ENABLING TECHNOLOGIES DAILY NURSING WORK AND ITS PRACTICAL IMPLICATIONS

Vander Luiz Da Silva
Federal University of Technology Paraná, Brazil
E-mail: luizvnder@gmail.com

Myller Augusto Santos Gomes
State University of Midwest Paraná, Brazil
E-mail: myller_3@hotmail.com

João Luiz ko
Federal University of Technology Paraná, Brazil
E-mail: kovaleski@utfpr.edu.br

ABSTRACT

In the health area, technological and scientific advances are paramount for the development of innovative technologies used in the treatment of diseases. Likewise, several categories of technologies are also useful in numerous activities for organizational management, resources management (medicines, data and information sets and people, among other) in the health field. Technologies are essential in work environments, but they also have implications, directly, for professionals who handle and operate them. Therefore, this study aims to identify the main technologies used by nursing professionals (nurses and technicians in nursing) and their impacts on work. Results were obtained through literature review, prioritizing case studies. Was carried out in at Scopus, PubMed, Web of Science, Emerald and Science Direct. Two analyses were conducted, bibliometrics, in order to explore the main data of the articles (years of publications, scientific journals and more frequent terms) and qualitative (highlight the main contributions of articles regarding the researched topic). In qualitative analysis, the articles were submitted to filtering procedures, ordered and selected for full reading. Technologies have potential to improve or create obstacles to the performance at work, health and well-being of the professionals. Health Information Technology was widely disseminated in case studies analyzed; it reduces informational and technical burden at work, access to support from colleagues in large centers and decision-making support, among others positive impacts.

Keywords: Health; Nurse; Work; Technology; Management.

85

1. INTRODUCTION

Nurses are professionals trained at higher education level, whose services are in the health area, such as health care. They carry out the planning and assistance provided to humans, executed in conjunction with nursing technicians and assistants (Gonçalves et al., 2015).

Nurses' work responsibilities include biomedical evaluation, psychosocial evaluation, support and teaching, management and application of medicines and various procedures, coordination of human care, activities of daily living and personal care (White et al., 2015).

In everyday life in public and private hospitals, basic health units, nursing centers, offices and health departments, nurses should be informed in real time for task planning, coordination and patient care, among other requirements (Yang and Rivera, 2015).

With technological and scientific advances, the work scenarios have presented several changes regarding the environment, work configuration and processes aided by technologies and techniques. In the nursing area, workers are influenced by these changes that occur in society (Gonçalves et al., 2015).

The insertion and management of technology in the work scenarios is a reflection of technical and political procedures in Technology Transfer (TT). TT aims to disseminate and retain technologies, in their different forms, and their elements such as technical support and knowledge (Silva, Kovaleski and Pagani 2019). TT not only encompasses the physical movement of technologies from one environment to another, but also the management of technologies in the organizational environment.

Consequently, the actions of TT and use of technology generate positive and /or negative impacts to those involved, such as workers inserted into the productive and managerial processes of goods and services. In this context, the objective of this study was identify the main technologies used by a group of health professionals (nurses), and their impacts on the performance, health and well-being of workers.

In the area of health technologies have generated progress for treatment of diseases and quality of life for patients. But for workers: What are these technologies? What are the impacts of technologies on work routines? and; What are their practical purposes? We propose to study such issues. Tian et al. (2014) discuss the importance of understanding the

86

reciprocal relationship between the implementation of technologies and management work. According to Sergeeva et al. (2016), largest share of studies on the impact of technologies on nursing professionals, such as mobile devices, provides insufficient information. These are limited studies on the real impact of technologies on the recruitment and retention of nursing workers (Gagnon et al. 2011). Research is needed to understand the intentional and unintentional impacts of the adoption of technologies in organizations (Schenk et al. 2018).

Results were obtained through literature review, prioritizing case studies. Therefore, a literature review was carried out in five international databases, Scopus, PubMed, Web of Science, Emerald and Science Direct. Two analyses were conducted, bibliometrics, in order to explore the main data of the articles (years of publications, main scientific journals and more frequent terms) and qualitative (highlight the main contributions of articles regarding the researched topic).

2. METHODOLOGY

Literature review is a scientific research aimed at identifying, selecting, evaluating and synthesizing relevant evidence on a given subject (Galvão, Pereira 2014). Through a review of literature, it is possible to explore data, information and generate knowledge to better understand the subject researched (Silva, Kovaleski & Pagani, 2018; Silva, 2019).

A literature review was developed, adopting protocols structured by Pagani, Kovaleski and Resende (2015). These authors present a methodology of nine phases, called Methodi Ordinatio, which encompasses from research planning to selecting articles.

After aligning the research, keywords, bibliographic databases and basic search criteria were defined, as described in Table 1.

Table 1: Basic procedures for literature review.

Description
i. Combination of keywords - "work" and "nursing".
ii. Data bases - Scopus, PubMed, Web of Science, Emerald and Science Direct, respectively.
iii. Basic criteria applied in each database - keywords inserted in titles, period all years, journal articles.

The first analysis performed was the bibliometric. The articles were transported from the databases to the Mendeley® reference manager. Duplicate articles had to be deleted. After this filtering, we analyzed the years of publications, main journals of articles, authors with higher indexes of publications and more frequent terms, respectively.

In order to carry out more detailed analysis, it was necessary to limit the research. In qualitative analysis, in particular, other keywords were used, generating three combinations:

- "Technology transfer" and "work" and "nursing";

- "Impact" and "technology" and "work" and "nursing", and;

- "Effect" and "technology" and "work" and "nursing".

For this portfolio of articles more lean, basic criteria applied in databases were: keywords inserted in title-abstract-keyword, except the "work" (inserted in title), period all years and all document types.

In the Mendeley® manager, duplicate articles were deleted and preliminary readings of articles, performed (titles and abstracts to eliminate studies outside the researched scope). One of the phases of Methodi Ordinatio is to order articles according to the impact factor, number of citations and year of publication, generating InOrdinatio values. According to Pagani, Kovaleski and Resende (2015), the pondering on these variables indicates scientific relevance of the article. Studies that used this methodology are: Buss et al. (2019), Corsi et al. (2019), Gomes et al. (2019), Pagani et al. (2019), Silva et al. (2019), Silva, Kovaleski and Pagani (2019), among others.

Therefore, after ordering articles, higher InOrdinatio values were selected for for full readings. Basically, the first analysis aimed to understand about nursing work, and the second, the insertion of technologies in the work of professionals, positive and negative impacts on performance, health and well-being.

3. RESULTS AND DISCUSSION

3.1. Bibliometrics

To explore the work scenarios of nursing professionals, such as professional performance, working conditions, work environment, human resources, education, among other correlated aspects, we conducted a bibliometric analysis of scientific articles. Due to the significant number of studies, only articles published in journals were considered. The results are presented in Table 2.

Table 2: Number of articles found in the searched databases.

Database					
Keyword	**Scopus**	**Pubmed**	**Web of science**	**Emerald**	**Science Direct**
″Work″ and ″Nursing″	2150	1988	884	154	178
Total	5354 journal articles				

It was necessary to eliminate duplicate articles, because the same article can be indexed in two or more different bases. Thus, out of 5354 articles, a portfolio of 3042 articles was created. It is therefore a portfolio focused on nursing work in general.

This portfolio was used in the analysis of distribution of publications over the years (Figure 1), major journals (Table 3), authors with higher numbers of articles and more frequent terms (Figures 2 and 3, respectively).
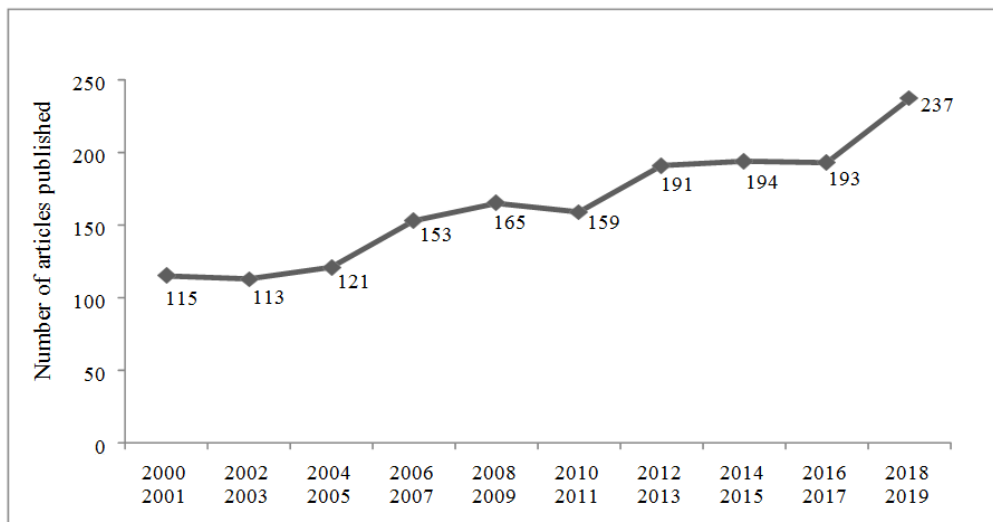

Figure 1: Number of articles published on nursing work.
Source: data research, (2020).

Data were grouped every two years with highlights in 2018-2019 (237 articles) and 2014-2015 (194 articles). Other 1401 articles are inserted in years prior to the years 2000, from 1948-1999 interruptions and other previous years.

Table 3 lists the journals with the highest representativeness, in terms of publications on work (working conditions and working environment), among other aspects oriented to nursing.

89

Table 3: Main journals of articles on nursing work.

Scientific journal	Number of articles published
Revista brasileira de enfermagem	97
Revista latino-americana de enfermagem	83
Sygeplejersken	73
Krankenpflege (Frankfurt am Main, Germany)	64
The Journal of nursing administration	64
Krankenpflege. Soins infirmiers	63
Journal of advanced nursing	63
Pflege Zeitschrift	61
International journal of nursing studies	54
Revista da Escola de Enfermagem	52
Journal of nursing management	50
Revista gaucha de enfermagem	47
Journal of clinical nursing	45
Nursing times	38
Kango] Japanese journal of nursing	36
Kango tenbo. The Japanese journal of nursing science	35
Nurse education today	34
Deutsche Krankenpflegezeitschrift	28
Revista de enfermeria (Barcelona, Spain)	27
Texto e Contexto Enfermagem	27
Sykepleien	27
Tijdschrift voor Bedrijfs- en Verzekeringsgeneeskunde	26
The Japanese journal for public health nurse	26
Nursing research	24
Nursing standard (Royal College of Nursing (Great Britain)	24
Scandinavian journal of caring sciences	22
Nursing outlook	22
Nursing management	19
Acta Paulista de Enfermagem	18
The American journal of nursing	18
Vardfacket	18
Osterreichische Krankenhaus-Zeitung	17
Work (Reading, Mass.)	17
TVZ : het vakblad voor de verpleging	15
ZfA. Zeitschrift für Alternsforschung	14
Soins la revue de reference infirmiere	13

Source: data research, (2020).

The prominent authors, as well as the most frequent terms inserted in the portfolio of 3052 articles, are presented in Figures 2 and 3, respectively.
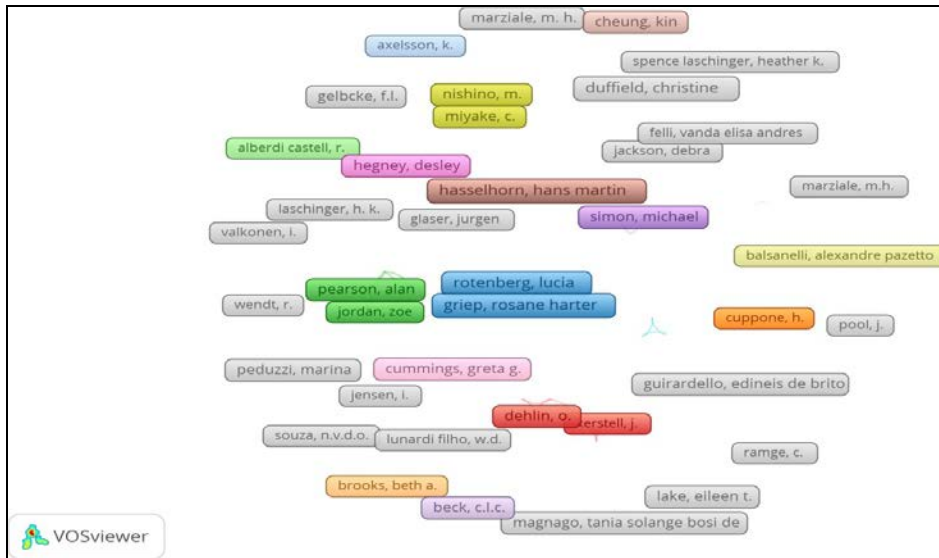
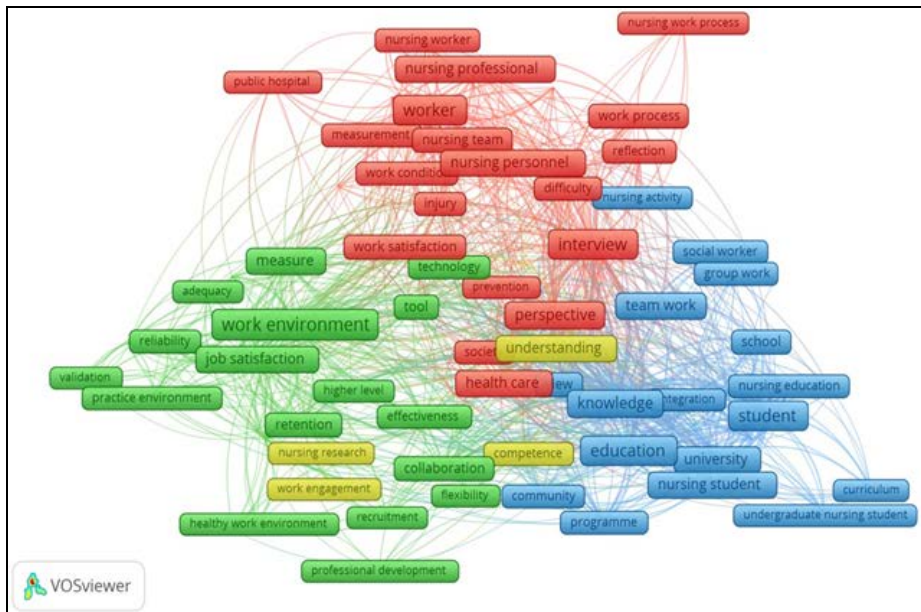Figure 2: Main authors with published articles on nursing work.

Figure 3: Most frequent terms in published articles on nursing work.

When the articles are about nursing work, we highlight discussions about work environments, professional development, education, and nursing. In this context, in view of Figure 3, a diversity of approaches can be better aligned and studied individually.

For a more detailed analysis, it was necessary to limit the searches in the databases. Three combinations of keywords and filtering criteria have been reset. In this case, we prioritize the articles on nursing work with technology issues (Table 4). Technology is an important element for carrying out human work, and in the area of health it has been used more frequently.

91

Table 4: Number of documents on nursing work and technologies.

Combination of keywords	Database				
	Scopus	PubMed	Web of Science	Emerald	Science Direct
"technology transfer" and "work" and "nursing"	15	0	1	0	0
"impact" and "technology" and "work" and "nursing"	29	11	22	10	3
"effect" and "technology" and "work" and "nursing"	19	1	5	6	0
Documents total (conferences papers, journal articles and book chapters)	63	12	33	16	3

The Scopus database presented a higher number of documents, 63, followed by Web of Science, 33. A total of 127 distinct documents were obtained in the five bases. Eliminating duplicities, performing preliminary readings (titles and abstracts reads), and ordering articles, respectively, 43 articles were selected for reading in full (Appendix 1).

3.2.   Qualitative analysis

Nurses are important professionals in the health sector, inserted in hospitals, health units, research centers, teaching institutions, and organizations of exams and clinical treatments. For work development, a series of competencies compose the profile of these professionals, such as interpersonal understanding (ability to understand people, especially patients, through situations, emotions and feelings), commitment (responsibility with their functions, effort and dedication), persuasion (ability to persuade, convince and influence the patient and/or family members), compassion (zeal for the patient and show concern for his comfort and well-being), critical thinking (ability to make assessments and judgments regarding the patient's clinical status and treatment), self-control (ability to control emotions in stressful moments and avoid misguided attitudes), among other competencies (Zhang et al. 2001).

Nurses are widely recognized in health services as important producers and consumers of information and knowledge about people's health care (Hendriks, Ligthart & Schouteten, 2016). A series of tasks are developed by them, varying according to the type of demand and the place of professional activity. Callen et al. (2013) describe some of the main functions of nurses (Table 5).

Table 5: Functions of nursing professionals.

Function	Description
Direct patient care	It encompasses tasks directly related to patient care, including direct communication with the patient and/or family members.
Medication monitoring	Tasks related to medicine monitoring for a particular patient.
Orient the patient	Provide information on medicines and procedures to the patient.
Monitor the patient	Monitor exams for result deadlines and other information
Communication with other nurses and doctor	The nurse constantly communicates with other nurses and doctor about the patient's condition and precautions.
General documentation and administrative functions	This is the recording of patient information on paper or computer, annotations, reports and other means.
Clinical readiness	Development of activities related to the functioning of the clinic in general, that is not related to individual care, direct or indirect, to the patient.

Source: Callen et al. (2013).

In a field study in two health units, White et al. (2015) found higher proportions of nurse's time in documentation tasks. In individual interventions with patients and medications, the proportion of time was considerable. In this same study, registered nurses were interrupted on average 3.6 times per hour, mainly by other nurses, which demonstrate the constant exchange of information and knowledge at work. In Higgins et al. (2017), the main nursing activities were documentation processes in the electronic system, review of medicines, evaluation of patients and interaction, personal communication with health professionals or patient care, respectively. On average, nurses spent 33% of a work shift interacting with electronic records technology.

Table 6 presents some of the main articles selected. Data from these articles such as year of publication, number of citations and impact factor of the journal are described in Appendix 1.

Table 6: Main information of the analyzed articles.

No.	Author	Title	Main focus of the study	Basic methodological procedure
1.	Sergeeva et al. (2016)	Mobile devices in the operating room: Intended and unintended consequences for nurses' work.	Report the results of a case study of the consequences of the use of mobile devices for the practical work of nurses.	Delivering mobile devices (iPod Touch) to 180 surgical workers. Systematic observations were conducted and supplemented with 35 semi-structured interviews.
2.	White et al. (2015)	The examination of nursing work through a role accountability framework	Analyze the work of nurses and describe the amounts of time spent on clinical responsibilities and other work	Monitoring and recording activities of 35 nurses and 17 medical assistance assistants.

93

			activities.
3.	Cho et al. (2015)	Effects of nurse staffing, work environments, and education on patient mortality: An observational study	Investigate the effects of factors (work environment and nurse's education) on mortality rates of patients in acute care.	16 hospitals for treatment of patients in acute condition were randomly selected. Of these, 14 hospitals agreed to participate in the study, involving 1024 nurses. Application of questionnaires and systematic observation.
4.	Hitt e Tambe (2016)	Health Care Information Technology, Work Organization, And Nursing Home Performance	Investigate whether the use of an electronic medical record system is associated with the most efficient levels of performance in nursing homes.	304 nursing homes involving nurses from these locations were studied.
5.	Tian et al. (2014)	Evaluating Bar Coding-Aided Medication Administration through Identification of Nursing Work Deficiencies	Investigate the effects of the use of a barcode medicine administration system on the work of nurses.	20 members of the health team were interviewed, including nurses and pharmacists. Two scenarios were analyzed before and after the implementation of the system.
6.	Hendriks, Ligthart e Schouteten (2016)	Knowledge management, health information technology and nurses' work engagement	Provide information on how Health Information Technology affects explicit and tacit knowledge at work.	Interviews with 74 nurses.
7.	Yang e Rivera (2015)	An observational study of hands-free communication devices mediated interruption dynamics in a nursing work system	Examine how the integration of speakerphone communication devices works in nursing work.	Observation and registration of activities of 12 nurses
8.	Gagnon et al. (2011)	Supporting work practices through telehealth: impact on nurses in peripheral regions	Report how work practice, supported by Information Technologies, can influence nursing professionals.	Individual interviews with directors of Nursing Services and Human Resources, in five organizations.
9.	Aiken et al. (2012)	The Effects of Nurse Staffing and Nurse Education on Patient Deaths in Hospitals with Different Nurse Work Environments	Report the conditional circumstances of investments in nursing for better results.	Sending questionnaires to 272,783 nurses with 39% return of answers.
10.	Callen et al. (2013)	Can technology change the work of nurses? Evaluation of a drug monitoring system for ambulatory chronic disease patients	To evaluate the impact of an electronic drug monitoring system on nursing.	Quantitative measures were selected before and after the intervention. Interviews with three nurses and one clinical nursing specialist were conducted.
11.	Kossman et al. (2006)	Perceptions of Impact of Electronic Health Records on Nurses' Work	It addresses the use of Electronic Health Records during patient care by nurses.	40 nurses were interviewed in surgical and intensive care units.
12.	Higgins et al. (2017)	Hospital Nurses' Work Activity in a Technology-Rich Environment. A Triangulated Quality Improvement Assessment	Describe the work activities of hospital nurses and their perceptions to the electronic records system.	Systematic observations and questionnaires were applied. 79 nurses participated in the study.
13.	Schenk et al. (2018)	Impact of Adoption of a Comprehensive Electronic Health Record on Nursing Work and Caring Efficacy	Measurement differences in the effectiveness of work and care, before and one year after the adoption of a comprehensive electronic	Observations were made before and after the adoption of the system. Three units of a hospital were studied, as well as 44 nurses involved.

94

			health system.	
14.	Bergey, Goldsack, Robinson (2019)	Invisible work and changing roles: Health information technology implementation and reorganization of work practices for the inpatient nursing team.	Analyze the impacts of information technology on nursing work issues.	Interviews with nursing managers and staff in two hospitals.

Source: data research (2020).

These articles present direct focuses on the scope proposed in this study. All of them are the result of case studies in hospitals in the Netherlands, South Korea, the United States, Canada and Australia, as well as involving health units or homes aimed at nursing professionals.

Technologies are essential for progress in organizations, represent large investments in human resources and impact the health sector. They have the potential to improve or create obstacles to the performance at work, health and well-being of the professionals involved, whether nurses, pharmacists, doctors, assistants and technicians (Kossman, 2006). Technologies can be either for activity management, planning, demand control, processes or products of the organization, or present themselves in the form of equipment for treating patients that, manipulated and managed by professionals, interfere with their work. Table 7 describes some of the technologies and their impacts reported in scientific articles.

Table 7: Technologies and their impacts on the work of nursing professionals.

No.	Technology or practice	Positive impact	Negative impact
1.	Mobile devices	Improvements were observed in the way nurses spent time during stable parts of operations. Wellness and greater satisfaction at work.	The perceived increase in the distraction of nurses in work activities.
2.	Pilot Function Analysis Technology	Useful for understanding nursing responsibilities and finding gaps between real and ideal practice for professionals.	-
3.	Adjusted models with a focus an analysis of work environments and education	The adjusted models indicated significant effects of the nurses' work environment on patient mortality. The level of training of nurses was also associated with favorable results.	-
4.	Health Information Technology	Health Information Technology has been associated with minimizing nurse errors and improvements in patient care.	-
5.	Health Information Technology Systems	-	Processes interrupted by system failures, technological limitations of interfaces.
7.	Hands-free communication devices	Communication devices are promising in improving nursing workflow, efficiency in communication and continuity of patient care.	Interference at inopportune times by the emitting source.
8.	Health Information Technology System	Reduction of informational and technical burden at work, access to support from colleagues in large centers, decreased feeling of professional isolation, distance training, decision-making support, greater access to continuing education, among others.	-

95

10.	The electronic medication monitoring system	Reduced time spent on the complex task of monitoring medicines, allowing nurses to spend a greater proportion of their time on other patient care activities.	-
11.	Electronic Health Records System	Facilitated access to relevant clinical information, such as transcribed reports, laboratory and diagnostic test results.	Dependence on technology. Cases of computer failures, for example.
13.		-	Reduction of the effectiveness of care after the implementation of the system.
14.	Health Information Technology System	Appropriate processing of information. Reduction of waste with manual documentation records.	The additional working time required to interact with computers.

Source: data research (2020).

Information and Communication Technologies are innovative solutions that can be used to develop strategies, optimize the use of available resources, design new nursing work practices and facilitate the transfer of information and knowledge (Gagnon et al. 2011).

In general, the main functional characteristics of health information technology are clinical documentation, report management and data analysis results, inbound management of medical orders, medicines and/or other resources, decision support, electronic communication and connectivity, patient support, care planning, management of administrative processes, among others (Chaudhry et al. 2006).

Sergeeva et al. (2016) found significant savings the time and effort of nurses, since annotations and content readings were facilitated by mobile devices used at work. Information technology connects people to the network, providing information exchange between professionals and patients with content, responses and instructions to those involved (Baggio, Erdmann & Sasso 2010).

Other positive impacts relate to the Internet to verify unknown abbreviations, read and learn about procedures and instruments, as well as communication facilitated by texts and images.

The use of technologies at work also reflects on learning, since nurses can be better prepared for surgeries, benefiting external memory and interactions with surgeons (Sergeeva et al., 2016).

In other departments and functions, process automation and digitization can reduce costs, eliminate medication waste and errors, and provide decision support (Hitt & Tambe, 2016). Electronic health records system facilitates the process of administering medicines,

obtaining reports and communicating with other environments (Kossman, 2006). Electronic medical records are employed in the administration of resources (data and information), clinical monitoring, decision-making and coordination of patient care (Kutney-Lee et al. 2019).

In Gagnon et al. (2011)'s study, the implementation of a computerized tool provided a more organized view of profiles, as well as prioritization of patient service needs. These practices are important for less stressful work due to excessive documentation. According to Aiken et al. (2012), improving work requires investments not only with technologies, but changes in the culture and management of the organization and the professionals involved.

Technology or organizational system adopted increases the complexity of the work of nurses, who in practice are trained to care for their patients, but it also potentiates the reduction of work overload, improves the quality of care and reduces adverse events and errors (Baggio, Erdmann & Sasso 2010).

On the other hand, excess technologies can create a distance between nursing professionals and patients, affecting practical perceptions that would be important and exchanges of sentiments/social interactions (Gonçalves et al., 2015), as well as distractions generated - defined as activities or stimuli irrelevant to the moment (Sergeeva et al., 2016), among others impacts. Contact and mutual coexistence between people should not be ignored, as it contributes to healthy and constructive relationships of patient care (Baggio, Erdmann & Sasso 2010).

According to Barra et al. (2006), regardless of the use and types of modern technologies adopted, it is up to the nurse to maintain a humanized presence with the patient. In the context of management, the technology, in its different forms, is not negligible, on the contrary, it can be a great opportunity to facilitate the work, generating other advantages, although it needs to be properly evaluated and managed.

About to technologies in nursing work, some challenges are pointed out by Huston (2013), establishing a balance of technological and human factors in work management, training professionals to adequately manage technologies and ensure that the use of technology is ethical.

The work can also be supported by characteristics of the physical environment, generating quality care to the patient (Kutney-Lee et al. 2019). A suitable work

environment, in terms of infrastructure, together with factors such as autonomy, lower working pressure, supervisor support (Zborowsky, 2010), involvement of nurses in administrative decision-making, strong nursing leadership, teamwork and professional recognition can increase job satisfaction and reduce stress among nurses (Zborowsky, 2010; Kutney-Lee et al. 2019).

As for professional training, obtaining a better value for investments in nursing requires better staff and a better-educated workforce (Aiken et al., 2012). More detailed favorable results are indicated in the studies by Aiken et al. (2012) and Cho et al. (2015). Training and investment in education aim to make professionals accomplished, as well as valued before their superiors and recognition of their skills and functions.

4. CONCLUSIONS

This study aimed to identify the technologies most used by nursing professionals (nurses and technicians) from a literature review. These professionals are essential in hospitals, health units and other public and private organizations, acting in the treatment of patients with various diseases or needs.

A considerable portfolio of articles was used for bibliometric analysis, providing data and information from cycles of scientific publications, journals, authors and terms related to work in nursing (professional profile, work environment, training and education). These articles are the results of case studies in countries around the world, broadening horizons of knowledge.

There is a growing discussion about digital technologies applied with special attention to electronic medical records in the health sector to precisely manage resources and job management. Nursing professionals are directly or indirectly influenced by these technologies in the performance of tasks, well-being, a personal and collective health and learning. Therefore, the implantation of technologies, devices or digital systems should assist professionals in their work, otherwise they may not be viable. Therefore, managers must assess impacts and minimize them if they are negative.

REFERENCES

Aiken, L. H., Cimiotti, J. P., Sloane, D. M., Smith, H. L., Flynn, L., & Neff, D. F. (2012). Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. **The Journal of nursing administration**, 42(10), 10-22.

98

Baggio, M. A., Erdmann, A. L., & Sasso, G. T. M. D. (2010). El cuidado humano y la tecnología en la enfermería contemporánea y compleja**. Texto & Contexto-Enfermagem**, 19(2), 378-385.

Barra, D. C. C., do Nascimento, E. R. P., de Jesus Martins, J., Albuquerque, G. L., & Erdmann, A. L. (2006). Evolução histórica e impacto da tecnologia na área da saúde e da enfermagem. **Revista Eletrônica de Enfermagem**, 8(3).

Bergey, M. R., Goldsack, J. C., & Robinson, E. J. (2019). Invisible work and changing roles: Health information technology implementation and reorganization of work practices for the inpatient nursing team. **Social Science & Medicine**, 235, 112387-112394.

Buss, A. H., Kovaleski, J. L., Pagani, R. N., da Silva, V. L., & Silva, J. D. M. (2019). Proposal to Reuse Rubber Waste from End-Of-Life Tires Using Thermosetting Resin. **Sustainability**, 11(24), 6997.

Callen, J., Hordern, A., Gibson, K., Li, L., Hains, I. M., & Westbrook, J. I. (2013). Can technology change the work of nurses? Evaluation of a drug monitoring system for ambulatory chronic disease patients. **International journal of medical informatics**, 82(3), 159-167.

Campos, E. A. R., Pagani, R. N., Resende, L. M., & Pontes, J. (2018). Construction and qualitative assessment of a bibliographic portfolio using the methodology Methodi Ordinatio. **Scientometrics**, 116(2), 815-842.

Chaudhry, B., Wang, J., Wu, S., Maglione, M., Mojica, W., Roth, E., Sally, M. A., Morton, P., & Shekelle, P. G. (2006). Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. **Annals of internal medicine**, 144(10), 742-752.

Cho, E., Sloane, D. M., Kim, E. Y., Kim, S., Choi, M., Yoo, I. Y., ... & Aiken, L. H. (2015). Effects of nurse staffing, work environments, and education on patient mortality: an observational study**. International journal of nursing studies**, 52(2), 535-542.

Corsi, A., Pagani, R. N., & Kovaleski, J. L. (2019). Technology transfer for sustainable development: Social impacts depicted and some other answers to a few questions. **Journal of Cleaner Production**, 245, 118552. doi 10.1016/j.jclepro.2019.118522

Gagnon, M. P., Paré, G., Pollender, H., Duplantie, J., Côté, J., Fortin, J. P., Labadie, R., Dupplaa, E., Thifaut, M. C., Courcy, F., McGinn, C. A., Ly, B. P., Trépanier, A., Malo, F. B. (2011). Supporting work practices through telehealth: impact on nurses in peripheral regions. **BMC health services research**, 11(1), 27.

Galvão, T. F., & Pereira, M. G. (2014). Systematic reviews of the literature: steps for preparation. Epidemiol. **Serv. Saúde, Brasília**, 23, 183-184.

Gomes, M. A. S., Kovaleski, J. L., Pagani, R. N., & Zammar, G. (2019). Government Initiative in Brazilian Public Health: A Technology Transfer Analysis. **International journal of environmental research and public health**, 16(17), 3012.

Gonçalves, F. G. D. A., Souza, N. V. D. D. O., Zeitoune, R. C. G., Adame, G. F. P. L., & Nascimento, S. M. P. D. (2015). Impacts of neoliberalism on hospital nursing work. **Texto & Contexto- Enfermagem**, 24(3), 646-653.

Grange, L. I. L., & Buys, A. J. (2002). A review of technology transfer mechanisms. **South African Journal of Industrial Engineering**, 13(1), 81-100.

Hendriks, P. H., Ligthart, P. E., & Schouteten, R. L. (2016). Knowledge management, health information technology and nurses' work engagement. **Health care management review**, 41(3), 256-266.

Higgins, L. W., Shovel, J. A., Bilderback, A. L., Lorenz, H. L., Martin, S. C., Rogers, D. J., & Minnier, T. E. (2017). Hospital nurses' work activity in a technology-rich environment: a triangulated quality improvement assessment. **Journal of nursing care quality**, 32(3), 208-217.

Hitt, L. M., & Tambe, P. (2016). Health care information technology, work organization, and nursing home performance. **ILR Review**, 69(4), 834-859.

Huston, C. (2013). The impact of emerging technology on nursing care: Warp speed ahead. **The Online Journal of Issues in Nursing**, 18(2), 1-19.

Kossman, S. P. (2006). Perceptions of impact of electronic health records on nurses' work. **Studies in health technology and informatics**, 122, 337.

Kutney-Lee, A., Sloane, D. M., Bowles, K. H., Burns, L. R., & Aiken, L. H. (2019). Electronic Health Record Adoption and Nurse Reports of Usability and Quality of Care: The Role of Work Environment. **Applied clinical informatics**, 10(01), 129-139.

Pagani, R. N., Kovaleski, J. L., & Resende, L. M. (2015). Methodi ordinatio®: a proposed methodology to select and rank relevant scientific papers encompassing the impact factor, number of citation, and year of publication. **Scientometrics**, 105(3), 2109-2135.

Pagani, R. N., Kovaleski, J. L., & Resende, L. M. (2018). Avanços na composição da Methodi Ordinatio para revisão sistemática de literatura. **Ci.Inf.**, 46(2), 161-187.

Pagani, R. N., Ramond, B., Da Silva, V. L., Zammar, G., & Kovaleski, J. L. (2019). Key factors in university-to-university knowledge and technology transfer on international student mobility. **Knowledge Management Research & Practice**), 1-19, doi 10.1080/14778238.2019.1678415.

Schenk, E., Schleyer, R., Jones, C. R., Fincham, S., Daratha, K. B., & Monsen, K. A. (2018). Impact of Adoption of a Comprehensive Electronic Health Record on Nursing Work and Caring Efficacy. **Computers, Informatics, Nursing**, 36(7), 331-339.

Sergeeva, A., Aij, K., Van den Hooff, B., & Huysman, M. (2016). Mobile devices in the operating room: Intended and unintended consequences for nurses' work. **Health informatics journal**, 22(4), 1101-1110.

Silva, V. L. (2019). **Analysis of External Technology Transfer oriented to the Industry 4.0: Collaborative links between supplier and manufacturing industry**. 109 p. Dissertation (Masters in Production Engineering), Federal University of Technology, Paraná, Brazil.

Silva, V. L., Kovaleski, J. L., & Pagani, R. N. (2018). Technology transfer in the supply chain oriented to industry 4.0: a literature review. **Technology Analysis & Strategic Management**, 31(5), 546-562.

Silva, V. L., Kovaleski, J. L., Pagani, R. N., Silva, J. M., & Corsi, A. (2019). Implementation of Industry 4.0 concept in companies: empirical evidences. **International Journal of Computer Integrated Manufacturing**, 33(4), 325-342. DOI 10.1080/0951192X.2019.1699258.

Tian, R., Lee, B. C., Yucel, G., Abel, S. R., Hultgren, K. E., & Duffy, V. G. (2014). Evaluating Bar Coding-Aided Medication Administration through Identification of Nursing Work Deficiencies. **Human Factors and Ergonomics in Manufacturing & Service Industries**, 24(4), 468-478.

White, D. E., Jackson, K., Besner, J., & Norris, J. M. (2015). The examination of nursing work through a role accountability framework. **Journal of nursing management**, 23(5), 604-612.

Yang, Y., & Rivera, A. J. (2015). An observational study of hands-free communication devices mediated interruption dynamics in a nursing work system. **Health Policy and Technology**, 4(4), 378-386.

Zborowsky, T., Bunker-Hellmich, L., Morelli, A., & O'Neill, M. (2010). Centralized vs. decentralized nursing stations: Effects on nurses' functional use of space and work environment. **Health Environments Research & Design Journal**, 3(4), 19-42.

Zhang, Z. X., Luk, W., Arthur, D., & Wong, T. (2001). Nursing competencies: personal characteristics contributing to effective nursing performance. **Journal of advanced nursing**, **33(4), 467-474.**

Appendix 1

Table 8: Main data of the analyzed articles.

Author	Title	Year of publication	Number of citations	Impact factor	InOrdinatio values of Methodi Ordinatio
Aiken, L.H., Cimiotti, J.P., Sloane, D.M., Smith, H.L., Flynn, L. and Neff, D.F.	Effects of Nurse Staffing and Nurse Education on Patient Deaths in Hospitals With Different Nurse Work Environments	2011	865	3,795	885,00
Cho, E., Sloane, D., Kim, E.-Y., Kim, S., Choi, M., Yoo, I., Lee, H. and Aiken, L	Effects of nurse staffing, work environments, and education on patient mortality: An observational study	2015	199	3,57	259,00
Warshawsky, N. and Havens, D.	Global use of the practice environment Scale of the Nursing Work Index	2011	226	2,02	246,00
Kossman, S. and Scheidenhelm, S.	Nurses' perceptions of the impact of electronic health records on work and patient outcomes	2008	221	1,029	211,00
Arnold, D.	Putting it into practice is difficult. A qualitative study on	2000	254	0	164,00

101

	the theory-practice transfer in the case of kinesthetics				
Scott, S., Estabrooks, C., Allen, M. and Pollock, C.	A context of uncertainty: How context shapes nurses' research utilization behaviors	2008	127	3,03	117,00
Georgiou, A., Prgomet, M., Paoloni, R., Creswick, N., Hordern, A., Walter, S. and Westbrook, J.	The Effect of Computerized Provider Order Entry Systems on Clinical Care and Work Processes in Emergency Departments: A Systematic Review of the Quantitative Literature	2013	73	5,212	113,01
Wisner, K., Lyndon, A. and Chesla, C.	The electronic health record's impact on nurses' cognitive work: An integrative review	2019	6	3,57	106,00
Wisner, K., Lyndon, A. and Chesla, C.A.	The electronic health record's impact on nurses' cognitive work: An integrative review	2019	6	3,57	106,00
Kishita, N., Hammond, L., Dietrich, C. and Mioshi, E.	Which interventions work for dementia family carers?: An updated systematic review of randomized controlled trials of carer interventions	2018	14	2,47	104,00
Kutney-Lee, A., Sloane, D.M., Bowles, K.H., Burns, L.R. and Aiken, L.H.	Electronic Health Record Adoption and Nurse Reports of Usability and Quality of Care: The Role of Work Environment	2019	3	1,306	103,00
Prihodova, L., Guerin, S., Tunney, C. and Kernohan, W.	Key components of knowledge transfer and exchange in health services research: Findings from a systematic scoping review	2019	3	2,376	103,00
da Silva Martins, S., da Silva, M. and da Silva, I.	The impact of technology on the work process of the nursing team	2019	0	0	100,00

102

	working in hemodialysis				
Bergey, M., Goldsack, J. and Robinson, E.	Invisible work and changing roles: Health information technology implementation and reorganization of work practices for the inpatient nursing team	2019	0	3,087	100,00
Gazza, C., Pelayo, S., Kovacs, B., Schiro, J. and Marcilly, R.	Impact of Work Organization on Technology Use: He Case of Hydration Process with a Smart Drinking Glass	2019	0	0	100,00
Halvorsen, M., Austad, H., Landmark, A., Ausen, D., Svagård, I., Tomasevic, T. and Trondsen, T.	Redesigning Work with a Lightweight Approach to Coordination Technology	2019	0	1,029	100,00
Gao, Y., Kong, D., Fu, X.-J. and Pi, H.-Y.	Application and effect evaluation of infusion management system based on internet of things technology in nursing work	2018	4	0	94,00
Schenk, E., Schleyer, R., Jones, C., Fincham, S., Daratha, K. and Monsen, K.	Impact of Adoption of a Comprehensive Electronic Health Record on Nursing Work and Caring Efficacy	2018	4	1,029	94,00
Henneman, E.	Recognizing the ordinary as extraordinary: Insight into the "Way We Work" to improve patient safety outcomes	2017	11	2,063	91,00
Higgins, L.W., Shovel, J.A., Bilderback, A.L., Lorenz, H.L., Martin, S.C., Rogers, D.J. and Minnier, T.E.	Hospital Nurses' Work Activity in a Technology-Rich Environment A Triangulated Quality Improvement Assessment	2017	11	1,5	91,00
Aroldi, J., Peres, H. and	Impact perception at work from an	2018	0	0	90,00

103

Mira, V.	online training on the prevention of pressure injury				
Hitt, L. and Tambe, P.	Health care information technology, work organization, and nursing home performance	2016	19	0	89,00
Sergeeva, A., Aij, K., Van Den Hooff, B. and Huysman, M.	Mobile devices in the operating room: Intended and unintended consequences for nurses' work	2016	14	2,297	84,00
White, D., Jackson, K., Besner, J. and Norris, J.	The examination of nursing work through a role accountability framework	2015	24	2,386	84,00
Zborowsky, T., Bunker-Hellmich, L., Morelli, A. and O'Neill, M.	Centralized vs. decentralized nursing stations: Effects on nurses' functional use of space and work environment	2010	74	1,545	84,00
Von Ah, D., Storey, S., Tallman, E., Nielsen, A., Johns, S. and Pressler, S.	Cancer, cognitive impairment, and work-related outcomes: An integrative review	2016	12	1,438	82,00
Hendriks, P., Ligthart, P. and Schouteten, R.	Knowledge management, health information technology and nurses' work engagement	2016	10	2,636	80,00
Chao, C.-A.	The impact of electronic health records on collaborative work routines: A narrative network analysis	2016	7	2,731	77,00
Krol, M. and Brouwer, W.	Unpaid work in health economic evaluations	2015	14	3,087	74,00
Yang, Y. and Rivera, A.J.	An observational study of hands-free communication devices mediated interruption dynamics in a nursing	2015	11	0	71,00

104

	work system				
Gonçalves, F., Souza, N., Zeitoune, R., Adame, G. and do Nascimento, S.	Impacts of neoliberalism on hospital nursing work	2015	7	0	67,00
Effken, J., Brewer, B., Logue, M., Gephart, S. and Verran, J	Using Cognitive Work Analysis to fit decision support tools to nurse managers' work flow	2011	44	2,731	64,00
Callen, J., Hordern, A., Gibson, K., Li, L., Hains, I. and Westbrook, J.	Can technology change the work of nurses? Evaluation of a drug monitoring system for ambulatory chronic disease patients	2013	23	2,731	63,00
Parsons, J. and Rubin, D.	Cleveland clinic's prescription for growth Health-care provider blends entrepreneurial zeal and cost-management into its	2015	0	0	60,00
Tian, R., Lee, B., Yucel, G., Abel, S., Hultgren, K. and Duffy, V.	Evaluating bar coding-aided medication administration through identification of nursing work deficiencies	2014	4	1	54,00
Gerhart Jr., D., O'Shea, K. and Muller, S.	Advancing medication infusion safety through the clinical integration of technology.	2013	10	0	50,00
Kossman, S.	Perceptions of impact of electronic health records on nurses' work	2006	68	0	38,00
Springer, R.	Pharmaceutical industry discursives and the marketization of nursing work: A case example	2011	16	1,071	36,00
Crigger, N.	Towards a viable and just global nursing ethics	2008	41	1,957	31,00
Gagnon, M.-P.,					

Paré, G., Pollender, H., Duplantie, J., Côté, J., Fortin, J.-P., Labadie, R., Duplàa, E., Thifault, M.-C., Courcy, F., McGinn, C., Ly, B., Trépanier, A. and Malo, F.-B.	Supporting work practices through telehealth: Impact on nurses in peripheral regions	2011	11	1,932	31,00
Hebert, M. and Benbasat, I.	Adopting information technology in hospitals: The relationship between attitudes/expectations and behavior	1994	158	0	8,00
Gallagher, R.	Primary care and pain medicine - A community solution to the public health problem of chronic pain	1999	102	2,716	2,00
Strauss, A., Fagerhaugh, S., Suczek, B. and Wiener, C.	Sentimental work in the technologized hospital	1982	257	2,211	-13,00

106