The Hitchhiker's Guide to nursing informatics theory: using the Data-Knowledge-Information-Wisdom framework to guide informatics research

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Invited Guest Editor

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Editorial

Theory is one of the fundamental blocks of each scientific discipline. It is impossible to imagine biology without the theory of Evolution or physics without the theory of Relativity. Nursing informatics, a relatively new discipline, is also thirsty for its own theory. However, it is challenging to find literature that provides clear theoretical guidance for nurse infomaticians. In this commentary, I will briefly overview a theoretical framework that has high potential to serve as one of the foundations for nursing informatics. I will also argue that to apply the described framework, it needs to be merged with a nursing specific theory. I will provide an example of my dissertation work to illustrate the necessary merge. This commentary might be used as a theoretical blueprint -or the Hitchhiker's Guide- to guide nursing informatics research and practice.

The Data-Information-Knowledge-Wisdom framework

Nursing informatics was created by the merge of three well established scientific fields: Information science, Computer science and Nursing science. One of the most compelling definitions of the discipline states: "Nursing informatics science and practice integrates nursing, its information and knowledge and their management with information and communication technologies to promote the health of people, families and communities worldwide" (International Medical Informatics Association – Nursing Working Group, 2010). Unfortunately, very few attempts were made to generate a broad theoretical framework for nursing informatics. There are several challenges to generate such framework. First, the interdisciplinary nature of nursing informatics demands the use of broad enough theoretical framework to encompass all the disciplines. Also, the required theoretical framework should consider the practice/application domain; the implementation of nursing informatics in real healthcare settings. Recently, it was suggested that the Data-Information-Knowledge-Wisdom (DIKW) framework has a high potential to address these challenges and this framework was adopted by the American Nurses Association (American Nurses Association, 2008; Matney, Brewster, Sward, Cloyes, & Staggers, 2011).

Historically, the development of the DIKW framework was urged by a search for a new theoretical model explaining the emerging field of Nursing Informatics in 1980-90s. In their seminal work, Graves and Corcoran (1989) defined that *data, information*, and *knowledge* are fundamental concepts for the discipline. Their framework was widely accepted by the international nursing community (Matney et al., 2011; McGonigle & Mastrian, 2011). In 2008, the American Nurses Association revised the Scope and Standards for nursing informatics to include an additional concept, wisdom (American Nurses Association, 2008). Recently, Matney and colleagues (2011) have expanded on the components of the DIKW framework:

- **Data**: are the smallest components of the DIKW framework. They are commonly presented as discrete facts; product of observation with little interpretation (Matney et al., 2011). These are the discrete factors describing the patient or his/her environment. Examples include patient's medical diagnosis (e.g. International Statistical Classification of Diseases (ICD-9) diagnosis #428.0: Congestive heart failure, unspecified) or living status (e.g. living alone; living with family; living in a retirement community; etc.). A single piece of data, datum, often has little meaning in isolation.

- **Information**: might be thought of as "data + meaning" (Matney et al., 2011). Information is often constructed by combining different data points into a meaningful picture, given certain context. Information is a continuum of progressively developing and clustered data; it answers questions such as "who", "what", "where", and "when". For example, a combination of patient's ICD-9 diagnosis #428.0 "Congestive heart failure, unspecified" and living status "living alone" has a certain meaning in a context of an older adult.

- **Knowledge**: is information that has been synthesized so that relations and interactions are defined and formalized; it is build of meaningful information constructed of discrete data points (Matney et al., 2011). Knowledge is often affected by assumptions and central theories of a scientific discipline and is derived by discovering patterns of relationships between different clusters of information. Knowledge answers questions of "why" or "how".
  For healthcare professionals, the combination of different information clusters, such as the ICD-9 diagnosis #428.0 "Congestive heart failure, unspecified" + living status "living alone" with an additional information that an older man (78 years old) was just discharged from hospital to home with a complicated new medication regimen (e.g. blood thinners) might indicate that this person is at a high risk for drug-related adverse effects (e.g. bleeding).

- **Wisdom**: is an appropriate use of knowledge to manage and solve human problems (American Nurses Association, 2008; Matney et al., 2011). Wisdom implies a form of ethics, or knowing why certain things or procedures should or should not be implemented in healthcare practice. In nursing, wisdom guides the nurse in recognizing the situation at hand based on patients' values, nurse's experience, and healthcare knowledge. Combining all these components, the nurse decides on a nursing intervention or action. Benner (2000) presents wisdom as a clinical judgment integrating intuition, emotions and the senses. Using the previous examples, wisdom will be displayed when the homecare nurse will consider prioritizing the elderly heart failure patient using blood thinners for an immediate intervention, such as a first nursing visit within the first hours of discharge from hospital to assure appropriate use of medications.

The boundaries of the DIKW framework components are not strict; rather, they are interrelated and there is a "constant flux" between the framework parts. Simply put, data is used to generate information and knowledge while the derived new knowledge coupled with wisdom, might trigger assessment of new data elements (Matney et al., 2011).

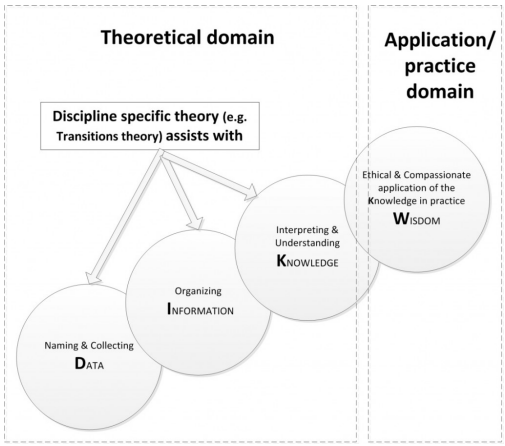
Applying the Data-Information-Knowledge-Wisdom framework to guide informatics research

The DIKW framework does not propose any relations between the distinct *data* elements that lead to the generation of meaningful *information* and *knowledge*. To accomplish that, a discipline specific theory is required in combination with the DIKW framework. To illustrate that, I will use a practical example from my dissertation focusing on identifying patients' risk for poor outcomes during transition from hospital to homecare.

In my dissertation, I have chosen to use the nursing specific Transitions theory (Meleis, 2010) to describe the transition of interest (patient's transition from hospital to home). As nurses frequently study and manage various types of transitions (e.g. immigration transition, health-illness transition, administrative transition, etc), Transitions theory has been easily adopted and welcomed in nursing research, education, and practice (Im, 2011; Meleis, Sawyer, Im, Messias, & Schumacher, 2000). In my dissertation, the Transitions theory helps me to analyze the different elements affecting transition from hospital to home. For example, the Transitions theory suggests that several personal conditions (such as the high level of family support) might facilitate hospital to home transitions for older adults and should be measured. Thus, the discipline specific theory serves as the glue that binds all the distinct *data* points (e.g. caregiver's availability to assist with patient's basic needs) together to produce meaningful *information* (e.g. the level of family support). This *information* is then synthesized and used – with the help of Transitions theory- to build *knowledge* about the specific phenomenon. This example illustrates the DIK aspects of the DIKW framework in the context of Transitions theory.

The *wisdom* component of the DIKW framework is often addressed by the clinicians in the field. For example, the final product of my dissertation will be a decision support tool helping homecare clinicians with identification of patients' risk for poor outcomes. When using the tool in practice, the clinicians will have to act according to a specific knowledge present in each clinical situation (e.g. ethics, clinical practice regulations in each particular state in the US etc.). In other words, the clinicians will use their *wisdom* to interpret suggestions and make clinical judgments using information received from the decision support tool. Figure I presents the possible interplay between the discipline specific theory (Transitions theory) and different components of the DIKW framework.

Figure I: Combining the discipline specific and DIKW theoretical frameworks



In summary, this editorial presents a possible theoretical blueprint for nursing and healthcare informatics researchers that intend to use the DIKW framework. The combination of discipline specific theories and the DIKW framework offers a useful tool to examine the theoretical aspects and guide the practical application of informatics research.

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Author's Bio

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Maxim Topaz, MA, RN, is a Spencer Scholar, a Fulbright Fellow and a PhD Student in Nursing at the University of Pennsylvania. He earned his Bachelors in Nursing and Masters in Gerontology (cum laude) from the University of Haifa, Israel.

In the past, Maxim was involved in nursing practice and education in Israel. In his current work, Maxim focuses on Electronic Medical Records, Clinical Decision Support and Standardized Terminologies. Maxim has more than a dozen of publications in healthcare informatics http://scholar.google.com/citations?hl=en&user=7MxxJ2UAAAAJ&view_op=list_works&pagesize=100. Currently, he serves as a Chair of the Students' group with International Medical Informatics Association Nursing Informatics Special Interest Group (IMIA-NISIG). Also, Maxim serves as a member of the Student Editorial Board with the Journal of American Medical Informatics Association. Additionally, Maxim is involved in several informatics oriented policy making efforts with the Office of National Coordinator for Health Information Technology (ONC) in the U.S. and the Israeli Ministry of Health, Department of Information Technology. Maxim is recipient of several informatics awards, for example the PhD Student Informatics Methodologist award from received at the First International Conference on Research Methods for Standardized Terminologies http://omahasystempartnership.org/international-conference-on-research-methods-for-standardized-terminologies/conference-methodologist-awards/.

“I am thrilled to be involved in the expanding and fast-paced field of healthcare informatics. Nurses- the largest sector of healthcare providers worldwide- are in the midst of health information technology revolution. Nursing informatics has a high potential to improve patient outcomes, increase the quality of healthcare and bridge the gap between healthcare science and practice.”

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