A method and knowledge base for automated inference of patient problems from structured data in an electronic medical record. *J Am Med Inform Assoc*. 2011;18:859-867.

35. Poissant L, Taylor L, Huang A, Tamblyn R. Assessing the accuracy of an inter-institutional automated patient-specific health problem list. *BMC Med Inform Decis Mak*. 2010 Feb 23;10:10.

36. Wang SJ, Bates DW, Chueh HC, Karson AS, Maviglia SM, Greim JA, Frost JP, Kuperman GJ. Automated coded ambulatory problem lists: evaluation of a vocabulary and a data entry tool. *Int J Med Inform.* 2003 Dec;72(1-3):17-28.

37. Bakel LA, Wilson K, Tyler A, Tham E, Reese J, Bothner J, Kaplan DW. A quality improvement study to improve inpatient problem list use. *Hosp Pediatr*. 2014;4(4):205-10.

38. Pacheco JA, Thompson W, Kho A. Automatically detecting problem list omissions of type 2 diabetes cases using electronic medical records. *AMIA Annu Symp Proc*. 2011;2011:1062-9.

39. Banerjee ES, Gambler A, Fogleman C. Adding obesity to the problem list increases the rate of providers addressing obesity. *Fam Med.* 2013 Oct;45(9):629-33.

40. Van Vleck TT, Wilcox A, Stetson PD, Johnson SB, Elhadad N. Content and structure of clinical problem lists: a corpus analysis. *AMIA Annu Symp Proc.* 2008 Nov 6:753-7.

41. Wright A, Maloney FL, Feblowitz JC. Clinician attitudes toward and use of electronic problem lists: a thematic analysis. *BMC Med Inform Decis Mak.* 2011 May 25;11:36.

42. Holmes C, Brown M, Hilaire DS, Wright A. Healthcare provider attitudes towards the problem list in an electronic health record: a mixed-methods qualitative study. *BMC Med Inform Decis Mak.* 2012 Nov 11;12:127.

43. Englebright J, Aldrich K, Taylor CR. Defining and incorporating basic nursing care actions into the electronic health record. *Journal of Nursing Scholarship.* 2014;46(1):50-57.

44. Rosenberg S. Utilizing the language of Jean Watson's Caring Theory within a computerized clinical documentation system. *CIN: Computers, Informatics, Nursing*. 2006;24(1):53–56.

45. Almunawar MN, Anshari M, Younis MZ, Kisa A. Electronic health object: Transforming health care systems from static to interactive and extensible. *Inquiry: The Journal of Health Care Organization, Provision, and Financing*. 2015;52:1-10.

46. Li YC, Lee PS, Jian WS, Kuo CH. Electronic health record goes personal world wide. *IMIA Yearbook of Medical Informatics*. 2009;40-43.

47. Monsen KA, Diane A, Holland E, Fung-Houger PW, Vanderboom CE. Seeing the whole person: feasibility of using the Omaha System to describe strengths of older adults with chronic illness. *Research and Theory for Nursing Practice: An International Journal.* 2014;28(4):299-315.

48. Rotegaard AK, Ruland CM. Patient centeredness in terminologies: Coverage of health assets Concepts in the International Classification of Nursing Practice. *Journal of Biomedical Informatics*. 2010;43:805–811.

49. Rotegaard AK, Ruland CM. Representation of patients' health asset concepts in the International Classification of Nursing Practice (ICNP). *Stud Health Technol Inform*. 2009;146:314-9.

50. Holmes C. The problem list beyond meaningful use. Part I: The problems with problem lists. *J AHIMA*. 2011 Feb;82(2):30-3.

Chapter 3 Special Content – A Strengths-based Data Capture Model: Mining data-driven and person-centered health assets

(Accepted by JAMIA Open on March 18, 2018 with revisions; this is the revised copy based on suggested revisions from March 18, 2018 and it was resubmitted to JAMIA Open)

ABSTRACT

With healthcare policy directives advancing value-based care, risk assessments and management have permeated healthcare discourse. The conventional problem-based infrastructure defines what data are employed to build this discourse and how it unfolds. Such a healthcare model tends to bias data for risk assessment and risk management toward problems and does not capture data about health assets or strengths. The purpose of this paper is to explore and illustrate the incorporation of a Strengths-based Data Capture Model into risk assessment and management by harnessing data-driven and person-centered health assets using the Omaha System. This Strengths-based Data Capture Model encourages and enables use of whole-person data including strengths at the individual level and, in aggregate, at the population level. When aggregated, such data may be used for the development of strengths-based population health metrics that will promote evaluation of data-driven and person-centered care, outcomes and value.

INTRODUCTION

In this era of healthcare, given resource constraints and new payment models, there has been a focus on the value of care, which can be defined differently based on the adopted perspective from payers, clinicians, healthcare industry, caregivers, or patients.[1] From an economic viewpoint, the value of care is the achieved health outcomes per dollar spent.[2] This need catalyzes a shift towards risk management to boost performance in healthcare that is applicable to payers, providers, and patients alike. However, risk predictions and care management solutions intended to improve healthcare generally lack a whole-person perspective that includes social and behavioral determinants of health, as well as patient problems and strengths.[3-5] There is a critical need to represent and capture such data in the electronic health record (EHR) to align with the emerging paradigm shift towards strengths-based, whole-person, value-based care.[2-6]

The use of problem lists as the center of patient records proposed by Dr. Lawrence Weed in the late 1960s[7] still defines current healthcare practice and documentation in the United States. A problem-oriented healthcare infrastructure, while a useful information and knowledge management strategy, perhaps unintentionally emphasizes documentation and management of negative aspects of patient health status; rather than considering a whole-person perspective consisting of both problems and strengths.[3,8] Today, healthcare is being redefined to move beyond the current primary healthcare information model around management of illnesses, data silos, and narrow use cases towards a person-centered integrated care, research, wellness, and community ecosystem.[9] Accompanied with these changes, new data sources have emerged including clinical practice and documentation of individuals' strengths to create an innovative

vision and solution.[3,10-12] Scholars and clinicians have demonstrated that there is an opportunity to examine such a strengths-based whole-person model using an existing standardized terminology, the Omaha System.[3,6,12-15] The purpose of this paper is to explore and illustrate the incorporation of a Strengths-based Data Capture Model into risk assessment and management by harnessing data-driven and person-centered health assets using the Omaha System.

STRENGTHS, STRENGTHS-BASED APPROACH AND THE OMAHA SYSTEM

Strengths and strengths-based approach

Strengths are defined as health assets that present themselves as skills, capacities, actions, talents, potential, and gifts in each individual, each family member, each team member, the family as a whole, and the community.[8,16] A strengths-based care approach is a whole-person, person-centered intervention that leverages the use of the positive, the potential, and what is working to address problems and deficits to capitalize and mobilize strengths to support health.[17] It is based on a positive relationship among providers and patients that employs strengths and supports emotional as well as physical wellbeing.[16,18-20] However, merely capturing a staying-positive outlook could also neglect problems and deficits.[21] Hence, in the context of healthcare, strengths data should be meaningful and useful to support better health and health outcomes. From a whole-person perspective, both strengths and problems of individuals and populations need to be considered and made visible in data.[22] Such data can be utilized to improve health care value and patient health.

The Omaha System

The Omaha System[12] consists of three interrelated valid and reliable components: a) the Problem Classification Scheme to assess health (including 42 Problem concepts); b) the Intervention Scheme to describe care management and services (including 4 Categories and 75 Targets); and c) the Problem Rating Scale for Outcomes to measure Knowledge, Behavior, and Status in relation to an identified Problem concept (1 = lowest to 5 = highest). The Omaha System is a standardized vocabulary for health and health care. It is intended to taxonomically and simply describe all of health as 42 defined Problem concepts within four holistic Domains: Environmental, Psychosocial, Physiological, and Health-related Behaviors. The Problem concept terms and definitions are intended to be neutral. Problem concept-specific terms may be used to represent and capture both positive (strengths) and negative (signs/symptoms) attributes, which are not mutually exclusive.[12] For example, within the Environmental domain, *Difficulty buying necessities* is a sign/symptom of the Income problem concept, while *Having sufficient funds* is a strength. Within the Psychosocial domain, *Mood swings* is a sign/symptom of the Mental health problem concept, while *Mental wellbeing* is a strength. Within the Physiological domain, *Rash* is a sign/symptom of the Skin problem concept; while *Intact skin* is a strength. Within the Health-related Behaviors domain, *An unbalanced diet* is a sign/symptom of the Nutrition problem concept, while *A balanced diet for age/condition* is a strength.

Strengths-based Omaha System Research

Strengths-based research has been conducted by many different healthcare disciplines.[3, 8,12-13,15-16,18-20,19-20,23] Early studies using the Omaha System have explored whole-person data capture at both individual and community levels, including strengths

as well as problems.[3,6,13-15] It was feasible to use the Omaha System to classify and quantify strengths and needs of older adults with chronic conditions[3,6] and to capture community-level strengths such as *Presence of faith communities* (Spirituality problem concept) and *Access to fresh produce* (Nutrition problem concept).[14]

An exploratory study of 242 residents in senior living communities using de-identified EHR data showed that all residents had at least one problem indicated by signs/symptoms, and had more strengths than signs/symptoms (on average, residents had 16 strengths and 14 signs/symptoms).[15] The most frequent signs/symptoms were *Difficulty with bathing* (Health-related Behaviors/Personal care problem concept – 52.1% of sample), *Difficulty with money management* (Environmental/Income – 46.7%), *Diminished judgment* (Physiological/Cognition – 44.6%), and *Unable to take medications without help* (Health-related Behaviors/Medication regimen – 44.6%). The most frequent strengths were *Maintains good relationships with family* (Psychosocial/Interpersonal relationship – 71.5%), *Good oral hygiene* (Physiological/Oral health – 70.7%), *Regularly eats a balanced diet* (Health-related Behaviors/Nutrition – 62.8%) and *Extensive family engagements* (Psychosocial/Social contact – 60.3%). Residents who had more strengths than signs/symptoms (n=137) compared to those with more signs/symptoms than strengths (n=105) had higher average overall Omaha System Knowledge (3.2 vs. 2.4; p<.001), Behavior (3.9 vs. 3.2; p<.001), and Status (3.7 vs. 3.1; p<.001) scores. These findings align with and extend previous research among older adults with chronic conditions,[3,17] and demonstrate the potential to conduct data-driven comparisons of strengths and problems across populations and settings. Such whole-person data capture could inform clinical judgment regarding care for patients so that effective and person-

centered approaches could be created and implemented in their care. For example, patients who have strengths in Psychosocial Domain (*Someone to drive to appointments*) and Health-related Behaviors Domains (*Medication adherence*) may need different recommendations and approaches to care compared to patients who experience signs/symptoms in these areas.

RISK PREDICTION AND MANAGEMENT

In healthcare, risk assessments are employed to provide anticipatory guidance in preventing an individual's health problems.[23] The increased use of comprehensive EHRs and advancements in data mining offers promising opportunities for application of existing risk metrics and for development and validation of new risk prediction models.[24] Similar to the problem focused assessment infrastructure, the use of risk to estimate future health status gives rise to probability predictions[25] that do not reflect strengths an individual could leverage to enhance health. Risk is differently described as risk analysis, risk assessment, and risk management; and is often assessed to inform health promotion and disease prevention, health risk reduction, and public health research.[26] Risk predictions may bias clinical decisions due to the problem-based perspective. For example, frailty is a common metric used to predict health status for older adults, and such metrics include only problems and signs/symptoms.[27] Metrics may better predict overall wellbeing if strengths are incorporated.

Behavioral and lifestyle changes have often been seen as influential factors on the outcomes of disease management. Health policymakers have turned their concern toward health outcomes, cost-effectiveness, and preventive measures to maximize the value of healthcare.[26] Risk management has long been recognized to be important in this regard,

and is often associated with environmental, social, and behavioral factors beyond traditional medical care. Therefore, capturing a patient's strengths not only aligns with the Institute of Medicine (IOM) recommendation to document data about social and behavioral factors in EHRs,[4-5] but also presents a potential to better use patient strengths to improve their health outcomes and return in healthcare value. When healthcare is perceived to be driven by "care markets" (*"homo economicus"*), the healthcare return in value has more to do with solutions for problems by addressing "more markets, more complete markets, more perfect markets, more financialization, new technologies, new ways to monetize" and "abandons the project of individual or collective mastery of existence"[28(p.28)]. However, management of behavioral and lifestyle factors using patient strengths imply patient engagement, self-management, and personal responsibilities with the underlying principle that humans are essentially "caring people" (*"homines curans"*) and "care must be adequately and equally provided for all, and all must contribute their fair share to care". [28(p.28)] In this situation, care markets function within the contexts of interaction with patients. Patients' behaviors impact their own health management and associated healthcare outcomes. Leveraging the use of their strengths may create positive results and better risk management.

A STRENGTHS-BASED DATA CAPTURE MODEL

To move beyond a problem-based data framework that correlates problems with health risks, we need a data capture model that generates whole-person information and knowledge to improve health outcomes. We propose a strengths-based data capture model that illustrates the necessary components of a data-driven approach to whole-person care. Data reflecting a whole-person assessment including social and behavioral

determinants as well as problems and strengths must be routinely captured using a consistent terminology as described above. Adopting a consistent terminology will enable the use of sharable and comparable data for information exchange, data aggregation, and reporting. Large datasets generated based on this model may be mined to inform the development of metrics for value-based risk prediction models for various populations. Improved health management can then follow, using a data-driven approach to plan interventions that address risk and leverage strengths, in order to maximize health outcomes and value.

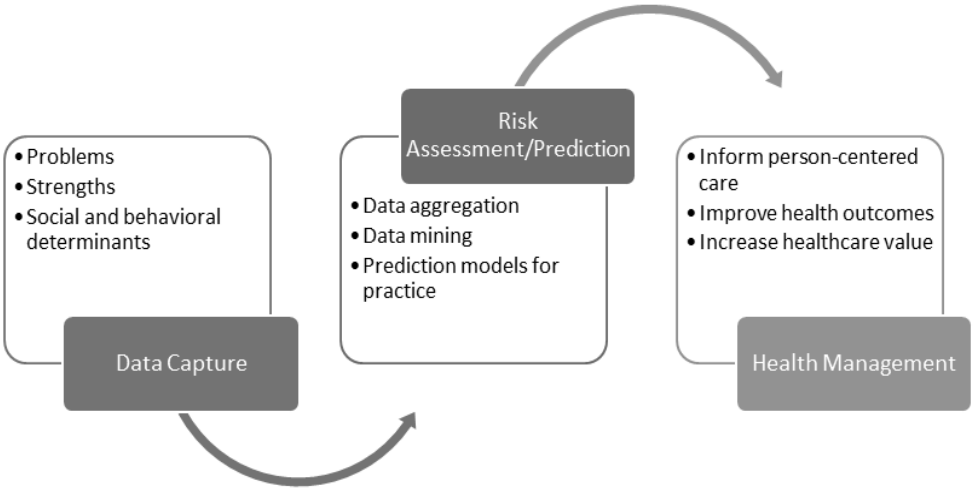


Figure 1. Strengths-based Data Capture Model

Person-centered, precision care research and services recognize and emphasize individual differences and partnership with patients.[29-30] This is a paradigm shift divergent from traditional care perspectives toward personalization,[28] and results in a shift of responsibility in risk-based management from providers to patients. From this person-centered perspective, person-centered data capture should be present at the point of care and services, making patients full partners in data capture as well as care. Thus, a strengths-based data capture model assumes that patients will be involved as central

partners in self-assessment of strengths and needs. Furthermore, focusing on the whole-person perspective in aggregate data will create opportunities to take a more inclusive and positive approach to the understanding of population health. Risk predictions based on risk assessments are usually produced by trending the aggregated data at the population level and applying as clinical guides and recommendations in patient care. When data standards that incorporate strengths and problems are used within EHRs, interoperable and sharable data between patients at both individual level and population level will facilitate both a person-centered approach and a scalable information management system. This model is envisioned by informaticians with the goal of using data to inform and improve health, and staying adaptable and scalable according to patient-specific needs and strengths.[31-32] It is incumbent upon all stakeholders including patients to work together to jointly define the notion of whole-person health for patients with multiple challenges and needs.

CONCLUSION

The perspective presented in this article and illustrated through our research both exists today and is futuristic**.** There is a critical need for use of a strengths-based vocabulary for risk assessment and management to realize the potential of strengths and enhance health value. The Omaha System has been used to operationalize and capture data as described in this innovative model and care process. The whole-person model built upon both problem-based risk predictions and strengths will enable a paradigm shift from deficit to whole-person health that includes both problems and strengths. We recognize this as a major groundbreaking endeavor with regard to who, what, and how to define and use data to promote health, and prevent and manage disease, and we welcome

conversation to advance and further develop the model across disciplines, populations, and settings.

Funding Statement

The first author is a recipient of the Robert Wood Johnson Foundation Future of Nursing Scholar award for her PhD study in nursing at the University of Minnesota. This research received no other specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests Statement

The authors have no competing interests to declare.

Contributorship Statement

This paper was drafted by the first author and reviewed and revised by co-authors.

References

1. Gentry S, Badrinath P. Defining health in the era of value-based care: Lessons from England of relevance to other health systems. *Cureus.* 2017 Mar; 9(3): e1079. doi: 10.7759/cureus.1079.
2. Porter ME. What is value in health care? *N Engl J Med* 2010; 363:2477-2481. DOI: 10.1056/NEJMp1011024.
3. Monsen KA, Peters J, Schlesner S, et al. The gap in Big Data: Getting to wellbeing, strengths, and a whole-person perspective. *Glob Adv Health Med*. 2015;4(3):31–39.
4. Institute of Medicine. *Capturing social and behavioral domains in electronic health records: Phase 1*. 2014. Washington, DC: The National Academies Press.
5. Institute of Medicine. *Capturing social and behavioral domains and measures in electronic health records: Phase 2*. 2014. Washington, DC: The National Academies Press.
6. Monsen KA, Holland DE, Fung-Houger PW, Vanderboom, CE. Seeing the whole-person: feasibility of using the Omaha System to describe strengths of older adults with chronic illness. *Res Theory Nurs Pract.*. 2014;28(4).
7. Weed LL. Medical records that guide and teach. *New Engl J Med.* 1968;278:652e7.
8. Rotegård AK, Ruland CM, & Fagermoen MS. Nurse perceptions and experiences of patient health assets in oncology care: a qualitative study. *Res Theory Nurs Pract.* 2011;25(4): 284-301.
9. American Medical Informatics Association (AMIA). *Redefining Our Picture of Health: Towards a Person-Centered Integrated Care, Research, Wellness, and Community Ecosystem.* A White Paper of the 2017 AMIA Policy Invitational. 2017.

Retrieved from https://www.amia.org/sites/default/files/API-2017-White-Paper-Redefining-our-Picture-of-Health.pdf.

10. Chunchu K, Mauksch L. Patient centered care plan in the EHR: Improving collaboration and engagement. *Fam Syst Health*. 2012;30(3):199–209.
11. Almunawar MN, Anshari M, Younis MZ, Kisa A. Electronic health object: Transforming health care systems from static to interactive and extensible. *Inquiry.* 2015;52:1-10.
12. Martin KS. *The Omaha System: A key to Practice, Documentation, and Information Management.* (reprinted 2nd ed.). 2005. Omaha, NE: Health Connections Press.
13. Monsen KA, Vanderboom CE, Olson KS, Larson ME, Holland DE. Care coordination from a strengths perspective: A practice-based evidence evaluation of evidence-based practice. *Res Theory Nurs Pract.* 2017;31(1). doi:10.1891/1541-6577.31.1.39.
14. Gao G, Kerr MJ, & Monsen KA. Feasibility of describing wellbeing and strengths at the community level utilizing the Omaha system. In W. Sermeus, P.M. Procter and P. Weber (Eds.), Studies in Health Technology and Informatics: *Nursing Informatics.* 2016;1062-1063.Amsterdam, Netherlands: IOS Press. doi: 10.3233/978-1-61499-658-3-1062.
15. Gao G, Kerr M, Lindquist RA, Chi C, Monsen KA. An exploratory study of older adults' strengths, needs, and outcomes using electronic health record data in a senior living community. Poster presentation at AMIA 2017 Annual Symposium in Washington, D. C., Nov. 4-8, 2017.

16. Miles P, Bruns EJ, Osher TW, Walker JS. *The wraparound process user's guide: A handbook for families.* 2006. Portland, OR: National Wraparound Initiative, Research and Training Center on Family Support and Children's Mental Health, Portland State University.
17. Gottlieb LN. *Strengths-Based Nursing Care: Health And Healing For Person And Family*. 2013. New York: Springer Publishing Comparny, LLC.
18. Boult C, Green AF, Boult LB, et al. Successful models of comprehensive care for older adults with chronic conditions: Evidence for the Institute of Medicine's "retooling for an aging America" report. *J Am Geriatr Soc.*. 2009;57(12): 2328–2337.
19. Bodenheimer T. Coordinating care: A major (unreimbursed) task of primary care. *Ann Intern Med.* 2007;147(10):730–731.
20. Counsell SR, Holder CM, Liebenauer LL, et al. Effects of a multicomponent intervention on functional outcomes and process of care in hospitalized older patients: A randomized controlled trial of acute care for elders (ACE) in a community hospital. *J Am Geriatr Soc*. 2000;48(12):1572–1581.
21. Ehrenreich B. *Bright-sided: How Positive Thinking Is Undermining America*. 2009. New York: Metropolitan Books Henry Holt and Company, LLC.
22. Kotoulas S, Sedlazek W, Lopez V, et al. Enabling person-centric care using linked data technologies. In *Studies in Health Technology and Informatics*. 2014. https://doi.org/10.3233/978-1-61499-432-9-692.
23. Duncan PM, Garcia AC, Frankowski, BL, Carey PA, Kallock EA, Dixon RD, Shaw JS. Inspiring healthy adolescent choices: A rationale for and guide to strength promotion in primary care. *J Adolesc Health.* 2007;41:525–535.

24. Goldstein BA, Navar AM, Pencina MJ. Risk prediction with electronic health records: The importance of model validation and clinical context. *JAMA Cardiol.* 2016 Dec 1;1(9): 976–977. doi: 10.1001/jamacardio.2016.3826.

25. Garland D. The rise of risk. In Ericson R, Doyle A (Eds.), *Risk and Morality*. 2003;48-86. Toronto: University of Toronto Press.

26. Callahan D, Jennings B. Ethics and public health: Forging a strong relationship. *Am J Public Health*. 2002; 92(2), 169-176.

27. Gao G, Maganti S, Monsen KA. Older adults, frailty, and the social and behavioral determinants of health. *Big Data and Information Analytics (BDIA)*. 2017. ISSN 2380-6974.

28. Tronto J. There is an alternative: homines curans and the limits of neoliberalism, Int J Care Caring. 2017;1(1): 27-43, DOI: 10.1332/239788217X14866281687583.

29. Martin CM, Félix-Bortolotti M. Person-centred health care: a critical assessment of current and emerging research approaches. *J Eval Clin Pract.* 2014 Dec;20(6):1056-64. doi: 10.1111/jep.12283.

30. Andersen JH, Whyte SR. Measuring risk, managing values: health technology and subjectivity in Denmark. *Anthropol Med*. 2014;21(3): 265-276.

31. Miles A. Person-centered medicine - at the intersection of science, ethics and humanism. *Int J Person Centered Med.*. 2012;2(3):329-333.

32. Sine DM, Sharpe VA. Ethics, risk, and patient-centered care: How collaboration between clinical ethicists and risk management leads to respectful patient care. *J Healthc Risk Manag.* 2011;31(1): 32-37.

Chapter 4 Special Content – Discovering Associations among Older Adults' Characteristics and Planned Nursing Interventions Using Electronic Health Record Data

(Intend to submit to Research and Theory for Nursing Practice)

Abstract

Background and Purpose: Little is known about how nursing assessments of strengths and signs/symptoms inform intervention planning in assisted living communities. The purpose of this study was to discover associations among older adults' characteristics and their planned nursing interventions.

Methods: This study employed a data-driven method, latent class analysis, using existing electronic health record data from a senior living community in the Midwest. A convenience sample comprised de-identified data of wellbeing assessments and care plans for 243 residents. Latent class analysis, descriptive, and inferential statistics were used to group the sample, summarize strengths and problems attributes, nursing interventions, and Knowledge, Behavior, and Status scores, and detect differences.

Results: Three groups presented based on patterns of strengths and signs/symptoms combined with problem concepts: Living Well (n=95) had more strengths and fewer signs/symptoms; Lower Strengths (n=99) had fewer strengths and more signs/symptoms; and Resilient Survivors (n=49) had more strengths and more signs/symptoms. Some associations were found among group characteristics and planned interventions. Living Well had the lowest average number of planned interventions per resident (Mean = 2.7; SD = 1.7) followed by Lower Strengths (Mean = 3.8; SD = 2.6) and Resilient Survivors (Mean = 4.1; SD = 3.4).

Implications for Practice: This study offers new knowledge in the use of a strengths-based ontology to facilitate a nursing discourse that leverages use of older adults' strengths to address their problems and support them living a healthier life. It also offers the potential to complement the problem-based infrastructure in clinical practice and documentation.

Key words: Strengths, problems, data-driven research, older adults, the Omaha System

Background and Purpose

The aging population is steadily increasing in the U.S. and around the globe. The U.S. senior population is projected to represent 21% of its total population in 2030 (Federal Interagency Forum on Aging-Related Statistics, 2016). The world is also seeing a similar trend of growth (Das, 2015). The aging population and the concomitant increase in the prevalence of chronic illness drive costs in healthcare that account for 75% of annual U.S. health care spending (Institute of Medicine, 2012). The primary healthcare information technology model today is deployed around management of illnesses with data silos and narrow use cases in need of a redesign (AMIA, 2017). As healthcare is being redefined towards a person-centered integrated care, research, wellness, and community ecosystem (AMIA, 2017), new data sources including clinical practice and documentation of individuals' strengths are being utilized to create an innovative approach to healthy aging and healthy living (Monsen, Vanderboom, Olson, Larson, & Holland, 2017a; Monsen, Peters, Schlesner, Vanderboom, & Holland, 2015; Monsen, Holland, Fung-Houger, & Vanderboom, 2014). Such an approach presents a potential to complement a data gap related to the psychosocial and behavioral domains in problem-based electronic health records (EHRs) (Monsen et al., 2015; Institute of Medicine, 2014a; Institute of Medicine, 2014b; Gao, Kerr, Lindquist,& Monsen, 2016), and support the vision for a person-centered integrated care, research, wellness, and community ecosystem.

The use of an information system is conducive to more complete and accurate documentation by healthcare professionals (Häyrinen, Saranto, & Nykänen, 2008) as the primary knowledge management for healthcare (Agency for Healthcare Research and

Quality, 2012). The inclusion of strengths data expands knowledge management built upon the narrow use cases of disease management and provides whole-person data capture in the facilitation of health promotion and wellbeing. Strengths refer to health assets that are characterized by skills, capacities, actions, talents, potential, and gifts in an individual, each family member, each team member, the family as a whole, and the community (Rotegård, Ruland, & Fagermoen, 2011; Miles, Bruns, Osher, & Walker, 2006). Findings of emerging strengths-based studies demonstrate a whole-person approach to clinical practice and documentation utilizing formalized strengths attributes captured by the Omaha System (Monsen et al., 2014) in the EHR of a senior living community (Monsen et al., 2015) and care coordination in community (Monsen et al., 2017a). Standardizing terminology supports nurses to establish care plans from bland statements of intent to unambiguous, prescriptive, and coded actions (Moore & Stonham, 2010). Research also demonstrates that nurses tailor evidence-based interventions differentially by problems based on quality evaluation of nursing care and interventions (Monsen, Swenson, Klotzbach, Mathiason, & Johnson, 2017b). Studies also suggest that public health nurses document routine and tailored interventions in EHRs using the Omaha System (Martin, 2005; Monsen & Martin, 2002; Monsen, Radosevich, Kerr, & Fulkerson, 2011).

The Omaha System is a comprehensive standardized language, interface terminology, and measure designed to enhance practice, documentation, and information management across settings (Martin, 2005). It has been used in community care settings to document assessments, interventions, and outcomes of older adults. This terminology consists of three components including the Problem Classification Scheme, the

Intervention Scheme, and the Problem Rating Scale for Outcomes. The Problem Classification Scheme has 42 standardized problem concepts within Environmental, Psychosocial, Physiological and Health-related Behaviors Domains to describe nursing assessments for problem-specific strengths and signs/symptoms. The Intervention Scheme is related to the Problem Classification Scheme, and it has 4 standardized categories in action terms and 75 standardized targets to document nursing care plans and services for each identified problem concept. The Problem Rating Scale for Outcomes measures the Problem concepts using three 5-point Likert-type scales pertaining to the severity of Knowledge, Behavior, and Status (KBS) concepts (1 = lowest to 5 = highest). Each of the KBS rating scales presents a continuous evaluation framework for assessing and evaluating an individual's problem-specific rating over time. The reliability and validity of the Omaha System components have been tested and established in multiple settings in research (Martin, 2005). Along with the emergence of whole-person oriented data sources including strengths in EHRs, more investigation is needed to explore relationships between nursing assessments and care planning. Furthermore, there is limited knowledge regarding how strengths data contribute to nurses' care planning for interventions.

The purpose of this study was to discover data-driven associations among older adults' characteristics and their planned nursing interventions captured by the Omaha System. This study had two aims: 1) To use a latent class analysis (LCA) model to group older adults by strengths and signs/symptoms; 2) To examine group membership associated with interventions by problem addressed; category; and problem-category-target combinations.

Methods

Design and Sample

This retrospective, comparative study employed a data-driven model, LCA, using existing EHR nursing data. The population under study was older adults residing in a senior living community of a Midwest metropolitan area. A convenience sample comprised de-identified data for 243 assisted living residents with wellbeing assessments and nursing care plans in the same year.

This research was reviewed and deemed not human subjects research by the Institutional Review Boards at the University of Minnesota and approved by the leadership of this senior living community. Data were stored within the secure data shelter of the University of Minnesota Academic Health Center, and accessed and used for this research following institutional procedures.

Instruments and Measures

Strengths and problems of residents, nursing interventions, and residents' KBS scores were described and coded by the Omaha System classification schemata. Strengths and problems of residents were operationalized and documented by using the Problem concepts in the Problem Classification Scheme combined with problem-specific customized strengths indicators created by the institution of the current study and signs/symptoms, respectively. Planned nursing interventions were documented using the Intervention Scheme on two hierarchical levels of categories and targets. KBS scores were recorded by the Problem Rating Scale for Outcomes. The KBS rating scale is related to the Problem Classification Scheme and measures KBS scores related to the Problem Classification Scheme and the Intervention Scheme.

Data Mappings

The Omaha System was already in place in the EHR of this senior community, but the build of the EHR used non-standard representation which necessitated a data mapping process. Mappings of assessment and care plan data to the Omaha System terminology were performed by the first author. The assessment data were mapped and coded to the Omaha System problem concepts and sign/symptoms as well as strength indicators. The assessment had 35 questions with multiple answers displayed in a total of 282 rows. The care plan data consisted of 1830 rows of data related to an identified problem/need and expected KBS outcome for residents. Data were mapped to the Omaha System problem concepts, categories, and targets. An Omaha System expert reviewed 10% of the mappings; and any differences were further resolved by a third Omaha System expert until consensus was reached.

Data Collection and Analysis

Assessments of residents and planned interventions with KBS scores were conducted by nursing staff at the point of care. After data acquisition following institutional research procedures, data were formatted and constructed for data analysis according to institutional research protocols.

The LCA model was performed on this sample with variables that presented with 5% or more of residents with strengths and signs/symptoms in each Omaha System problem concept. LCA was used to separate residents into 3, 4, and 5 groups based on the assessments of their strengths and signs/symptoms combined with problem concepts using Proc LCA from the Methodology Center at Penn State (Lanza, Dziak, Huang, Wagner, & Collins, 2015). The Cognition problem was not included in the modeling

analysis to avoid having the model only separated based on a resident's strengths and signs/symptoms in cognition and using this problem concept to predict problems in cognition. Similarly, Bowel function and Urinary function signs/symptoms were also not included in the model building. The selection of 3 groups was found to be the preferred model based on the lowest Bayesian Information Criterion (BIC) and Consistent Akeike's Information Criterion (CAIC). Descriptive statistics were used to summarize strength and problem attributes, nursing interventions, and baseline KBS scores. The identified groups were then evaluated using the statistical analytics software package R and Microsoft Excel. Statistical tests of chi square and ANOVA were performed to test for differences in interventions, characteristics and KBS scores between groups in the statistical analytics software SAS version 9.4.

Results

Total Sample Demographic Characteristics

The average age for this entire sample (n = 243) was 86 years (SD = 7.8) (Table 1). The majority of residents were female and Caucasian. Widowed and married were the majority of the marital status of the sample, with widowed at a higher percentage than married.

Table 1

Demographics of Total Sample

Total n = 243								
	Mean or n	*SD or %*		*n*	*%*		*n*	*%*
Age			Race/ Ethnicity			Marital Status		
Mean	86.0	7.8	White/ Caucasian	196	80.7%	Married	81	33.3%
Undocumented	0	0%	Undocumented	47	19.3%	Divorced	11	4.5%
Gender						Widowed	100	41.2%
Female	153	63.0%				Single	18	7.4%
Male	88	36.2%				Significant Other	1	0.4%
Undocumented	2	0.8%				Undocumented	32	13.2%

Aim 1: Grouping by Strengths and Signs/Symptoms

Out of the 42 Omaha System problems, a subset of a total of 34 problems (Table 2) was present in the wellbeing assessments (33 problem concepts excluding Abuse) and care plans (33 problem terms excluding Neglect). Their definitions are listed in Appendix 1.

Table 2

Domains and Corresponding Problems

Domains	Problems
Environmental Domain	Income; Residence; Neighborhood/workplace safety
Psychosocial Domain	Communication with community resources; Social contact; Role change; Interpersonal relationship; Spirituality; Grief; Mental health; Sexuality; Neglect; Abuse
Physiological Domain	Hearing; Vision; Speech and language; Oral health; Cognition; Pain; Consciousness; Skin; Neuro-musculo-skeletal function; Respiration; Circulation; Digestion-hydration; Bowel function; Urinary function
Health-related Behaviors Domain	Nutrition; Sleep and rest patterns; Physical activity; Personal care; Substance use; Health care supervision; Medication regimen

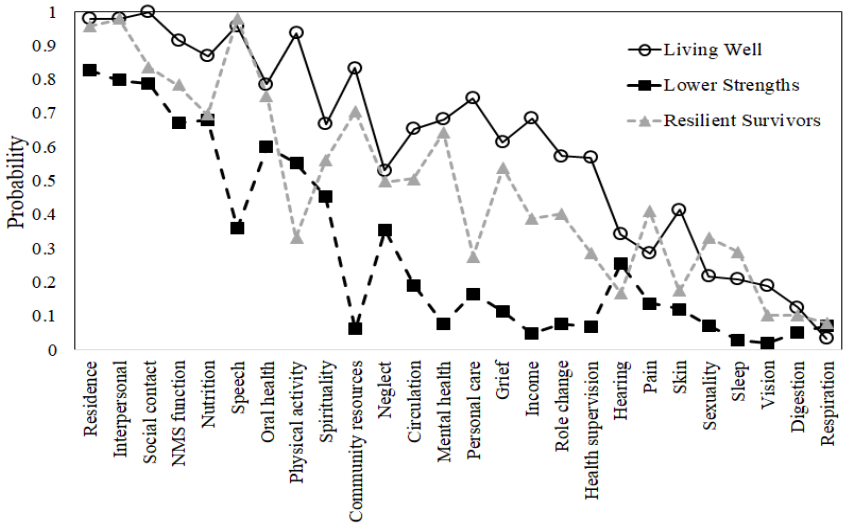
Based on this LCA model, 26 problem concepts (Figure 1) were selected to model residents' strengths out of 33 problems excluding Abuse (Table 2), and 26 different

problem concepts (Figure 2) out of 33 problems excluding Abuse (Table 2) were included for signs/symptoms. The LCA model categorized the sample into three groups: Group 1 (Living Well) – a more strengths group with fewer signs/symptoms; Group 2 (Lower Strengths) – a fewer strengths group with more signs/symptoms; and Group 3 (Resilient Survivors) – a more strengths group with more signs/symptoms.

Living Well consisted of residents with more strengths across all 4 domains: including both problem concepts in Environmental; 7 concepts in Psychosocial; 7 concepts in Physiological; and 4 concepts in Health-related Behaviors domain. In total, Living Well had more strengths in 20 problem concepts out of 26 included. The top 5 problem concepts in strengths based on the percentage of residents for this group included: Social contact, Interpersonal relationship, Residence, Speech and language, and Physical activity.

In contrast, Lower Strengths had fewer strengths in 23 problem concepts out of 26 within 4 domains. They included both problem concepts in Environmental, all 9 concepts in Psychosocial, 8 concepts in Physiological, and 4 concepts in Health-related Behaviors. The top 5 problem concepts in strengths for this group included: Residence, Interpersonal relationship, Social contact, Nutrition, and Neuro-musculo-skeletal function.

Resilient Survivors had more strengths in 6 problem concepts including: Interpersonal relationship, Sexuality, Speech and language, Pain, Respiration, Sleep and rest patterns. This group also had more strengths in many problem concepts after Living Well. The top 5 problem concepts for this group included: Interpersonal relationship, Residence, Speech and language, Social contact, and Neuro-musculo-skeletal function.



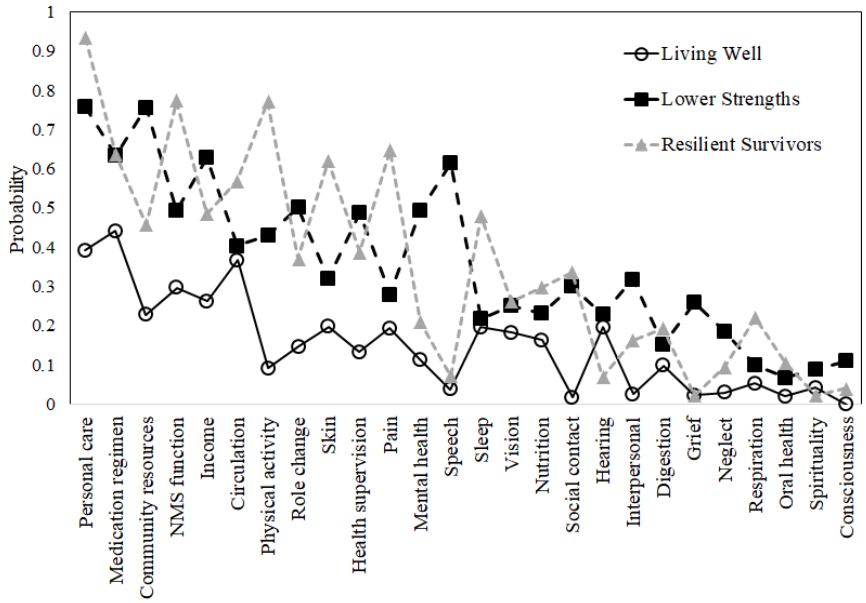
Notes. Interpersonal = Interpersonal relationship; NMS function = Neuro-musculo-skeletal function; Speech = Speech and language; Community resources = Communication with community resources; Health supervision = Health care supervision; Sleep = Sleep and rest patterns; Digestion = Digestion-hydration

Figure 1. Latent class analysis groups by strengths.

Besides having more strengths in most problem concepts, Living Well also had fewer signs/symptoms in 23 out of 26 concepts within all 4 domains (Figure 2). The top 5 problems in signs/symptoms for this group were Medication regimen, Personal care, Circulation, Neuro-musculo-skeletal function, and Income.

Lower Strengths had more signs/symptoms in 11 problem concepts mostly in Environmental and Psychosocial domains while Resilient Survivors showed more signs/symptoms in 15 problem concepts mostly in Physiological and Health-related Behaviors domains. The top 5 problems in signs/symptoms for Lower Strengths were Personal care, Communication with community resources, Speech and language, Medication regimen, and Income. The top 5 problems in signs/symptoms for Resilient Survivors were Personal care, Neuro-musculo-skeletal function, Physical activity, Pain, and Skin.

The leading problem with the more signs/symptoms was Personal care among all three groups. Living Well did not demonstrate the most signs/symptoms in any problem concept. There revealed some differences in the domains where problems occurred in these groups.



Notes. Community resources = Communication with community resources; NMS function = Neuro-musculo-skeletal function; Health supervision = Health care supervision; Speech = Speech and language; Interpersonal = Interpersonal relationship; Digestion = Digestion-hydration

Figure 2. Latent class analysis groups by signs/symptoms.

A comparison of the three groups was done on strengths and signs/symptoms for Cognition, Bowel Function, and Urinary Function (Table 3). All were significantly different in Cognition strengths and in Cognition, Bowel function, and Urinary function signs/symptoms.

Table 3

Strengths and signs/symptoms in Cognition, Bowel function, or Urinary function by group

	Living Well n = 95		Lower Strengths n = 99		Resilient Survivors n =49			
	n	%	n	%	n	%	χ2	*p* value
Strengths								
Cognition	62	65%	5	5%	26	53%	80.1	<.001
Signs/Symptoms								
Cognition	40	42%	80	81%	27	55%	41.1	<.001
Bowel function	6	6%	28	28%	12	24%	16.5	<.001
Urinary function	22	23%	51	52%	25	51%	19.1	<.001

Demographic Characteristics by Group and KBS Scores

The sample of 243 EHR records was categorized into three groups separated by the LCA model: Living Well (n=95), Lower Strengths (n=99), and Resilient Survivors (n=49). Their demographic characteristics are described in Table 4. There were no between group differences in age, gender or race/ethnicity, but there were significant differences in marital status ($p < 0.001$).

Table 4

Demographics by Group

	Living Well n = 95		*Lower Strengths n = 99*		*Resilient Survivors n =49*	
	Mean or n	*SD or %*	*Mean or n*	*SD or %*	*Mean or n*	*SD or %*
Age						
Mean	85.8	7.8	86.1	7.7	86.3	8.2
Race/Ethnicity						
White/ Caucasian	75	78.9%	84	84.8%	37	75.5%
Undocumented	20	21.1%	15	15.2%	12	24.5%
Marital Status						
Married	20	21.1%	45	45.5%	16	32.7%
Widowed	48	50.5%	39	39.4%	13	26.5%
Other or Undocumented	27	29%	15	15%	20	41%
Gender						
Female	66	69.5%	54	54.5%	33	67.3%
Male	29	30.5%	44	44.4%	15	30.6%
Undocumented	0	0%	1	1.0%	1	2.0%

KBS Scores. There were significant differences in all baseline KBS scores by groups (Table 5). Overall, Living Well had the highest mean KBS scores, Lower Strengths had the lowest, and Resilient Survivors' KBS scores fell in-between. Living Well had the highest baseline KBS scores, also more strengths and fewer signs/symptoms. Even though Resilient Survivors had more signs/symptoms in the Physiological and Health-related Behaviors domains than Lower Strengths, they had more strengths than Lower Strengths. Resilient Survivors showed better overall mean baseline KBS scores than Lower Strengths.

Table 5

Baseline Mean KBS by Group

	Living Well n = 95		Lower Strengths n = 99		Resilient Survivors n = 49			
	Mean	SD	Mean	SD	Mean	SD	F Statistic	*P* Value
Mean K	3.3[B]	0.8	2.3[A,C]	0.7	3.0[B]	0.8	34.4	<.001
Mean B	4.0[B,C]	0.7	3.2[A]	0.8	3.6[A]	0.8	29.1	<.001
Mean S	3.9[B]	0.7	3.2[A,C]	0.7	3.4[A,B]	0.7	16.8	<.001

Notes. A – different from Living Well group; B – different from Lower Strength group; C – different from Resilient Survivors.

Aim 2: Associations of Group Membership with Planned Interventions by Problem, Category, Problem-Category-Target Combinations

Overall Findings

Overall, this study categorized three distinct groups with different strengths and signs/symptoms characteristics, planned nursing interventions, and KBS scores (Figure 3). Living Well had more strengths and fewer signs/symptoms, fewest planned nursing interventions, and highest KBS scores. Lower Strengths had fewer strengths and more signs/symptoms in Environmental and Psychosocial domains, second most planned

nursing interventions, and lowest KBS scores. Resilient Survivors had more strengths and more signs/symptoms in Physiological and Health-related Behaviors domains, most planned nursing interventions, and second highest KBS scores.

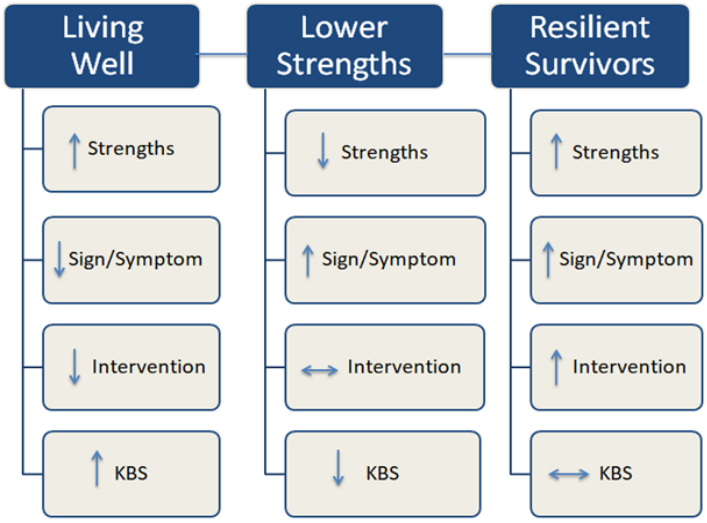
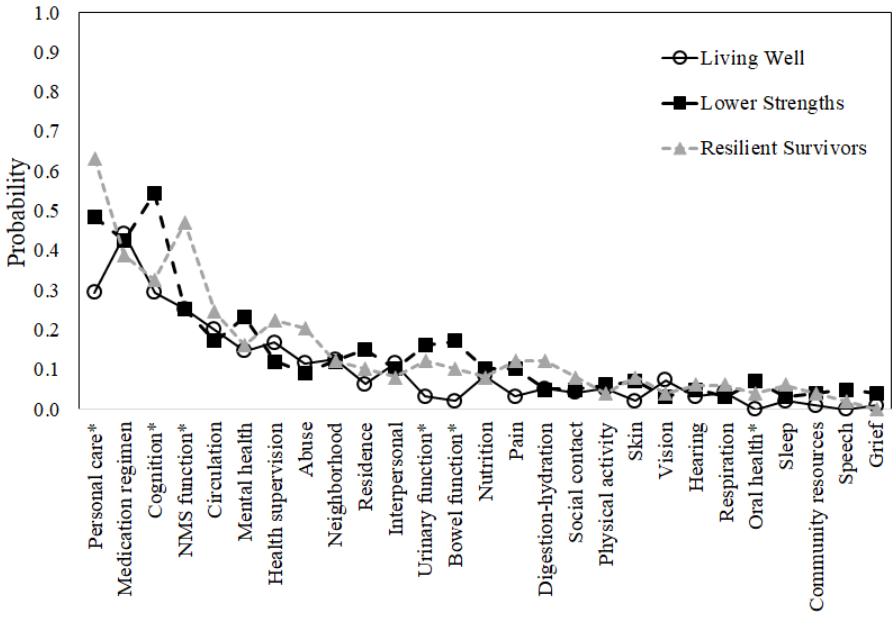


Figure 3. Overall findings of strengths, signs/symptoms, planned interventions, and KBS scores by group

Planned Interventions by Problem. With regard to nursing interventions, more planned activities by nurses in 27 problem concepts were observed among Lower Strengths and Resilient Survivors (Figure 4). Significant differences were found for Cognition, Neuro-musculo-skeletal function, Bowel function, Personal care, Oral health, and Urinary function between groups. Among the problems that showed significant differences among three groups, all the problems belonged to the Physiological domain except Personal care in the Health-related Behaviors domain. For the rest of the problems, no significant differences were detected.



Notes. "*" indicates significant statistical differences $p < .05$. NMS function = Neuro-musculo-skeletal function; Health supervision = Health care supervision; Neighborhood = Neighborhood/workplace safety; Interpersonal = Interpersonal relationship; Sleep = Sleep and rest patterns; Community resources = Communication with community resources; Speech = Speech and language

Figure 4. Interventions by problem concept for three groups.

Planned Interventions by Category and Problem-Category-Target Combinations.

Planned nursing interventions were further examined based on category and an intervention string created by a problem concept combined with a category and a target. All 4 Omaha System categories appeared in planned interventions, including: Teaching, Guidance, and Counseling; Treatments and Procedures; Case Management; and Surveillance. A subset of 34 targets out of 75 standardized targets was presented in this study sample (Table 6).

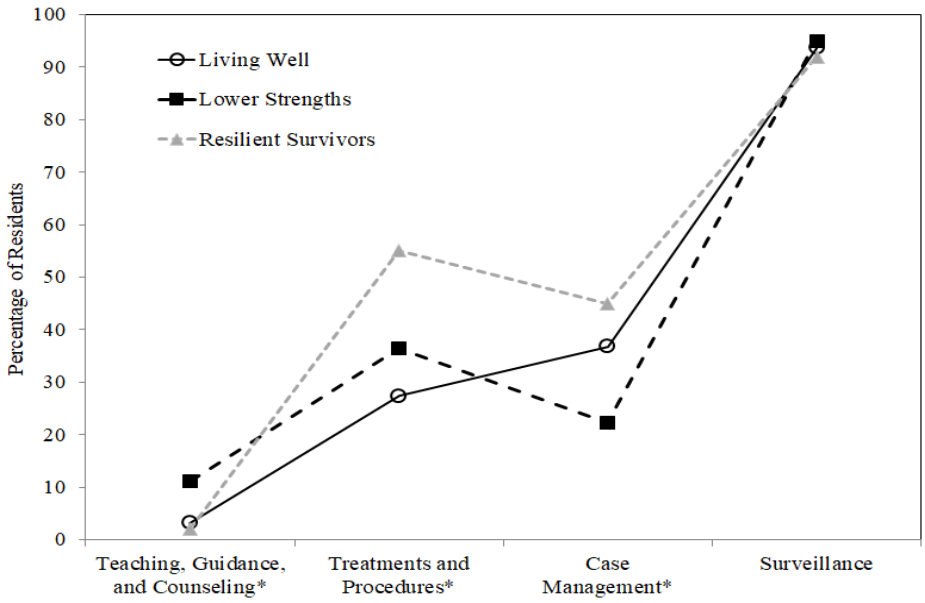
Table 6

Targets

Targets		
• bladder care	• medication action/side effects	• transportation

Targets		
• bowel care • cardiac care • dressing change/wound care • durable medical equipment • end-of-life care • exercises • finances • interaction • laboratory findings • medical/ dental care	• medication administration • medication set-up • mobility/transfers • ostomy care • personal hygiene • relaxation/breathing techniques • respiratory care • safety • sickness/injury care • signs/symptoms-mental/emotional • signs/symptoms-physical • support group	• wellness • continuity of care • dietary management • homemaking/ housekeeping • medication coordination/ ordering • nursing care • occupational therapy care • physical therapy care • speech and language pathology care

Different patterns in planned interventions were revealed among the three groups (Figure 4) with significant differences for three categories: Teaching, Guidance, and Counseling ($p = 0.029$); Treatments and Procedures ($p = 0.005$); and Case Management ($p = 0.011$). There was no difference for the category of Surveillance between the three groups.



Note. "*" indicates significant statistical difference.

Figure 5. Planned interventions by categories and by percentage of residents.

There were significant differences (p = .001) in the average numbers of planned interventions per resident among the three groups. Living Well had the lowest average number of planned interventions per resident (Mean = 2.7; SD = 1.7) followed by Lower Strengths (Mean = 3.8; SD = 2.6) and Resilient Survivors (Mean = 4.1; SD = 3.4).

Discussion

In this descriptive, comparative study of older adults' characteristics and interventions, different patterns of strengths and signs/symptoms among three data-driven groups were associated with planned nursing interventions and KBS scores. Older adults with more strengths and fewer signs/symptoms had fewer planned nursing care interventions, similar to other findings in that the number of Omaha System strengths concepts per person was positively correlated with patient reported self-care ability (Monsen et al., 2014). This group also demonstrated overall higher KBS scores. In contrast, older adults with fewer strengths showed more signs/symptoms in Psychosocial and Environmental domains as well as the Cognition problem even though they might have fewer signs/symptoms in Physiological and Health-related Behaviors domains.

Sample Characteristics

The demographic features were characterized by advanced age, predominantly female and Caucasian across the whole sample and by group. These characteristics are consistent with the demographics in the senior living population, indicating that advancement in age and being a female may contribute to the likelihood of an older adult moving into a senior living community. Such trends also correspond to the growing life

expectancies and the larger proportion of females in the senior population in the United States (Federal Interagency Forum on Aging-Related Statistics, 2016). In moving forward with these demographic changes in the social landscape, it has become more important now to identify needs early so that preventive measures and adequate support could be offered to maintain older adults' health and independence in living.

Aim 1: Group Characteristics

The LCA model identified three distinct groups based on whole-person assessments including strengths and signs/symptoms. This is the first study of its kind; however, it is widely known that the aging process differs and that individuals need varying levels of care (Wadensten & Carlsson, 2003). Further research is needed to determine whether these groups may be present in other settings.

Older adults demonstrated more strengths in Interpersonal relationship and Social contact among three groups. Such a finding aligns with previous study results (Monsen et al., 2015; Monsens et al., 2014) and research that older adults had higher levels of interpersonal strengths (Isaacowitz, Vaillant, & Seligman, 2003). The big differences in strengths that characterize the more strengths groups (Living Well and Resilient Survivors) and fewer strengths group (Lower Strengths) are in Speech and language, Communication with community resources, Mental health, and Grief that are closely related to communication and psychosocial factors. Strengths in these areas may increase the capacities of older adults' strengths to promote their health and positive outcomes. The study results also suggest that Physical activity appeared to be a strength that distinguished the group with the most strengths (Living Well) from the groups having fewer strengths (Lower Strengths and Resilient Survivors). Such a finding supports

research that associates physical activity with enhanced quality of life (McAuley et al., 2006; Netz, Wu, Becker, Tenenbaum, 2005).

Lower Strengths, the group that had fewer strengths, showed more signs/symptoms among these three groups mostly related to Environmental and Psychosocial domains. Resilient Survivors had more signs/symptoms mostly related to Physiological and Health-related Behaviors domains. This finding suggests that older adults who have more signs/symptoms related to physiological problems could still possess higher strengths than those with signs/symptoms in Environmental and Psychosocial domains.

Signs/symptoms were mainly from the Physiological Domain across all groups, and the groups differed in their physiological issues. Age-related reduction in muscle strength and cardiovascular function further the declining physical ability with age (Fiatarone-Singh & Mayer, 2002; Rajeski & Mihalko, 2001). Older adults commonly suffer from pain and other serious problems related to pain (Takai, Yamamoto-Mitani, Okamoto, Koyama, & Honda, 2010). Further research is needed to understand how physiological problems relate to strengths and whole-person health, and define resident groups.

The most common problem in older adults among these groups is Personal care. This aligns with the literature in that nearly one-half of older adults had difficulty or received help in the last month with daily activities in this country (Freedman & Spillman, 2014) and is likely related to one of the reasons older adults decide to live in residential assisted living communities (Liepelt, 2015).

The finding that there were significant differences among the three groups related to Cognition suggests that it may play an important role in fostering older adults' strengths or may accelerate the need for personal care. Older adults who maintain cognitive function have a unique profile that differentiates them from those with decline (Yaffe et al., 2009).

Cognition signs/symptoms among the three groups demonstrated similar patterns with Bowel function and Urinary function signs/symptoms. The finding that the group with highest percentage of residents in Cognition signs/symptoms also had the highest percentage of residents in Bowel function and Urinary function signs/symptoms suggests that Cognition signs/symptoms may be related to the inability to self-manage bowel and bladder functions. These findings seem to align with research that has shown associations of cognitive impairment with an increased risk in functional status decline (Stuck et al., 1999; Royall et al., 2007).

The finding that Living Well had the highest KBS scores and more strengths and Lower Strengths had the lowest KBS scores and fewer strengths further reinforces group differences. Interestingly, Resilient Survivors' KBS scores fell in between and their strengths also fell in between these two groups. In addition, the magnitude of KBS score differences suggests clinical significance, indicating meaningful and practical differences (Johnson et al., 2013) between these groups. It illustrates the association of older adults' strengths and problem attributes with their KBS baseline status.

Aim 2: Group Membership with Planned Interventions

Study results suggest that nurses plan more interventions and activities in care for those older adults who have more signs/symptoms and tailor their care to address their

problems. A pattern was noted between the average number of planned interventions per resident and the number of strengths and signs/symptoms. Overall, the group that had more strengths and fewer signs/symptoms also received the least planned interventions per resident. The group that had more signs/symptoms in physiological problems and health-related behaviors ended up with a higher average number in planned interventions. Further investigation is needed to explore whether physiological problems and health-related behaviors may require more nursing interventions as suggested in research that nurses adjust their care plans according to their needs (Monsen et al., 2017b). Such a finding also suggests that physiological problems and health-related behaviors do not necessarily negatively affect strengths in other domains.

The finding that there was a significant difference in Personal care among the three groups is consistent with other results that define these groups, although all groups have more than 25% of residents requiring Personal care interventions. This reinforces the notion that individuals seek out and reside in assisted living because they need personal care and health challenges (Liepelt, 2015). Personal care had the most signs/symptoms in the entire sample and was also one of the top five problems nurses have addressed in their care plans.

The finding of between-group differences in intervention categories suggests that nursing assessments of strengths and signs/symptoms are associated with the planning of interventions. This is the first known study to demonstrate intervention tailoring in assisted living, and aligns with the literature on intervention tailoring in other populations and settings (Monsen et al., 2017b; Martin, 2005; Monsen & Martin, 2002; Monsen et al., 2011). Teaching, Guidance, and Counseling is used to delineate nursing activities

designed to provide information, encourage action and responsibility for self-care and coping, and assist the individual and family to make decisions and solve problems (Martin, 2005). The finding that the Lower Strengths group received a higher percentage of planned Teaching, Guidance, and Counseling intervention suggests that this group may need more reminders, prompts, encouragements, and directions to engage in self-care as indicated in the care plans. Treatments and Procedures are used to describe technical activities such as wound care, specimen collection, resistive exercises, and medications prescriptions designed to prevent, decrease, or alleviate signs/symptoms for an individual (Martin, 2005). The finding that Resilient Survivors had more planned Treatments and Procedures interventions may reflect needs to address a greater number of Physiological signs/symptoms. There was no difference in Surveillance activities. Such a finding aligns with research in other populations and settings that nurses actively monitor the health and safety of individuals under their care (Monsen et al., 2017b; Harding, Galano, Martin, Huntington, & Schellenbach (2007); LeCroy & Davis, 2016).

Implications for Nursing Practice

This study has implications for nursing practice in the U.S. and around the world. As both the U.S. and the world face a growing aging population (Das, 2015) with chronic illnesses, there is an increasing need to support them to live well in the community. Use of a whole-person assessment and tailored interventions may aid in leveraging the use of older adults' strengths to address their problems and needs; and may become valuable strategies to support them to live a better and longer life. This study offers new insights and potential in the use of a strengths-based ontology, the Omaha System, to facilitate this process and discourse.

This research also generates some hypotheses for future research. Based on the study findings, further tests are needed to examine whether for the Living Well group, higher KBS, more strengths, and fewer signs/symptoms lead to fewer Treatments and Procedures interventions; whether for the Low Strengths group, more Cognition signs/symptoms are associated with more signs/symptoms in the Psychosocial domain, fewer strengths, and lower KBS status; and whether for the Resilient Survivors group, more signs/symptoms in Physiological problems and Health-related Behaviors lead to more hands-on, Treatments and Procedures interventions.

Limitations

This study has limitations common to all observational data. Since this study uses existing EHR nursing data and a convenience sample, it lacks randomization, manipulation of nursing interventions and probability sampling. As a result, many confounding factors cannot be controlled which could impact both the internal validity and external validity of this study. However, use of a valid standardized terminology may enhance documentation quality (Martin, 2005). Future research including prospective, randomized trials of strengths-based intervention approaches is needed.

Conclusions

The study has aligned with and extended previous research findings regarding older adults' whole-person health including strengths and signs/symptoms. In addition, it also reveals new knowledge about planned nursing interventions associated with the whole-person assessment. Distinct groups of older adults were identified, and intervention tailoring was demonstrated. Further research is needed to validate the data-driven groups in other settings, and to evaluate the impact of implementing whole-person

assessments and care planning on health care outcomes and wellbeing across the continuum of care.

Acknowledgement

The first author is a recipient of the Robert Wood Johnson Foundation Future of Nursing Scholar award for her PhD study in nursing at the University of Minnesota. This research received no other specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

The authors also like to acknowledge Robin Austin for her review of the mapping to the Omaha System, Sasank Maganti for de-identifying the EHR data, and Mary Jo Kreitzer and Katherine Todd for their collaboration in the provision of the EHR data for this research.

References

Agency for Healthcare Research and Quality. (2012). Prospects for care coordination measurement using electronic data sources. Publication no. 12-0014-EF. Washington, DC: AHRQ.

American Medical Informatics Association (AMIA). (2017). Redefining our picture of health: Towards a person-centered integrated care, research, wellness, and community ecosystem. *A White Paper of the 2017 AMIA Policy Invitational.* Retrieved from https://www.amia.org/sites/default/files/API-2017-White-Paper-Redefining-our-Picture-of-Health.pdf.

Das, R., (2015). A silver tsunami invades the health of nations. Retrived from https://www.forbes.com/sites/reenitadas/2015/08/11/a-silver-tsunami-invades-the-health-of-nations/#4719c9b23efd.

Gao, G., Kerr, M., Lindquist, R., & Monsen, K. (2016). Documentation of patient problems and strengths in electronic health records. *Internal Medicine: Open Access, 6,* 221doi:10.4172/2165-8048.1000221.

Federal Interagency Forum on Aging-Related Statistics. (2016). *Older Americans 2016: Key Indicators of Well-Being.* Federal Interagency Forum on Aging-Related Statistics. Washington, DC: U.S. Government Printing Office.

Fiatarone-Singh, M. & Mayer, J. (2002). Exercise comes of age rationale and recommendations for a geriatric exercise prescription. *Journal of Gerontology Medical Sciences., 57a*, M262-82.

Freedman, V.A. & Spillman, B.C. (2014). Disability and care needs among older Americans. *The Milbank Quarterly, 92*(3), 509-41. doi: 10.1111/1468-0009.12076.

Harding, K., Galano, J., Martin, J., Huntington, L., Schellenbach, C.J. (2007). Healthy Families America effectiveness: a comprehensive review of outcomes. *Journal of Prevention & Intervention in the Community, 34*(1–2), 149–79.

Häyrinen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: a review of the research literature. *International Journal of Medical Informatics, 77*(5), 291-304.

Institute of Medicine. (2012). *Living Well with Chronic Illness: A Call for Public Health Action.* Washington, DC: National Academies Press.

Institute of Medicine. (2014a). *Capturing Social and Behavioral Domains in Electronic Health Records: Phase I.* Washington, DC: The National Academies Press.

Institute of Medicine. (2014b). *Capturing Social and Behavioral Domains in Electronic Health Records: Phase II.* Washington, DC: The National Academies Press.

Isaacowitz, D.M., Vaillant, G.E., Seligman, M.E. (2003). Strengths and satisfaction across the adult lifespan. *International Journal of Aging & Human Development, 57*(2), 181-201.

Johnson, K.E., McMorris, B.J., Raynor, L.A., & Monsen, K.A. (2013). What big size you have! Using effect Sizes to determine the impact of public health nursing interventions. *Applied Clinical Informatics, 4,* 434-444. DOI: 10.4338/ACI-2013-07-RA-0044.

Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A., & Collins, L. M. (2015). *PROC LCA & PROC LTA users' guide (Version 1.3.2).* University Park: The Methodology Center, Penn State. Retrieved from http://methodology.psu.edu.

LeCroy, C.W. & Davis, M.F. (2016). Randomized trial of healthy families Arizona: quantitative and qualitative outcomes. *Research on Social Work Practice,* [online] [cit. 2016-12-26].

Liepelt, K. (2015). Top Reasons for Moving to a Senior Living Community. Retrieved from https://seniorhousingnews.com/2015/11/12/top-reasons-for-moving-to-a-senior-living-community/.

Martin, K.S. (2005). *The Omaha System: A key to Practice, Documentation, and Information Management.* (reprinted 2nd ed.). Omaha, NE: Health Connections Press.

McAuley, E., Konopack, J.F., Morris. K.S., Motl, R.W., Hu, L., Doerksen, S.E., & Rosengren, K. (2006). Physical activity and functional limitations in older women: influence of self-efficacy. *The journals of gerontology. Series B, Psychological sciences and social sciences, 61*(5), P270-P277.

Miles, P., Bruns, E. J., Osher, T. W., & Walker, J. S. (2006). *The wraparound process user's guide: A handbook for families.* Portland, OR: National Wraparound Initiative, Research and Training Center on Family Support and Children's Mental Health, Portland State University.

Monsen, K.A, Vanderboom, C.E., Olson, K.S., Larson, M.E., & Holland, D.E. (2017a). Care coordination from a strengths perspective: A practice-based evidence evaluation of evidence-based practice. *Research and Theory for Nursing Practice. An International Journal, 31*(1). doi:10.1891/1541-6577.31.1.39.

Monsen, K.A, Swenson, S.M., Klotzbach, L.S., Mathiason, M.A., & Johnson, K.E. (2017b). Empirical evaluation of the changes in public health nursing interventions

after the implementation of an evidence-based family home visiting guideline. *Kontakt, 19,* e75-e85. http://dx.doi.org/10.1016/j.kontakt.2017.03.002.

Monsen, K.A., Peters, J., Schlesner, S., Vanderboom, C.E., & Holland, D.E. (2015). The gap in big data: Getting to wellbeing, strength, and a whole-person perspective. *Global Advances in Health and Medicine, 4*(3), 31-39.

Monsen, K.A., Holland, D.E., Fung-Houger, P.W., & Vanderboom, C.E. (2014). Seeing the whole person: Feasibility of using the Omaha System to describe strengths of older adults with chronic illness. *Research and Theory for Nursing Practice. An International Journal, 28*(4), 299-315.

Monsen, K.A., Radosevich, D.M., Kerr, M.J., & Fulkerson, J.A. (2011). Public health nurses tailor home visiting interventions. *Public Health Nursing, 28*(2), 119-28.

Monsen, K.A. & Martin, K.S. (2002). Developing an outcomes management program in a public health department. *Outcomes Management, 6*(2), 62-6.

Moore, R. & Stonham, G. (2010). Electronic care records give nurses access to information that can transform patient care. *Nursing Times, 106*(13), 8-9.

Netz, Y., Wu, M., Becker, B.J., Tenenbaum, G. (2005). Physical activity and psychological well-being in advanced age: a meta-analysis of intervention studies. *Psychology and Aging, 20*(2), 272–284.

Rajeski, W. & Mihalko, S. (2001). Physical activity and quality of life in older adults. *The Journal of Gerontology Medical Science, 56A,* 23-36.

Rotegård, A.K., Ruland, C.M., & Fagermoen, M.S. (2011). Nurse perceptions and experiences of patient health assets in oncology care: a qualitative study. *Research and Theory for Nursing Practice An International Journal, 25*(4), 284-301.

Royall, D.R., Lauterbach, E.C., Kaufer, D., Malloy, P., Coburn, K.L., & Black, K.J. (2007). The cognitive correlates of functional status: a review from the Committee on Research of the American Neuropsychiatric Association. *The Journal of Neuropsychiatry & Clinical Neurosciences, 19*(3), 249-65.

Steverink, N., Lindenberg, S., Slaets, J.P.J. (2005). How to understand and improve older people's self-management of wellbeing. *European Journal of Ageing, 2,* 235–244.DOI 10.1007/s10433-005-0012-y.

Takai, Y., Yamamoto-Mitani, N., Okamoto, Y., Koyama, K., Honda, A. (2010). Literature review of pain prevalence among older residents of nursing homes. *Pain Management Nursing, 11*(4): 209-23. doi: 10.1016/j.pmn.2010.08.006.

The U.S. Department of Health and Human Services (HHS). (2016). HealtyPeople2020. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/older-adults#1. Accessed on 12/12/2016.

Wadensten, B. & Carlsson, M. (2003). Theory-driven guidelines for practical care of older people, based on the theory of gerotranscendence. *Journal of Advanced Nursing*, *41*(5), 462-70.

Yaffe, K., Fiocco, A.J., Lindquist, K., Vittinghoff, E., Simonsick, E.M., Newman, A.B., Satterfield, S., Rosano, C., Rubin, S.M., Ayonayon, H.N., Harris, T.B., & and For the Health ABC Study. (2009). Predictors of maintaining cognitive function in older adults. *Neurology*, *72*(23), 2029–2035. DOI: 10.1212/WNL.0b013e3181a92c36.

Appendix 1: Definitions of Omaha System Domains and Problems (Martin 2005)

Omaha System Domain (Definition)	Omaha System Problem	Definition
Environmental (Material resources and physical surrounds both inside and outside the living area, neighborhood, and broader community)	Income	Money from wages, pensions, subsidies, interest, dividends, or other sources available for living and health care expenses.
	Residence	Living area.
	Neighborhood/ workplace safety	Freedom from illness, injury or loss in the community or place of employment.
Psychosocial (Patterns of behavior, emotions, communication, relationships, and development)	Communication with community resources	Interaction between the individual/family/community and social service organizations, schools, and businesses in regard to services, information, and goods/supplies.
	Social contact	Interaction between the individual/family/community and others outside the immediate living area.
	Role change	Additions to or removal of a set of expected behavioral characteristics.
	Interpersonal relationship	Associations or bonds between the individual/family/ community and others.
	Spirituality	Beliefs and practices that involve faith, religion, values, the spirit, and/or the soul.
	Grief	Suffering and distress associated with loss.
	Mental health	Development and use of mental/emotional abilities to adjust to life situations, interact with others, and engage in activities.
	Sexuality	Attitudes, feelings, and behaviors related to intimacy and sexual activity.
	Neglect	Child or adult deprived of minimally accepted standards of food shelter, clothing, or care.
	Abuse	Child or adult subjected to nonaccidental physical, emotional, or sexual violence or injury.
Physiological (Functions and processes that maintain	Hearing	Perception of sound by the ears.
	Vision	Act or power of sensing with the eyes.

life)	Speech and language	Use of articulated vocal sounds, symbols, signs, or gestures for communication.
	Cognition	Ability to think and use information.
	Pain	Unpleasant sensory and emotional experience associated with actual or potential tissue damage.
	Consciousness	Awareness of and responsiveness to stimuli and the surroundings.
	Skin	Natural covering of the body.
	Neuro-musculo-skeletal function	Ability of nerves, muscles, and bones to perform or coordinate specific movement, sensation, or regulation.
	Respiration	Inhaling and exhaling air into the body and exchanging oxygen.
	Circulation	Pumping blood in adequate amounts and pressure throughout the body.
	Digestion-hydration	Process of converting food into forms that can be absorbed and assimilated, and maintain fluid balance.
	Bowel function	Transporting food through the gastrointestinal tract to eliminate wastes.
	Oral health	Condition of the mouth and gums and the number, type, and arrangement of the teeth.
	Urinary function	Production and excretion of urine.
Health-related Behaviors (Patterns of activities that maintain or promote wellness, promote recovery, and decrease the risk of disease)	Nutrition	Select, consume, and use food and fluids for energy, maintenance, growth, and health.
	Sleep and rest patterns	Periods of suspended motor and sensory activity and periods of inactivity, repose, or mental calm.
	Physical activity	State or quality of body movements during daily living.
	Personal care	Management of personal cleanliness and dressing.
	Substance use	Consumption of medicines, recreational drugs, or other materials likely to cause mood changes and/or psychological/ physical dependence, illness, and disease.
	Health care supervision	Management of the health care treatment plan by health care

		providers.
	Medication regimen	Use or application of over-the-counter and prescribed/ recommended medications and infusions to meet guidelines for therapeutic action, safety, and schedule.

Chapter 5 Synthesis

This chapter synthesizes and interprets the overall findings connected by a unifying theme presented across these three manuscripts in this dissertation. It also discusses the new contribution of the full set of findings to the body of science, and explains the importance of these manuscripts in relation to the main topic. This chapter is concluded by a discussion of new direction for future research and implications of these findings for nursing practice.

Overall Findings

A unifying theme across these manuscripts is the central focus on the use of strengths data to compose an individual's health story and experience. Such a consistent theme is unfolded in EHR documentation, data capture for risk assessment and health management, and strengths-based research using a data-driven model. As an emerging type of data, strengths data complement problem-based data to tell a whole-person health story and care experience.

In the critical review manuscript, the focal point of the narration of a health story in EHRs concentrates on a person's problems, but attentions to a whole-person data integration including strengths are emerging (Monsen et al., 2014; Monsen et al., 2015). This review used 8 Search terms and two databases. The search results returned 602 articles. 24 articles were selected for review. Four themes unfolded. The first theme (15 articles) focused on either individual or cross-institutional use of problem-oriented EHRs with a singular persona of patient health narration (Steindel, 2012; Bayegan & Nytro, 2002; De Clercq, 2008; Uto, Iwaanakuchi, Muranaga, & Kumamoto, 2013; Wasserman

& Wang, 2003; Fung & Xu, 2015; Wright et al., 2011; Poissant, Taylor, Huang, & Tamblyn, 2010; Wang et al., 2013; Bakel et al., 2014; Pacheco, Thompson, & Kho, 2011; Banerjee, Gambler, & Fogleman, 2013; Van Vleck, Wilcox, Stetson, Johnson, & Elhadad, 2008; Wright, Maloney, & Feblowitz, 2011; Holmes, Brown, Hilaire, & Wright, 2012). The second theme (2 articles) addressed the extension of problem-based EHRs with other integration that incorporated multiple personas of patient health narration (Englebright, Aldrich, & Taylor, 2014; Rosenberg, 2006). The third theme (3 articles) elaborated upon patient-centered integration of the problem-oriented EHR that included a patient as a persona to communicate their own health experience (Chunchu & Mauksch, 2012; Almunawar, Anshari, Younis, & Kisa, 2015; Li, Lee, Jian, & Kuo, 2009). And the fourth theme (4 articles) detailed the construction of whole-person data capture to include strengths in the EHR documentation and an additional emerging positive perspective in the patient health narration in strengths-based research using the standardized terminologies, the Omaha System and the International Classification of Nursing Practice (Monsen et al, 2015; Monsen et al., 2014; Rotegaard & Ruland, 2010; Rotegaard & Ruland, 2009).

The critical review discovered that clinical documentation of patient care is typically framed under problem-oriented structure (Fung, McDonald, & Srinivasan, 2010; Dick & Steen, 1991; Campbell, 1998) following a method of organizing the problem list as the center of medical records to create a system of patient care solutions (Weed, 1968). Such a problem-oriented framework leaves a data gap in the documentation of psychosocial and behavioral domains in EHRs (Monsen et al., 2015; IOM, 2014a; IOM, 2014b; Gao et al., 2016). However, new data sources have presented emerging trends

toward a movement in EHR documentation from a singular provider's persona to multiple provider personas and a patient persona from both positive and negative perspectives of strengths and problems of a patient's health (Englebright, Aldrich, & Taylor, 2014; Rosenberg, 2006; Chunchu & Mauksch, 2012; Almunawar, Anshari, Younis, & Kisa, 2015; Li, Lee, Jian, & Kuo, 2009; Monsen et al, 2015; Monsen et al., 2014; Rotegaard & Ruland, 2010; Rotegaard & Ruland, 2009).

The conventional problem-oriented infrastructure dictates what data is employed based on problems to build healthcare discourse and how this discourse unfolds (Kuhn et al., 2015). Such a healthcare model tends to obscure data for risk assessment and risk management toward problems and negates the capture of health assets or strengths. In the second manuscript on the strengths-based data capture model, strengths data are envisioned to be added to this discourse and to build data capture in person-centered risk assessment and health management as health assets. As healthcare pushes forward to value-based care (Porter & Teisberg, 2006), capitalizing strengths as health assets and improving health value align with person-centered and person-driven efforts toward better health. The proposed strengths-based data capture model explores an innovative perspective that encourages data capture and data use established upon person-centered and population-oriented strengths to enhance healthcare quality, outcome and value. This future-driven model implies that prediction is established upon scalable upgrades that come with unfolding updates of new data trends and patterns. And it will always remain an ongoing endeavor with regard to who, what, and how to define and utilize health risks and health assets through data capture and knowledge representation to promote health, and prevent and manage disease.

In the last manuscript about strengths-based research, strengths data are explored in the context of wellbeing to detect associations among older adults' strengths, problems, and baseline KBS with nursing interventions in care planning captured in EHR data using a data-driven model.

This study suggests that strengths data encompass comprehensive domains of health. In addition, it also identifies that both positive attributes of strengths and negative attributes of signs/symptoms co-exist on a broad, global level as represented by Omaha System domains and a specific, conceptual level of topics as depicted by Omaha System problem concepts. Therefore, both types of strengths data and problem-based data should be created, structured, and made available in health information system (Kotoulas et al., 2014; Monsen et al., 2014; Monsen et al., 2015; Gao et al., 2016). To promote health and manage disease, positive attributes such as strengths should be captured and leveraged based on both global domains and their associated topics of concepts.

Some findings in this research about older adults' strengths and problems align with and extend previous research about older adults with chronic conditions (Monsen et al., 2014; Monsen et al., 2015; Dean, Koloby, & Wood, 1990; Penninx et al., 1997; Park, 2009) and demonstrate the potential to conduct data-driven comparisons of strengths and problems across populations and settings. This study also revealed new knowledge and found some associations among group characteristics of strengths and signs/symptoms and planned interventions. Strengths in certain areas such as physical activity may increase the capacities of older adults' strengths to promote their health and positive outcomes and supports research findings that consistently associate physical activity with enhanced quality of life (McAuley et al., 2006; Netz et al., 2005). This study also found

that nurses plan more interventions and activities in care for those older adults who have more problems related to physiological origins and health-related behaviors and tailor their care to address such problems. Such results concur with other studies' findings that the use of symptom assessment tools can significantly improve patient-centered care and patient outcomes (Ruland et al., 2010) and that conducting patients' assessments to elicit patient preferences and include them in nursing care planning is an effective strategy for improving nursing care and patient outcomes (Ruland, 1999).

Promotion of better person-centered health requires better data to document better strengths in addition to management of their health problems. A strengths-based approach requires the articulation of new sets of principles and structures as well as a new language to communicate (Gottlieb, 2013). The Omaha System terminology appears to be able to capture both types of strengths and problem-based data using both its domains at a global level and problem concepts at a local level of topical concepts as a strength-based vocabulary in clinical documentation. However, on an attribute level, even though a standardized description of negative attributes exists by using signs/symptoms in the Omaha System taxonomy, there lacks a standardized capture of positive attributes of strengths indicators. The need to discover and classify positive attributes in strengths still requires to be addressed so that strengths data can be available for data capture and use in clinical practice and in EHRs.

There is a need to further examine how a whole-person assessment including strengths may be leveraged to reduce risk and improve health care outcomes. Further study and replication with other datasets are needed. The cutting-edge knowledge about older adults' strengths and associated nursing care planning could be utilized to create a

platform for future research use of the Omaha System as a strength-based ontology in clinical practice and documentation.

Contributions

The exploration of strengths and problems data capture in EHRs provide illuminating results about the current state and emerging trends in clinical practice and documentation. The strengths-based data capture model offers a new insight into which a person's health risk and management could be performed. The strengths-based research adds new knowledge to the body of nursing science about strengths-data in older adults and related nursing care planning. These manuscripts all add different areas of knowledge or perspective to the main topic of strengths in this dissertation.

Implications/Future Directions

This dissertation has many implications for nursing practice. The emerging documentation of formalized strengths attributes may promote a holistic approach to clinical practice and documentation (Monsen et al., 2014; Monsen et al., 2015; Gao et al., 2016; Monsen et al., 2017a) using a person-centered, strength-based ontology. By adopting a strengths-based data capture model, future-oriented health management and health promotion can incorporate the use of personalized health assets and positive relationships in nursing care delivery and management. Findings outlined from the data-driven comparative study of strengths data in this dissertation showcase the terminology and language used to capture older adults' strengths. These findings suggest that strengths and problems are not only a dichotomy but also a continuous stream that flows through and coexists within health. This study gains a deeper insight into older adults' strengths and problems using a data-driven model as a method of inquiry in strengths-

based research. This method aids the exploratory analysis of various dimensions of older adults' strengths and problems and enables the examination and implications of nursing care planning constructs and associated meanings. There appears an urgent need for nursing to evaluate what constitutes strengths and how such data are captured in recounting a person's health story. Such data capture may serve to complement the gap in problem-based documentation and carry transformative implications toward a whole-person approach for nursing practice and care management.

Ongoing assessment of a person's strengths and assessment findings by nurses underpin many patient care decisions (Banning, 2008). Recognition of strengths and leveraging its use can improve patient outcomes by promoting prediction and prevention. Nurses play an important role in disease prevention and health promotion. Nurses are valuable resources in driving a change in clinical documentation as strengths-based data capture is adopted in assessment and management processes to advance whole-person oriented care.

The positive aspects as embodied in strengths reveal an opportunity to discover personal strengths and mobilize strengths as health assets and as an effective strategy for their own care. Data capture of strengths provides innovative data sources that can be transformed into meaningful knowledge to inform new opportunities and to harness personal health assets that have not been used within the conventional problem-based framework. This manuscript provides an overview of recent innovations in data sources that could be used to support capitalization of personal health assets demonstrated by strengths.

Based on what is presented in this dissertation, available strengths data are captured by a defined taxonomy using the Omaha System. Future research in this field would greatly benefit from a meaningful taxonomy and classification of strengths data. There appears a need for proposing a way of classifying strengths in data capture and strategically reviewing the existing strengths data focusing on the terminology development, that should include its entirety from classification to nomenclatures, language labels to concepts (Chute, 2000). Ways of improving on current strengths data capture designs should also be considered in order to achieve an efficient and effective strengths data capture and use for future clinical documentation and practice, including any set of actions that warrant data integrity, data availability from a secured electronic source. It is important to detect and execute strengths data whenever relevant and needed and use the taxonomies as sources of information and a guide for future research efforts and practice.

The findings in this dissertation point out a new direction for future research on strengths data and the construction of a whole-person, strengths-oriented ontology in the composition of a person's health story. Future research is needed to identify relevancy of strengths data and their attributes in different populations and healthcare settings and their impact in an individual's healthcare plannings and services.

References

Agency for Healthcare Research and Quality. (2012). Prospects for care coordination measurement using electronic data sources. Publication no. 12-0014-EF. Washington, DC: AHRQ.

AHIMA. (2008). AHIMA Best Practices for Problem Lists in an EHR Work Group: Best practices for problem lists in an EHR. *Journal of AHIMA, 79*(1), 73–77.

Almunawar, M.N., Anshari M, Younis MZ, & Kisa A. (2015). Electronic health object: Transforming health care systems from static to interactive and extensible. *Inquiry: The Journal of Health Care Organization, Provision, and Financing, 52*, 1-10.

American Medical Informatics Association (AMIA). (2017). Redefining our picture of health: Towards a person-centered integrated care, research, wellness, and community ecosystem. *A White Paper of the 2017 AMIA Policy Invitational.* Retrieved from https://www.amia.org/sites/default/files/API-2017-White-Paper-Redefining-our-Picture-of-Health.pdf.

American Nurses Association (2008). *Nursing informatics: Scope and standards of practice.* Silver Spring, MD: Nursesbooks.org.

Bachman, J.W. (2003). The patient-computer interview: a neglected tool that can aid the clinician. *Mayo Clinic Proceedings, 78,* 67-78.

Bakel, L.A., Wilson, K., Tyler, A., Tham, E., Reese, J., Bothner, J., & Kaplan, D.W. (2014). A quality improvement study to improve inpatient problem list use. *Hospital Pediatrics, 4*(4), 205-10.

Banerjee, E.S., Gambler, A., & Fogleman, C. (2013). Adding obesity to the problem list increases the rate of providers addressing obesity. *Family Medicine, 45*(9), 629-33.

Banning, M. (2008). A review of clinical decision making: models and current research. *Journal of Clinical Nursing, 17*(2), 187-95.

Bayegan, E. & Nytro, O. (2002). A problem-oriented, knowledge-based patient record system. *Studies in Health Technology and Informatics*, *90*, 272-276.

Campbell, J.R. (1998). Strategies for problem list implementation in a complex clinical enterprise. *AMIA Annual Symposium Proceedings,* 285-9.

Charon, R. (2012). At the membranes of care: stories in narrative medicine. *Academic Medicine, 87*(3), 342–347.

Chunchu, K. & Mauksch, L. (2012). Patient centered care plan in the EHR: Improving collaboration and engagement. *Families, Systems, & Health, 30*(3), 199–209.

Chute, C.G. (2000). Clinical classification and terminology: Some history and current observations. *Journal of the American Medical Informatics Association*, *7*(3), 298–303. https://doi.org/10.1136/jamia.2000.000298.

Cimino, J.J. (2013). Improving the electronic health record: getting what we wished for. *JAMA.*, *309*(10), 991-2.

Cusack, C.M., Hripcsak, G., Bloomrosen, M., Rosenbloom, S.T., Weaver, C.A., Wright, A., et al. (2013). The future state of clinical data capture and documentation: a report from AMIA's 2011 Policy Meeting. *Journal of the American Medical Informatics Association, 20,* 134-40. doi:10.1136/amiajnl-2012-001093.

Das, R., (2015). A silver tsunami invades the health of nations. Retrived from https://www.forbes.com/sites/reenitadas/2015/08/11/a-silver-tsunami-invades-the-health-of-nations/#4719c9b23efd.

De Clercq, E. (2008). From a conceptual problem-oriented electronic patient record model to running systems: A nationwide assessment. *International Journal of Medical Informatics, 77*(5), 346-53.

Dean, A., Koloby, B., & Wood, P. (1990). Effects of social support from various sources on depression in elderly persons. *Journal of Health and Social Behavior, 31,* 148–61.

Dick, R.S. & Steen EB. (eds.). (1991). *The Computer-Based Record: An Essential Technology for Health Care.* Institute of Medicine, National Academy of Sciences.

Englebright, J., Aldrich, K., & Taylor, C.R. (2014). Defining and incorporating basic nursing care actions into the electronic health record. *Journal of Nursing Scholarship, 46*(1), 50-57.

Federal Interagency Forum on Aging-Related Statistics. (2016). *Older Americans 2016: Key Indicators of Well-Being.* Federal Interagency Forum on Aging-Related Statistics. Washington, DC: U.S. Government Printing Office.

Fiatarone-Singh, M. & Mayer, J. (2002). Exercise comes of age rationale and recommendations for a geriatric exercise prescription. *Journal of Gerontology Medical Science., 57a*, M262-82.

Freedman, V.A. & Spillman, B.C. (2014). Disability and care needs among older Americans. The *Milbank Quarterly., 92*(3), 509-41. doi: 10.1111/1468-0009.12076.

Fung, K.W., McDonald, C., & Srinivasan, S. (2010). The UMLS-CORE project: A study of the problem list terminologies used in large healthcare institutions. *Journal of the American Medical Informatics Association, 17*(6), 675–680.

Fung, K.W. & Xu, J. (2015). An exploration of the properties of the CORE problem list subset and how it facilitates the implementation of SNOMED CT. *Journal of the American Medical Informatics Association*, *22*(3), 649-58.

Gao, G., Kerr, M., Lindquist, R., & Monsen, K. (2016). Documentation of patient problems and strengths in electronic health records. *Internal Medicine: Open Access, 6,* 221doi:10.4172/2165-8048.1000221.

Gerteis, J., Izrael, D., Deitz, D., LeRoy, L., Ricciardi, R., Miller, T., Basu, J. (2014). *Multiple Chronic Conditions Chartbook*. AHRQ Publications No, Q14-0038. Rockville, MD: Agency for Healthcare Research and Quality; Accessed February 18, 2017 @ https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/prevention-chronic-care/decision/mcc/mccchartbook.pdf.

Gottlieb, L.N. (2013). *Strengths-Based Nursing Care: Health And Healing For Person And Family*. New York: Springer Publishing Comparny, LLC.

Graves, J.R. & Corcoran, S. (1989). The study of nursing informatics. *Image–the Journal of Nursing Scholarship, 21*(4): 227-231.

Harding, K., Galano, J., Martin, J., Huntington, L., Schellenbach, C.J. (2007). Healthy Families America effectiveness: a comprehensive review of outcomes. *Journal of Prevention & Intervention in the Community, 34*(1–2):149–79.

Häyrinen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: a review of the research literature. *International Journal of Medical Informatics, 77*(5), 291-304.

HealthIT.gov. (2016). EHR Incentives & Certification. https://www.healthit.gov/providers-professionals/how-attain-meaningful-use. Accessed 25 May 2016.

HealthIt.gov. (2016). Maintain problem lists. https://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures/patient-problem-list Accessed 10 May 2016.

Holmes, C. (2011). The problem list beyond meaningful use. Part I: The problems with problem lists. *Journal of AHIMA, 82*(2):30-3.

Holmes, C., Brown, M., Hilaire, D.S., & Wright, A. (2012). Healthcare provider attitudes towards the problem list in an electronic health record: a mixed-methods qualitative study. *BMC Medical Informatics and Decision Making, 12,* 127.

Institute of Medicine. (2010). *The Future of Nursing: Leading Change, Advancing Health.* Washington, DC: National Academies Press.

Institute of Medicine. (2012). *Living Well with Chronic Illness: A Call for Public Health Action.* Washington, DC: National Academies Press.

Institute of Medicine. (2014a). *Capturing Social and Behavioral Domains in Electronic Health Records: Phase I.* Washington, DC: The National Academies Press.

Institute of Medicine. (2014b). *Capturing Social and Behavioral Domains in Electronic Health Records: Phase II.* Washington, DC: The National Academies Press.

Isaacowitz, D.M., Vaillant, G.E., Seligman, M.E. (2003). Strengths and satisfaction across the adult lifespan. *International Journal of Aging & Human Development, 57*(2), 181-201.

Johnson, K.E., McMorris, B.J., Raynor, L.A., & Monsen, K.A. (2013). What big size you have! Using effect Sizes to determine the impact of public health nursing interventions. *Applied Clinical Informatics, 4*, 434-444. DOI: 10.4338/ACI-2013-07-RA-0044.

Kaplan, D.M. (2007). Clear writing, clear thinking and the disappearing art of the problem list. *Journal of Hospital Medicine, 2*(4), 199-202.

Kotoulas, S., Sedlazek, W., Lopez, V., Sbodio, M., Stephenson, M., Tommasi, P., & Aonghusa, P.A. (2014). Enabling person-centric care using linked data technologies. *Studies in Health Technology and Informatics, 205*, 692-6.

Kreitzer, M.J. (2012). Spirituality and well-being: focusing on what matters. *Western Journal of Nursing Research*, *34*(6), 707-711.

Kuhn, T., Basch, P., Barr, M., & Yackel, T. (2015). Clinical documentation in the 21st century: Executive summary of a policy position paper from the American College of Physicians. *Annals of Internal Medicine, 162*, 301-303. doi:10.7326/M14-2128.

Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A., & Collins, L. M. (2015). *PROC LCA & PROC LTA users' guide* (Version 1.3.2). University Park: The Methodology Center, Penn State. Retrieved from http://methodology.psu.edu.

LeCroy, C.W. & Davis, M.F. (2016). Randomized trial of healthy families Arizona: quantitative and qualitative outcomes. *Research on Social Work Practice*. [online] [cit. 2016-12-26].

Li, Y.C., Lee, P.S., Jian, W.S., & Kuo, C.H. (2009). Electronic health record goes personal world wide. *IMIA Yearbook of Medical Informatics*, 40-43.

Liepelt, K. (2015). Top Reasons for Moving to a Senior Living Community. Retrieved from https://seniorhousingnews.com/2015/11/12/top-reasons-for-moving-to-a-senior-living-community/.

Martin, K.S. (2005). *The Omaha System: A key to Practice, Documentation, and Information Management.* (reprinted 2nd ed.). Omaha, NE: Health Connections Press.

Matney, S., Brewster, P.J., Sward, K.A., Cloyes, K.G., & Staggers. N. (2011). Philosophical approaches to the nursing informatics data-information- knowledge-wisdom framework. *Advances in Nursing Science, 34* (1):6-18.

McAuley, E., Konopack, J.F., Morris. K.S., Motl, R.W., Hu, L., Doerksen, S.E., & Rosengren, K. (2006). Physical activity and functional limitations in older women: influence of self-efficacy. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 61*(5), P270-P277.

Miles, P., Bruns, E. J., Osher, T. W., & Walker, J. S. (2006). *The wraparound process user's guide: A handbook for families*. Portland, OR: National Wraparound Initiative, Research and Training Center on Family Support and Children's Mental Health, Portland State University.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLOS Medicine, 6*(6), e1000097. doi:10.1371/journal.pmed1000097.

Monsen, K.A, Vanderboom, C.E., Olson, K.S., Larson, M.E., & Holland, D.E. (2017a). Care coordination from a strengths perspective: A practice-based evidence

evaluation of evidence-based practice. *Research and Theory for Nursing Practice An International Journal, 31*(1). doi:10.1891/1541-6577.31.1.39.

Monsen, K.A, Swenson, S.M., Klotzbach, L.S., Mathiason, M.A., & Johnson, K.E. (2017b). Empirical evaluation of the changes in public health nursing interventions after the implementation of an evidence-based family home visiting guideline. *Kontakt, 19*: e75-e85. http://dx.doi.org/10.1016/j.kontakt.2017.03.002.

Monsen, K.A., Peters, J., Schlesner, S., Vanderboom, C.E., & Holland, D.E. (2015). The gap in big data: Getting to wellbeing, strength, and a whole-person perspective. *Global Advances in Health and Medicine, 4*(3), 31-39.

Monsen, K.A., Holland, D.E., Fung-Houger, P.W., & Vanderboom, C.E. (2014). Seeing the whole person: Feasibility of using the Omaha System to describe strengths of older adults with chronic illness. *Research and Theory for Nursing Practice An International Journal, 28*(4), 299-315.

Monsen, K.A., Radosevich, D.M., Kerr, M.J., & Fulkerson, J.A. (2011). Public health nurses tailor home visiting interventions. *Public Health Nursing, 28*(2), 119-28.

Monsen, K.A. & Martin, K.S. (2002). Developing an outcomes management program in a public health department. *Outcomes Management, 6*(2), 62-6.

Moore, R. & Stonham, G.(2010). Electronic care records give nurses access to information that can transform patient care. *Nursing Times, 106*(13), 8-9.

Netz, Y., Wu, M., Becker, B.J., Tenenbaum, G. (2005). Physical activity and psychological well-being in advanced age: a meta-analysis of intervention studies. *Psychology and Aging, 20*(2), 272–284. 10.1037/0882-7974.20.2.272.

Pacheco, J.A., Thompson, W., & Kho, A. (2011). Automatically detecting problem list omissions of type 2 diabetes cases using electronic medical records. *AMIA Annual Symposium Proceedings*, 1062-9.

Park, N.S. (2009). The relationship of social engagement to psychological well-being of older adults in assisted living facilities. *Journal of Applied Gerontology, 28*(4), 461-481.

Penninx, B.W.J.H., van Tilburg, T., Kriegsman, D.M.W., Deeg, D.J.H., Boek, A.J.P., van Eijk. J.T.M. (1997). Effects of social support and personal coping resources on mortality in older age: the longitudinal Aging Study Amsterdam. *American Journal of Epidemiology, 146*, 510–9.

Petera, C., Raucha, A., Ciezaa, A., & Geyha, S. (2012). Stress, internal resources and functioning in a person with spinal cord disease. *Neuro Rehabilitation*, *30*:119–130.

Poissant, L., Taylor, L., Huang, A., & Tamblyn, R. (2010). Assessing the accuracy of an inter-institutional automated patient-specific health problem list. *BMC Medical Informatics and Decision Making*, *23*:10.

Popkess, S.A. (1981). Diganosing your patient's strengths. *Nursing, 11*(7):34-7.

Porter, M.E. & Teisberg, E.O. (2006). *Redefining health care: creating value-based competition on results.* Boston: Harvard Business School Press.

Rajeski, W. & Mihalko, S. (2001). Physical activity and quality of life in older adults. *Journal of Gerontology Medical Science, 56A*: 23-36.

Rosenberg, S. (2006). Utilizing the language of Jean Watson's Caring Theory within a computerized clinical documentation system. *CIN: Computers, Informatics, Nursing*, *24*(1), 53–56.

Rotegaard, A.K. & Ruland, C.M. (2009). Representation of patients' health asset concepts in the International Classification of Nursing Practice (ICNP). *Studies in Health Technology and Informatics, 146*, 314-9.

Rotegaard, A.K. & Ruland, C.M. (2010). Patient centeredness in terminologies: Coverage of health assets. Concepts in the International Classification of Nursing Practice. *Journal of Biomedical Informatics, 43,* 805–811.

Rotegård, A.K., Ruland, C.M., & Fagermoen, M.S. (2011). Nurse perceptions and experiences of patient health assets in oncology care: a qualitative study. *Research and Theory for Nursing Practice: An International Journal*, *25*(4), 284-301

Rotegård, A.K., Fagermoen, M.S., Ruland, C.M. (2012). Cancer patients' experiences of their personal strengths through illness and recovery. *Cancer Nursing, 35*(1), E8-E17.

Rothschild, A.S., Dietrich, L., Ball, M.J., Wurtz, H., Farish-Hunt, H., & Cortes-Comerer, N. (2005). Leveraging systems thinking to design patient-centered clinical documentation systems. *International Journal of Medical Informatics, 74*, 395-398.

Royall, D.R., Lauterbach, E.C., Kaufer, D., Malloy, P., Coburn, K.L., & Black, K.J. (2007).The cognitive correlates of functional status: a review from the Committee on Research of the American Neuropsychiatric Association. *The Journal of Neuropsychiatry & Clinical Neurosciences, 19*(3), 249-65.

Ruland, C.M. (1999). Decision support for patient preference-based care planning: effects on nursing care and patient outcomes. *Journal of the American Medical Informatics Association, 6*(4), 304-12.

Ruland, C.M., Holte, H.H., Røislien, J., Heaven, C., Hamilton, G.A., Kristiansen, J., Sandbæk, H., Kvaløy, S.O., Hasund, L., & Ellison, M.C. (2010). Effects of a computer-supported interactive tailored patient assessment tool on patient care, symptom distress, and patients' need for symptom management support: a randomized clinical trial. *Journal of the American Medical Informatics Association*, *17*(4), 403–410. https://doi.org/10.1136/jamia.2010.005660.

Slack, W.V., Kowaloff, H.B., Davis, R.B., Delbanco, T., Locke, S.E., Safran, C., et al. (2012). Evaluation of computer-based medical histories taken by patients at home. *Journal of the American Medical Informatics Association, 19*, 545-8. doi:10.1136/amiajnl-2011-000580.

Steindel, S.J. (2012). A comparison between a SNOMED CT Problem List and the ICD-10-CM/PCS HIPAA Code Sets. *Perspectives in Health Information Management*, *9*, 1b.

Steverink, N., Lindenberg, S., Slaets, J.P.J. (2005). How to understand and improve older people's self-management of wellbeing. *European Journal of Ageing*, *2*, 235–244.DOI 10.1007/s10433-005-0012-y.

Swan, M. (2009). Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. *International Journal of Environmental Research and Public Health*, *6*(2):492–525.

Takai, Y., Yamamoto-Mitani, N., Okamoto, Y., Koyama, K., Honda, A. (2010). Literature review of pain prevalence among older residents of nursing homes. *Pain Management Nursing, 11*(4), 209-23. doi: 10.1016/j.pmn.2010.08.006.

The U.S. Department of Health and Human Services (HHS). (2016). *HealtyPeople2020*. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/older-adults#1. Accessed on 12/12/2016.

Tsasis, P., Evans, J. M., Forrest, D., & Jones, R.K. (2013). Outcome mapping for health system integration. *Journal of Multidisciplinary Healthcare, 6,* 99-107.

Uto, Y., Iwaanakuchi, T., Muranaga, F., & Kumamoto, I. (2013). Development of the electronic patient record system based on problem oriented system. *Studies in Health Technology and Informatics*, *192*, 1036.

Van Vleck, T.T., Wilcox, A., Stetson, P.D., Johnson, S.B., & Elhadad, N. (2008). Content and structure of clinical problem lists: a corpus analysis. *AMIA Annual Symposium Proceedings, 6,* 753-7.

Wadensten, B. & Carlsson, M. (2003). Theory-driven guidelines for practical care of older people, based on the theory of gerotranscendence. *Journal of Advanced Nursing, 41*(5), 462-70.

Wang, S.J., Bates, D.W., Chueh, H.C., Karson, A.S., Maviglia, S.M., Greim, J.A., Frost, J.P., & Kuperman, G.J. (2003). Automated coded ambulatory problem lists: evaluation of a vocabulary and a data entry tool. *International Journal of Medical Informatics*, *72*(1-3), 17-28.

Wasserman, H. & Wang, J. (2003). An applied evaluation of SNOMED CT as a clinical vocabulary for the computerized diagnosis and problem list. *AMIA Annual Symposium Proceedings,* 699-703.

Weed, L.L. (1968). Medical records that guide and teach. *The New England Journal of Medicine, 278,* 652e7.

Wiley, L. (ed.). (1979). Nursing grand rounds: finding--and using--your patient's strengths. *Nursing, 9*(3), 40-5.

Wright, A., Pang, J., Feblowitz, J.C., Maloney, F.L., Wilcox, A.R, Ramelson, H.Z., Schneider, L.I., Bates, D.W. (2011). A method and knowledge base for automated inference of patient problems from structured data in an electronic medical record. *Journal of the American Medical Informatics Association, 18,* 859-867.

Wright, A., Maloney, F.L., & Feblowitz, J.C. (2011). Clinician attitudes toward and use of electronic problem lists: a thematic analysis. *BMC Medical Informatics and Decision Making,* 11:36.

Yaffe, K., Fiocco, A.J., Lindquist, K., Vittinghoff, E., Simonsick, E.M., Newman, A.B., Satterfield, S., Rosano, C., Rubin, S.M., Ayonayon, H.N., Harris, T.B., & and For the Health ABC Study. (2009). Predictors of maintaining cognitive function in older adults. *Neurology, 72*(23), 2029–2035. DOI:10.1212/WNL. 0b013e3181a92c36.

Appendix 1 Definitions of Omaha System Domains and Problems

(Martin 2005)

Omaha System Domain (Definition)	Omaha System Problem	Definition
Environmental (Material resources and physical surrounds both inside and outside the living area, neighborhood, and broader community)	Income	Money from wages, pensions, subsidies, interest, dividends, or other sources available for living and health care expenses.
	Residence	Living area.
	Neighborhood/ workplace safety	Freedom from illness, injury or loss in the community or place of employment.
Psychosocial (Patterns of behavior, emotions, communication, relationships, and development)	Communication with community resources	Interaction between the individual/family/community and social service organizations, schools, and businesses in regard to services, information, and goods/supplies.
	Social contact	Interaction between the individual/family/community and others outside the immediate living area.
	Role change	Additions to or removal of a set of expected behavioral characteristics.
	Interpersonal relationship	Associations or bonds between the individual/family/ community and others.
	Spirituality	Beliefs and practices that involve faith, religion, values, the spirit, and/or the soul.
	Grief	Suffering and distress associated with loss.
	Mental health	Development and use of mental/emotional abilities to adjust to life situations, interact with others, and engage in activities.
	Sexuality	Attitudes, feelings, and behaviors related to intimacy and sexual activity.
	Neglect	Child or adult deprived of minimally accepted standards of food shelter, clothing, or care.
	Abuse	Child or adult subjected to nonaccidental physical, emotional, or sexual violence or injury.
Physiological (Functions and processes that maintain life)	Hearing	Perception of sound by the ears.
	Vision	Act or power of sensing with the eyes.
	Speech and language	Use of articulated vocal sounds, symbols, signs, or gestures for communication.
	Cognition	Ability to think and use information.
	Pain	Unpleasant sensory and emotional experience associated with actual or potential tissue damage.
	Consciousness	Awareness of and responsiveness to stimuli and the surroundings.
	Skin	Natural covering of the body.
	Neuro-musculo-skeletal function	Ability of nerves, muscles, and bones to perform or coordinate specific movement, sensation, or regulation.
	Respiration	Inhaling and exhaling air into the body and exchanging oxygen.
	Circulation	Pumping blood in adequate amounts and pressure

Omaha System Domain (Definition)	Omaha System Problem	Definition
		throughout the body.
	Digestion-hydration	Process of converting food into forms that can be absorbed and assimilated, and maintain fluid balance.
	Bowel function	Transporting food through the gastrointestinal tract to eliminate wastes.
	Oral health	Condition of the mouth and gums and the number, type, and arrangement of the teeth.
	Urinary function	Production and excretion of urine.
Health-related Behaviors (Patterns of activities that maintain or promote wellness, promote recovery, and decrease the risk of disease)	Nutrition	Select, consume, and use food and fluids for energy, maintenance, growth, and health.
	Sleep and rest patterns	Periods of suspended motor and sensory activity and periods of inactivity, repose, or mental calm.
	Physical activity	State or quality of body movements during daily living.
	Personal care	Management of personal cleanliness and dressing.
	Substance use	Consumption of medicines, recreational drugs, or other materials likely to cause mood changes and/or psychological/ physical dependence, illness, and disease.
	Health care supervision	Management of the health care treatment plan by health care providers.
	Medication regimen	Use or application of over-the-counter and prescribed/ recommended medications and infusions to meet guidelines for therapeutic action, safety, and schedule.