

Development and Evaluation of an Electronic Nursing Documentation System

Mohsen Shafiee

Abadan University of Medical Sciences

Mostafa Shanbehzadeh

Ilam University of Medical Sciences

Zeinab Nassari

Abadan University of Medical Sciences

Hadi Kazemi-Arpanahi (✉ Hadi.kazemi67@yahoo.com)

Abadan University of Medical Sciences

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Abstract

Introduction:

nursing documentation is a critical aspect of the nursing care workflow. There is a varying degree in how detailed nursing reporting is described in scientific literature and care practice, and no uniform structured documentation is given.

Aims

This study aimed to describe the process of designing and evaluating the content of an electronic nursing documentation system to provide consistent and unified reporting in this context.

Methods

A four-step sequential methodological approach was utilized. The Minimum Data Set (MDS) development process consisting of two phases, as follows: A literature review was performed to attain an exhaustive overview of relevant elements of nursing and map the available evidence underpinning the development of the MDS. Second, the data included from the literature review were analyzed using a two-round Delphi study with content validation by an expert panel. Next, the electronic nursing system (ENS) was developed according to the finalized MDS, and finally, its performance was evaluated by involved the end-users.

Results

The proposed MDS was divided into administrative and clinical sections; including nursing assessment and nursing diagnosis process. Then, a web-based system with modular and layered architecture was designed based on derived MDS. Finally, to evaluate it, a survey by participating 150 registered nurses (RNs) was conducted and the positive impacts and negative impacts of the system were identified.

Conclusion

The developed system is suitable for the documentation of patient care in nursing care plans. However, nurses need further training in documenting patient care according to the nursing process, and in using the standard reporting templates to increase patient safety and improve documentation.

What Is Already Known And What This Paper Adds

1. The developed system in our study, the following features have been considered to solve the major problems of EMR.
2. In our study, unlike some studies, has a formal and organized structure according to the nursing process that has been shown to improve legislative compliance and the completeness of nursing documentation.
3. The electronic system developed in this study is in the way that the nurses fill out the pre-designed standard platform at the patient's bedside and don't need to write on paper and transfer it to the system.

4. One of the time-consuming and non-user-friendly problems of EMR systems is recording reports on paper and transferring them to the system, which was solved in our software.
5. The simplicity and fluency of the designed platform as well as the existence of scientific and approved abbreviations in this platform is another benefit of this software.
6. Another important exclusivity of this system is its ability to be used in general and specialized clinical wards such as CCU.

Introduction

Clinical documentation and access to reliable information are crucial facets of nursing decision-making in care practice (1). Nurses and other caregivers aim to exchange information regarding patients and administrative activities with good quality criteria such as precise, timeliness, concurrent, concise, comprehensive, organized, and confidential(2). Nursing documentation is defined as the written evidence that the nurse's authorized and moral responsibilities were met to enable care to be assessed (3). The storage of accurate and inclusive documentation of nursing interventions is important for some other reasons. It improves patients' outcomes, ensures the quality and safety of healthcare services, and facilitates communication between various health care stakeholders (4). Nursing documentation requires to be structured and reasonably organized, and arranged to reflect the phases of the nursing process, i.e., assessment, diagnosis, planning, implementation, and evaluation of patient situations (5). Despite the importance of clinical documentation, currently, there are undesirable situations of care recordings and a lack of an appropriate framework for documenting nursing care (6). Studies in Iran have revealed that the nursing documentation is not acceptable compliance to the standard. some studies that compared international standards with those in Iranian studies showed that nurses in other countries were further diligent concerning obedience to documentation principles and standards (7). Currently, the clinical nursing reporting in most hospitals in Iran is paper-based which may be like writing a story with a varied and inconsistent format. In most cases, there is no legislative defense for nursing staff because of the gradual fading and illegibility of manual records (8, 9). A nursing report is a routine event that takes place several times across the nurse's daily work so that nurses spend about 37% of their entire time working to writing nursing reports (10–12). One-half of all nurses must stay at work for 1–2 hours after the end of their shifts, and the chief reason for this is the need to complete nursing records (13). This approach has several drawbacks including, wasting time, disruption in delivering care to patients, medical errors, endangers the patient's safety, fading and illegibility of the manual documentation process, high staff turnover rates, legal problems and, etc. (14, 15). With fast developments in information technology, the health industry actively attempts to implement electronic medical records (EMRs), for clinical practice, research, education, and supervision purposes. The Nursing information system (NIS) as a module of EMR manages nursing care or services, and manages nursing actions in which data are assembled, exchanged, stored, extracted, presented, and transferred(16). The use of an EMR and electronic nursing documentation have been revealed to lead to higher quality, more complete, and more patient-centric documentation than manually nursing documentation. National Health information technology officials suggested the use of standard terminologies and data sets to enable interoperability across health information systems. Several terminologies exist that support nursing practice, but none have been broadly leveraged in Iran's E-health system (17). To comply with data standards, nursing specialists must decide which data items are essential for inclusion in the context of patient care, and what required data could be documented by other healthcare staff (18, 19). Therefore, to overcome the above-mentioned paper-based nursing documentation, some considerations are required to be addressed from a data management standpoint (20, 21). Thus, the purpose of this study is to design, development and evaluation of an electronic nursing documentation system and determination of its core data elements and validity of their corresponding values.

Method And Materials

Study design

A four-step sequential methodological approach was utilized. The MDS development process consisting of two phases, as follows: A literature review was performed to attain an exhaustive overview of relevant elements of nursing and map the available evidence underpinning the development of the MDS. Second, the data included from the literature review were analyzed using a two-round Delphi study with content validation by an expert panel. Then, a web-based system with modular and layered architecture was designed based on derived MDS. Finally, to evaluate it, a survey by participating 150 registered nurses (RNs) was conducted and the positive impacts and negative impacts of the system were identified.

1) Literature review

We performed a literature review to define the MDS-nursing reporting parameters. To do the study, first, an extensive literature review was performed in internet databases such as Web of Science, PubMed, ProQuest, Scopus, Magiran, and SID to identify the electronic nursing documentation system's potential data elements. This step thus comprises all those elements associated with nursing reporting templates. Thus, it is necessary to incorporate and collect all elements related to nursing practices including diagnosis, assessment, and intervention. Inclusion criteria were 1- full-text journal articles, 2-language (English or Persian), and 3- publication date (from 2011 or later). Figure1 shows the search strategy for identifying the relevant articles. The first part (Part A) included terms used for reporting templates. In the second part (Part B), the keywords related to digitalization were used. The third part (Part C) contained terms about studies on information system data architecture. The results of these three parts were combined using the Boolean operator "and, or". Searching was supplemented with checking the bibliographies of identified articles.

Furthermore, previously developed relevant classification systems were screened systematically to collect information on nursing reporting data elements, including the nursing diagnosis classification of the North American Nursing Diagnosis Association International (NANDA-I), and the Nursing Outcome Classification (NOC), Nursing Intervention Classification (NIC) and International Classification of Nursing Practice (ICNP). Finally, data fields were extracted from the related retrieved resources and entered into the checklist with two administrative and clinical sections.

2) Delphi phase

The initial MDS content was validated by the Delphi technique using two rounds as bellow:

Participants

Using purposive sampling, we convened nursing professionals working as university faculty members of nursing in Iran's Universities of Medical Sciences. Table1 shows the demographic characteristics of these experts.

Questionnaire development

The preliminary literature review provided the framework for developing a questionnaire to seek expert group members' individual views regarding the important elements to be included in the MDS. The participants were asked to assess the all-items' importance in the preliminary data list extracted from the literature review. Item importance was assessed based on a three-point Likert scale, that includes three options yes, no and unsure. Yes, meant the high importance of an element, and no meant the low importance of the element for inclusion. To add necessary data elements by experts, a blank row was provided at the end of the questionnaire. The content validity of the questionnaire was assessed by an expert panel, including 80 nurses. Also, a test-retest was used to evaluate the reliability of the questionnaire. The agreement was reached based on experts' agreement level for data elements by a scale was prespecified as $\geq 70\%$ of participants in agreement (e.g., of an item's importance) (22, 23).

Delphi survey rounds

After initial ranking, items with less than 60% agreement were deleted, those with more than 75% agreement excluded from the second round, and those with 60% to 75% agreement were surveyed in the second round. The checklists were individually presented to the experts who were blind to the scores of other experts, and if there was 75% consensus over a subject, it was included in the final MDS.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences software version 25 (Chicago, USA) with a few descriptive and analytical tests (chi-square, t-test, and paired t-test). It was used to summarize respondents' characteristics and demographic details. For each item outcome, the median, mean, and proportion ratings were calculated. For ranking scores, the median for each item outcome was calculated to determine rank. The statistical significance was considered at $p < .05$.

3) Nursing documentation software development tools

By using Visual Studio 2019 a web-based nursing documentation system was designed. We used this platform because of its numerous benefits (e.g., cost-effectiveness, scalability and accessibility, user-friendliness, fast and convenience, custom search, improved intellicode, clipboard, and refactoring attributes) (24). The developed system was implemented with cascading style sheets (CSS) technology as a web-based program. CSS, along with the Hypertext Markup Language (HTML), was used to describe the presentation of documents and set the document syntax, layout, display format, and visual effects (e.g., font type, color, spacing, and sizes). The code was written in JavaScript language for designing the website. Finally, Structured Query Language (SQL) was employed to develop the relational database (RDB). SQL provides efficient and systematic storage of data with high performance, availability, scalability, flexibility, management, and security (25).

4) Evaluation of the developed system

A pilot study was designed to assess the clinical nurses' views when working with the system. In this survey, the 150 registered nurses (RNs) participated. Participating nurses worked in a variety of clinical wards, including; the emergency department, the critical care wards, the medical-surgical wards, and others. The instrument used in this survey was a questionnaire, 35 items to measure three constructs (system quality, usage, and user satisfaction) which are grouped into three main sections: the extent of usage of the system, the quality of the system, and user satisfaction (26). A Likert-type scale was used to evaluate items. Responses were assigned a value of 1–5 ('never/almost never/not at all', to 'always/almost always/very great') for each item. Responses for usage and quality were assigned a value of 1–5 ('never/almost never/not at all' to 'always/ almost always') for each item. Responses for user satisfaction were assigned a value of 1–5 ('not at all', to 'very great') for each item. The questionnaire consisted of three constructs, with 35 items as follows: 12 items assessing 'use of the system, defined as the frequency of the use of the system in completing patient care-related tasks; 12 items assessing 'quality of the system, defined as the evaluation of the quality of the system, their outputs, and their responsiveness; 11 items assessing 'user satisfaction with EMR', defined as the extent to which nurses believe the system is important in improving their work; (26)

Ethical Considerations

The director of the research facility of the university approved the research protocol (approval ID: IR.ABADANUMS.REC.1400.065; date: 14/05/2021). All participants were required to sign a privacy agreement and study participation consent form before joining the expert panel. They were cognizant of the objectives of the study. They

were also informed that their participation was voluntary, and they had the liberty to withdraw from the study at any instance.

Results

Phase 1: Literature Review

Searching the online databases resulted in 3520 articles from PubMed, Embase, Scopus, Science Direct, and Cochrane after removing duplicates. Initial screening of titles and abstracts resulted in 145 articles, of which 113 articles were excluded because they did not address reporting template items in relation to nursing practices. Three further articles were identified through checking the bibliographies, leading to a total of 35 articles for full-text review (Figure 2).

Phase2: Delphi stage

In this study, after searching in scientific databases and according to the processes provided by NANDA, CCC, ICNP nursing calcifications, we extracted a set of data elements and validated via a two-round Delphi survey for inclusion in the final MDS of nursing documentation. We divided this dataset into three general categories, including administrative, nursing assessment, and nursing diagnoses. The number of participants in the Delphi stage was 80 people, including 74 individuals with nursing Ph.D. degrees, and six persons with MSC nursing degrees. About 43% of the participants were female, 88% of them had more than 10 years of clinical experience, and all participants had an RN degree. (Table 1)

Administrative information

This section has 19 items in our study. The items were delivered by the Delphi survey for nursing professionals. In the first round of Delphi, all items of this section were confirmed (Table 2).

Nursing assessment information:

This section has a total of 875 items that are divided into 9 categories. These categories are including (Table 2):

1. Cardiovascular system:

The cardiovascular system had 140 items. Items 1 to 60 (95.63% agreement), items 61 to 100 (89.87% agreement), items 101 to 130 (88.6% agreement) are accepted in the first stage of Delphi, and items 131 to 140 (85.46% agreement) are accepted in the second stage of Delphi and finally, all 140 cardiovascular items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

2. Muscle and Skeletal system

The Muscle and Skeletal system had 80 items. Items 1 to 40 (98.32% agreement), items 41 to 68 (92.87% agreement), items 69 to 78 (90.56% agreement) are accepted in the first stage of Delphi. Items 79 to 80 (65.36% agreement) are removed in the second stage of Delphi and finally, 77 Muscle and Skeletal items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

3. GU system

The GU system had 85 items. Items 1 to 30 (98.1% agreement), items 31 to 56 (96.23% agreement), items 57 to 82 (97% agreement) are accepted in the first stage of Delphi. Items 83 to 85 (65.66% agreement) are removed in the second stage of Delphi and finally, 82 GU items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

4. Renal system

The renal system had 50 items. Items 1 to 36 (89.1% agreement), items 37 to 45 (90.39% agreement), items 46 to 50 (98.85% agreement) are accepted in the first stage of Delphi and finally, all 50 renal items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

5. Neurological system

The Neurological system had 110 items. Items 1 to 48 (99% agreement), items 49 to 88 (91.41% agreement), items 89 to 100 (95% agreement), items 101 to 108 (88.64% agreement), are accepted in the first stage of Delphi. Items 109 to 110 (69.75% agreement) are removed in the second stage of Delphi and finally, 108 Neurological items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

6. Psychological and social

The Psychological and social had 65 items. Items 1 to 42 (98.12% agreement), items 43 to 58 (96.55% agreement), items 59 to 65 (100% agreement) are accepted in the first stage of Delphi and finally, all 65 Psychological and social were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

7. Skin system

The skin system had 55 items. Items 1 to 49 (100% agreement), items 50 to 55 (96% agreement) are accepted in the first stage of Delphi and finally all 55 skin items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

8. General appearance

The General appearance had 150 items. Items 1 to 36 (100% agreement), items 37 to 88 (94.96% agreement), items 89 to 95 (98% agreement), items 96 to 106 (96% agreement), items 107 to 120 (86.76% agreement), items 121 to 134 (79.23% agreement), items 135 to 145 (89% agreement), items 146 to 150 (88% agreement), are accepted in the first stage of Delphi and finally all 150 General appearance items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

9. Respiratory system

The respiratory system had 140 items. Items 1 to 55 (89.51% agreement), items 56 to 78 (98.23% agreement), items 79 to 100 (96.37% agreement), items 101 to 125 (95% agreement) are accepted in the first stage of Delphi, and items 126 to 140 (79.80% agreement) are accepted in the second stage of Delphi and finally, all 140 respiratory items were accepted. Each item had a percentage of acceptance that those items whose acceptance percentage was close to each other are listed in a column.

Due to a large amount of information, we had to provide, for example, only Table 3, which is an example of a platform developed for cardiovascular nursing assessment.

Source of nursing diagnoses:

In this study, we conducted a Delphi survey to determine the source for writing nursing diagnoses. For this purpose, the main sources for NANDA, ANA, ICNP, CCC, and CINA nursing diagnoses were selected and sent to the participants. 100% of the survey returned, the NANDA classification was accepted with 98% approval, and based on NANDA, nursing diagnoses were written and included in the final MDS of the nursing reporting system (Table 4).

Nursing documentation software development tools are shown in Figures 3 and 4.

System evaluation:

After developing the system, it was used experimentally by the users and a pilot study was performed on user satisfaction. This study was performed on 150 participating clinical nurses. 74.66% of the participants were female and their average age was 36.4 (SD±6.4). 45.33% of them were employed in the internal medicine-surgical wards, 35.33% works in critical wards, 12.66% in emergency wards, and 6.68% in other medical wards. The average work experience was 15.66 years (SD±4.5) (Table 5).

The extracted data are classified into three categories. Figure 5 and 6 identifies the positive and negative impact of developed Electronic Nursing Report by nurses after it using at the Abadan Hospitals respectively.

ENR system can improve the communication between departments (89% of the nurse who answered the question on communication agreed that the system functioned well and nurses were satisfied with the ENR system; it can also improve the quality of care of the patient (92%); by using it the retrieval and entry of patient information is an accurate and easy way (80%); access to the system is an easy and available (91%); the system can be used for in nurses in different wards (89%); reduces documentation errors (85%); legal system (65%); it's used bedside (93%), exchange information from shift to shift (79%) and enhances the productivity (87%).

The second section of the survey is shown in Figure 6 describing the negative impact of the ENR system: such as loss of confidentiality (35% of the nurses answering the question on the confidentiality issue agreed the ENR system require increased confidentiality); the ENR system is under utilities (35% of nurse agree); the hospital is still using a paper system in some departments (89%); the ENR system is time consuming (28% agree), and speed of the system is too slow (60%) and 17% of participants disagreed with the appropriateness of coding the nursing diagnosis and 15% of them disagreed with the appropriateness of the coding of the nursing assessment.

Discussion

The field of information technology is developing and with its progress, it can help the development of other sciences such as nursing science. In Iran, nursing documentation is still conducted in traditional and paper-based manners(8). Electronic nursing documentation needs that data is stored according to a uniform and structured framework. This study aims to design an electronic documentation system for unified recording nursing activities using standardized data elements which improve data quality, data interoperability, decision making, and paves the way for formulating global standards for nursing care. In this study, we conducted a systematic review study along with a two-round Delphi survey to prepare a formal and organized data structure and standard platform. This MDS could be applied to develop more patient-oriented, evidence-based, safely and high-quality nursing care. The developed MDS also helps to support decision-making. After the survey, it was found that it prevents 65% of the legal problems, 85% reduces documentation

errors, and also does not have the problems of the paper documentation process. 92% of nursing staff after using the system were satisfied with the increase in the quality of care, which is in line with a study in Oman(27). In Iran, nursing documentation is a paper-based approach, and nurses spend about one to two hours completing the nursing report(28). But, in this survey, 82% of nurses stated that their time was saved by using the developed system in this study. In our study, Nurses' satisfaction with filling nursing report documentation at the patient's bedside, and exchange information from one shift to another shift were 93% and 79%, respectively (12). In other words, filling or documentation the nursing report at the bedside and exchanging patient information from one shift to another are two important features of a nursing report and these features were considered in our designed system. Keeping information confidential by software is one of the most basic features of this tool. The designed system in our study, due to the team's support for its security, was able to obtain 65% satisfaction of nurses.

We found out from reviewed studies the benefits and problems of EMR systems, for example, equipment shortages and breakdowns, writing on paper and transferring to EMR (29), user-friendliness and interoperability, hardware and software problems, increased documentation load, lack of formal structure, unusable on the bedside and, etc.(30) Therefore, in the developed system in our study, the following features have been considered to solve the major problems of EMR. In our study, unlike some studies, has a formal and organized structure according to the nursing process that has been shown to improve legislative compliance and the completeness of nursing documentation(27, 30). Our software showed that with the advancement of EMR in nursing practice, many paper-based reporting problems such as; wasting time, disruption in design and clinical care of the patient, medical error, endangers the patient's safety, fading and illegibility of manual documentation, legal problems, and, etc. are resolved (8, 9). The electronic system developed in this study is in the way that the nurses fill out the pre-designed standard platform at the patient's bedside and don't need to write on paper and transfer it to the system. One of the time-consuming and non-user-friendly problems of EMR systems is recording reports on paper and transferring them to the system (29), which was solved in our software. On the other hand, this process is recorded at the patient's bedside, and the patient's information is not missed. Also, our software shows a graph of the progression of a patient's clinical conditions such as the patient's heart rate in different shifts to the user. The Mentioned items have been one of the strongest points of this system, which has been mentioned in a survey of clinical nurses. The simplicity and fluency of the designed platform as well as the existence of scientific and approved abbreviations in this platform is another benefit of this software that the nurses mentioned in the survey. Another important exclusivity of this system is its ability to be used in general and specialized clinical wards such as CCU. In the survey, nurses encouraged the software security factor in maintaining patient information and the support team of this system, which is a very important thing in any software. Finally, we must say that the software designed by us includes these features; 1) the existence of an official structure and approval by nursing professors, 2) can be used in all hospitals and different wards, 3) can be easily used in the bedside, 4) has the ability to report nursing from shift to shift, 5) After a survey of nurses working in the wards of Abadan hospitals, our system is user friendly, it is easy to learn and easily used.

Limitations

This study should have been used in more hospitals and with more nurses, and on the other hand, nurses were difficult to cooperate in this study because the work of nurses in clinical wards is hard and they lack time. Also, nurses needed the training to work with this system, which was done with a lot of effort. The infrastructure of some hospitals was not suitable for the components of this plan and it was very difficult to build the necessary infrastructure.

Conclusion

The primary purpose of the nursing documentation MDS was to scientifically reduce the amount of nursing report data collected and documented by nurses during the patient care process, as well as upsurge nursing pleasure due to a reduction in documentation burden. Involvement of the system end-users in a meaningful way during the development process resulted in an easier conversion from paper-based to computerized documentation, greater approval from nurses who use the electronic nursing documentation system, minimal complaints regarding its content in the practice setting.

Abbreviations

EMR: electronic medical record

RN: register nurse

CSS: cascading style sheets

HTML: Hypertext Markup Language

ENR: electronic nursing record

NIS: Nursing information system

NANDA: North American Nursing Diagnosis Association International

NOC: Nursing Outcome Classification

NIC: Nursing Intervention Classification

ICNP: International Classification of Nursing Practice

Declarations

Ethics approval and consent to participate:

The director of the research facility of the university approved the research protocol (approval ID: IR.ABADANUMS.REC.1400.065; date: 14/05/2021). All participants were required to sign a privacy agreement and study participation consent form before joining the expert panel. They were cognizant of the objectives of the study. They were also informed that their participation was voluntary, and they had the liberty to withdraw from the study at any instance. We have assured the participants that their participation in this research is entirely voluntary. Choose or not participate with them. If you do not participate in all the services received in this center, you will continue and nothing will change. We assured participants that participation in this study is not risk for their. The authors told the participants that if you are interested in collaborating, please allow us in writing to access the required documents and information. On the other hand, purposes of the study and the type of study were explained to the participants.

All of the above are stated in the informed consent form

Consent for publication:

All participants included in this research gave written informed consent to publish the data contained within this study.

Availability of data and material:

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Competing Interests:

Author(s): Mohsen Shafiee, Mostafa Shanbehzadeh, Zeinab Nassari, Hadi Kazemi-Arpanahi.

We declare that we have no significant competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript. We have described us potential competing financial, professional, and/or personal interests in the space.

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Authors' contributions:

M SH (1) and H AP performed a literature review to define the MDS-nursing reporting parameters. M SH (2), Z N performed Delphi survey. H AP and M SH (2) development electronic nursing report. Z N and M SH (1) performed evaluation of the developed system. M SH (1), H KA and M SH (2) contributed to the interpretation of the results. H KA, M SH (2) and M SH (1) took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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Tables

Table 1: Demographic characteristics of Delphi participants

Variables	frequency	percentage
gender		
female	43	53.75
male	37	46.25
Educational		
PhD nursing (RN)	74	92.5
Master nurse (RN)	6	7.5
Age		
30 - 40	19	23.75
40 - 50	48	60
>50	13	16.25
Work experience in clinical field (years)		
<10	12	15
10-15	28	35
15-20	24	30
20-25	8	10
>25	8	10
Total	80	100

Table 2: Administrative and Nursing assessment information

Administrative information									
patient demographic information			Round 1			Round 2			Final Decision
			Agree N (%)	Dis agree N (%)	Unsure N (%)	Agree N (%)	Dis agree N (%)	Unsure N (%)	
Patient name, age, gender, educational level, Marital Status, Employment status, admitted date, admitted time, admitting nurse, Admitting physician			100	0	0				kept
Physician, Ward, Bed, Hospital name, Phone, Insurance, Source of history			100	0	0				kept
Past medical history			85.62%	8.4%	5.98%				kept
Items related to the nursing assessment									
Body systems	Item numbers (total)	Item numbers	Round 1			Round 2			Final Decision
			Agree N (%)	Dis agree N (%)	Unsure N (%)	Agree N (%)	Dis agree N (%)	Unsure N (%)	
Cardiovascular system	140	1-60	95.63%	2.4%	1.97%				kept
		61-100	89.87%	6%	4.13%				kept
		101-130	88.6%	10.7%	0.7%				kept
		131-140	69.43%	29.11%	1.46%	85.46%	14.54%	0	kept
Muscle and Skeletal system	80	1-40	98.32%	0	1.68%				kept
		41-68	92.87%	7.13%	0				kept
		69 - 78	90.56%	7.4%	2.04%				kept
		79-80	62%	36%	2%	65.36%	34.64%	0	remove
GU system	85	1-30	98.1%	0	1.9%				kept
		31-56	96.23%	0	3.77%				kept
		57-82	97%	0	3%				kept
		83-85	70.25%	29.75%	0	65.66%	34.34%	0	remove
Renal system	50	1-36	89%	10%	1%				kept
		37-45	90.39%	0	9.61%				kept
		46-50	98.85%	0	1.15%				kept
Neurological system	110	1-48	99%	0.5%	0.5%				kept
		49 - 88	91.41%	2.36%	6.23%				kept
		89-100	95%	4%	1%				kept
		101-108	88.64%	11.36%	0				kept

		109-110	67%	30%	3%	69.75%	30.25%	0	remove
Psychological and social	65	1-42	98.12%	1.88%	0				kept
		43-58	96.55%	2.32%	1.13%				Kept
		59-65	100%	0	0				Kept
Skin system	55	1-49	100%	0	0				kept
		50-55	96%	0	4%				kept
General appearance	150	1-36	100%	0	0				kept
		37-88	94.96%	5.04%	0				kept
		89-95	98%	2%	0				kept
		96-106	96%	3%	1%				kept
		107-120	86.76%	0	13.24%				kept
		121-134	79.23%	20.77%	0				kept
		135-145	89%	11%	0				kept
		146-150	88%	12%	0				kept
Respiratory system	140	1-55	89.51%	9.39%	1.1%				kept
		56-78	98.23%	1.77%	0				Kept
		79-100	96.37%	3.2%	0.43%				Kept
		101-125	95%	0	5%				Kept
		126-140	70.26%	21.36%	8.38%	79.80%	20.2%	0	kept
		35-40	89%	10%	1%				kept

Table 3: A sample of final nursing reporting MDS: the cardiovascular system assessment data elements

Data elements	Data values	
HR		
BP	Invasive	
	Non-invasive	
Iv line	Peripheral	Angio cat Scalp
	Central	Triple lumen Double lumen Port Cat down
Site of iv line	Peripheral	Hand Leg Jugular
	Central	Subclavian Jugular Limb
Serum	Dose / MI/hr / Gtt/min	
Type of serum	Isotonic/ Hypertonic/ Hypotonic	
The patient needs blood products	No	
	Yes (if yes,)	FFP, Cryoprecipitate, Cryopoor Plasma (CPP), whole blood, platelet concentration, washed red blood cells, Low leukocyte red blood, Radiated red blood cells, Frozen red blood cells
Quality of pulse (power)	+, ++, +++, +++++	
Symptoms of dyspnea	PND (paroxysmal natural dyspnea), Orthopnea, dyspnea during exercise, dyspnea during rest,	
chest pain	yes	Onset, Site Radiation, Quality of pain, Pain aggravating factors, Pain Reduction Factors,
	no	
Capillary Refill time	Brisk (>2 sec), Sluggish (<2)	
Time to start the pain		
CVP (central vein pressure)	Normal, abnormal	
Rhythm	normal	

	arrhythmia	Irregular	Atrium arrhythmia, Early Stimulation Syndromes, AV arrhythmia & blocks, Branch blocks, Ventricular arrhythmia,
		Regular	SA node arrhythmia
patient needs a pacemaker	yes		Internal, External
	no		
Set up of pacemaker	Mode, Output, Rate		
Does the patient need a monitor?	Yes, no		
Does the patient need an IABP?	Yes, no		setup
Edema	yes		Localize, general
	no		
Edema	yes		Pitting, Not pitting
	no		
CPCR	yes		onset start, duration, end time of CPCR, Time to announce resuscitation code, Drug are used, Type of rhythm, shock,
	no		
CPR successful	yes		post-CPR care
	no		
ventilate the patient during CPR	ETT, LMA, AMBO bag		

Table 4: Source of nursing report

Nursing classification systems	Delphi survey rounds						Final Decision
	Round 1			Round 2			
	Agree N (%)	Dis agree N (%)	Unsure N (%)	Agree N (%)	Dis agree N (%)	Unsure N (%)	
NANDA	98	0	2				accepted
ANA	35.6	64.4	0				
ICNP	33.1	66.9					
CCC	45.2	54.8					
CINA	40.3	59.7					

Table 5: Descriptive demographics of clinical nurses in the survey

Variables	Frequency	percentage
Gender		
female	112	74.66
male	38	23.34
ward		
ER	19	12.66
Critical care	53	35.33
Medical and surgical	68	45.33
Other	10	6.68
	mean	SD
Age	36.4	± 6.4
Work experience in clinical field (years)	15.66	± 4.5

Figures

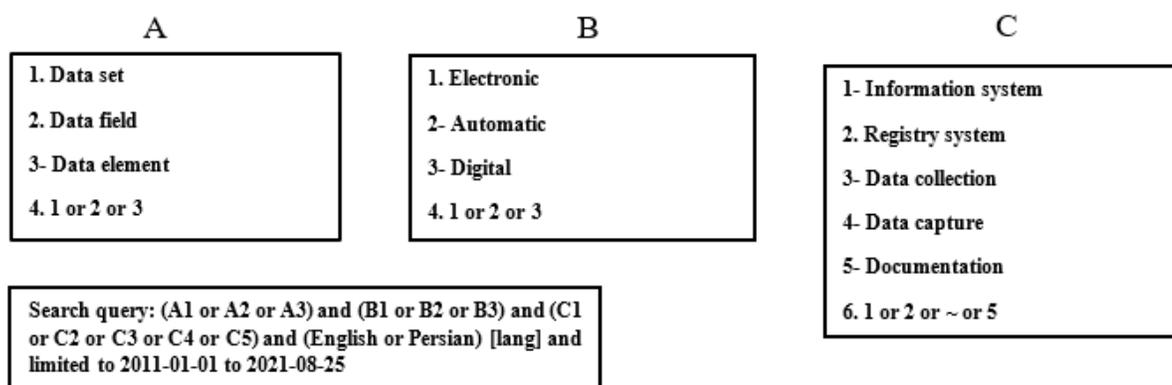


Figure 1

search strategy

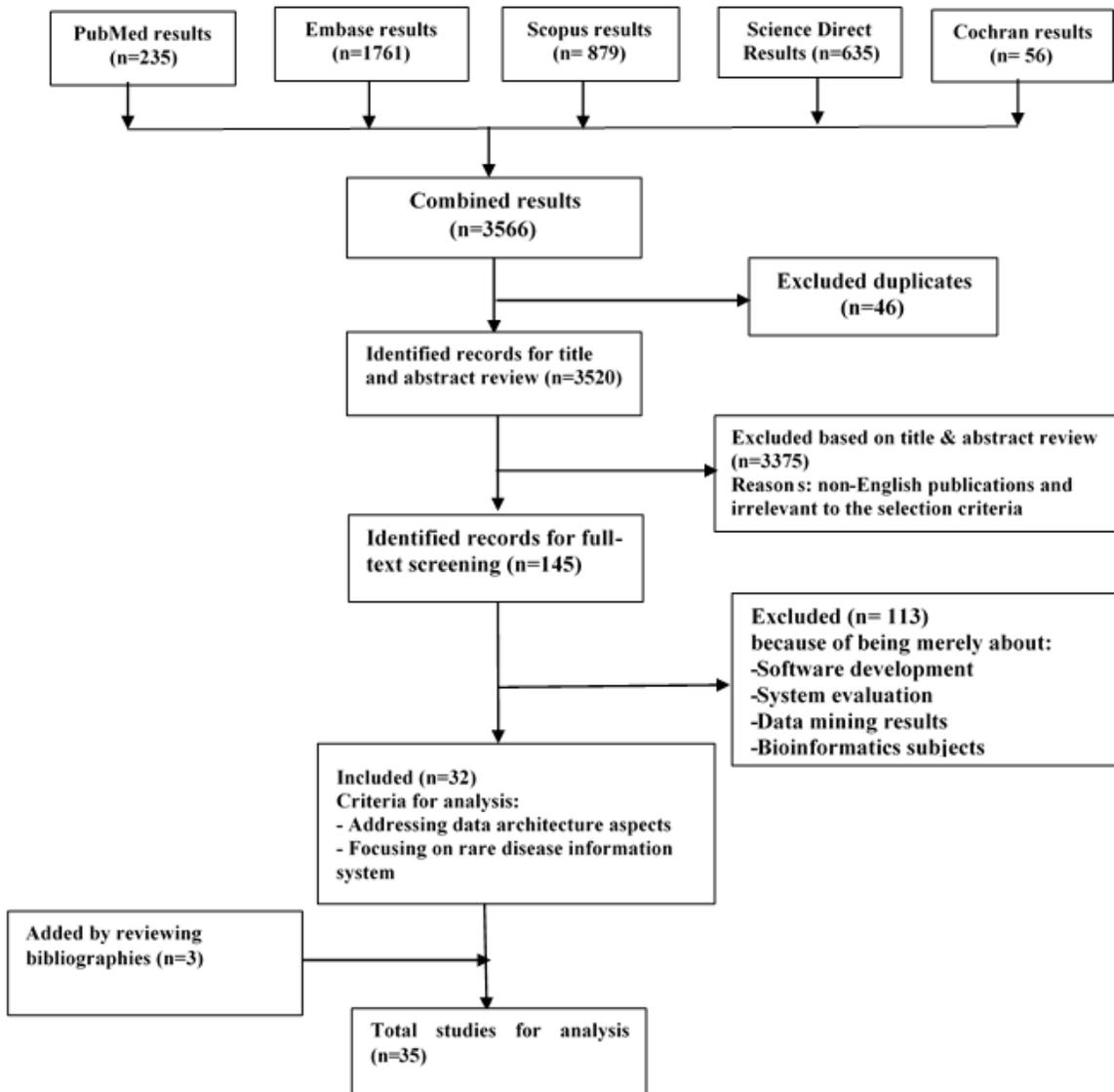


Figure 2

search flow diagram

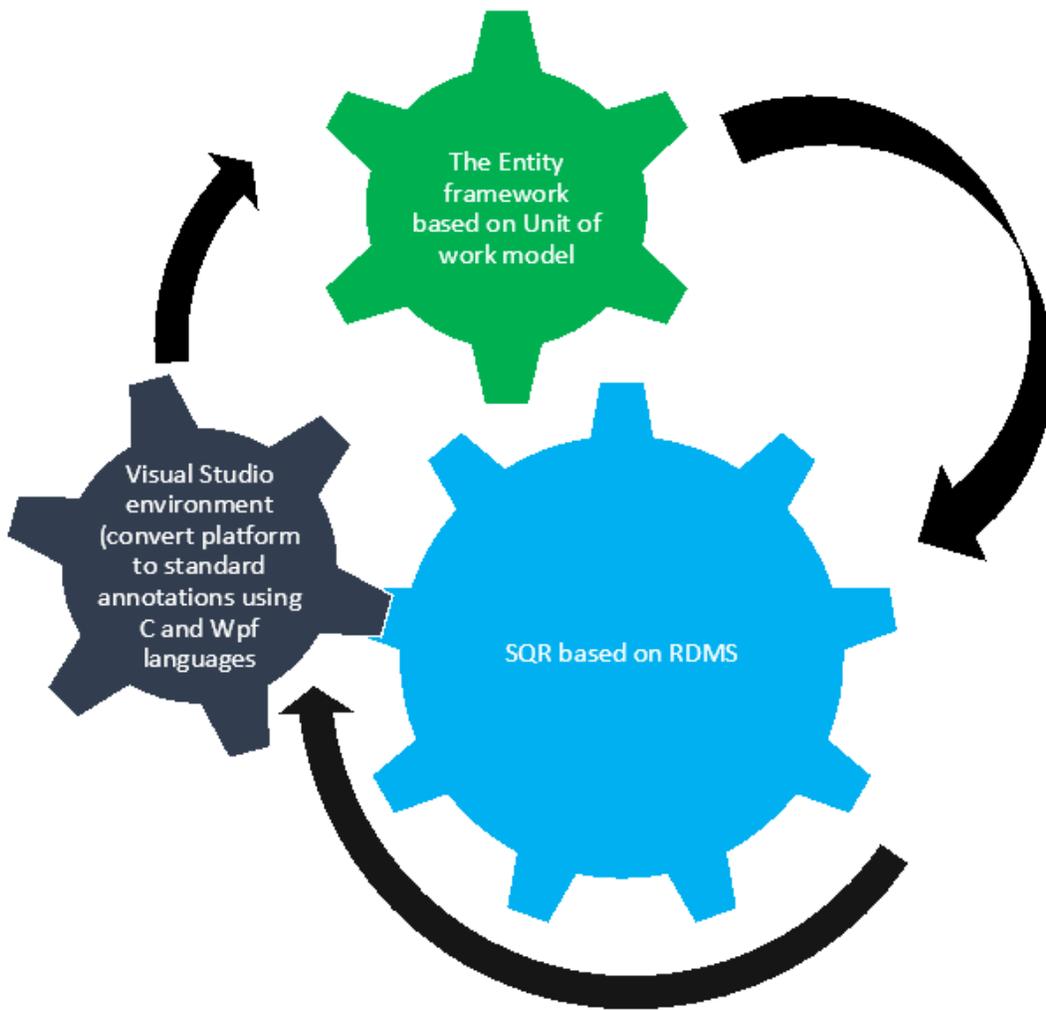


Figure 3

design process nursing documentation software development tool

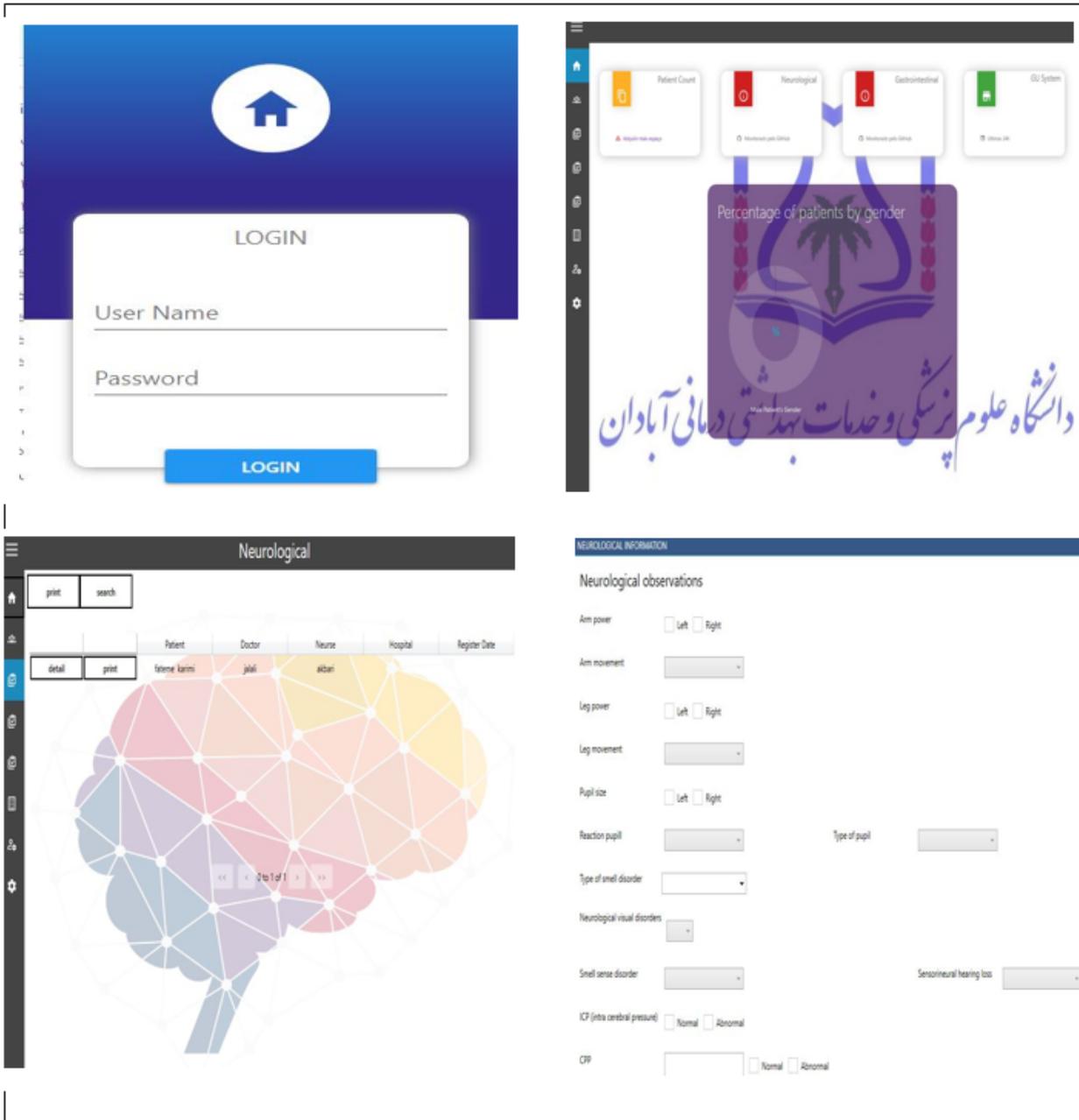


Figure 4

Nursing documentation software development fields

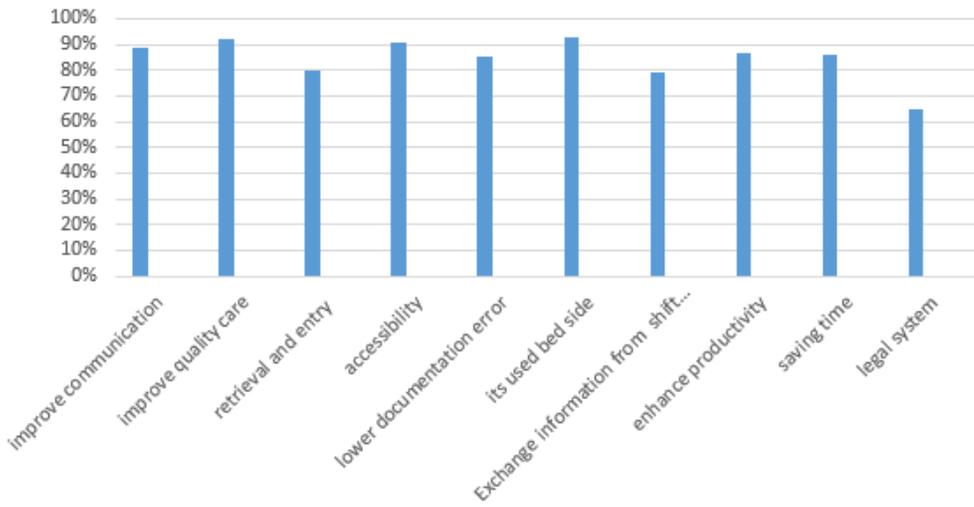


Figure 5

Positive impact of the ENR system

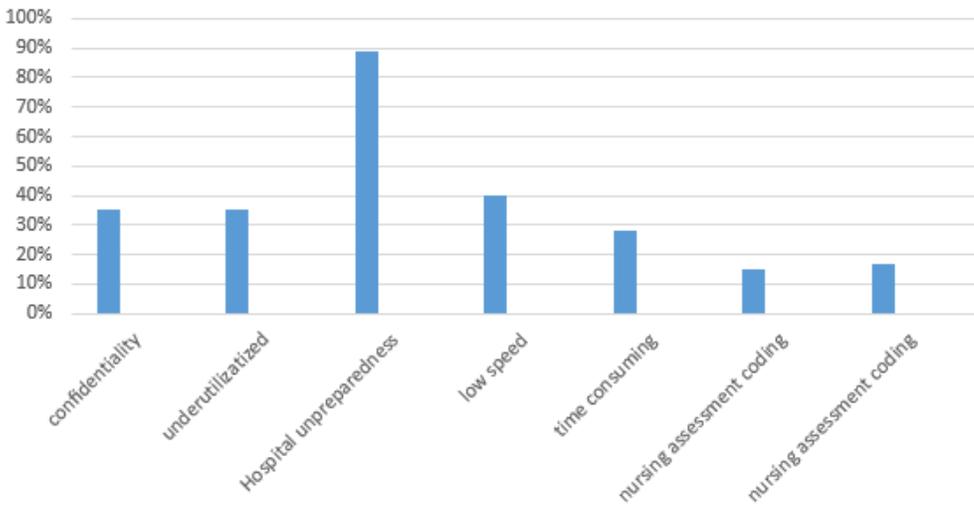


Figure 6

Negative impact of the ENR system