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ORIGINAL PAPER

DATAMINING TECHNIQUES – DECISION TREE: NEW VIEW ON NURSES' INTENTION TO LEAVE

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Abstract

Aim: The aim of the survey is to identify factors of the work environment which are important for general nurses when they are considering whether or not to leave their current employer. *Design:* The research consists of an observational and a cross-sectional study. *Methods:* Based on a modified interpretation of Herzberg's theory, we created a structured interview to investigate environmental factors. Interviewers carried out 1,992 interviews with hospital nurses working in the Czech Republic, between 2011 and 2012. The data gathered were analyzed with data mining tools – a decision tree and non-parametric tests. *Results:* If a good opportunity arose, 34.7% of nurses would leave their current employer. The analysis of the decision tree identified the factor "Patient care", i.e. a factor concerning the nature of the work itself, as the most important. Data mining offers a new view of the data and can reveal valuable information existing within the primary data. *Conclusion:* Data mining has great potential in nursing. In this research, the decision tree shows that the essence of the nursing profession is the nursing work itself and it is also the most significant stabilizing factor. The management of healthcare providers should create and maintain a work environment which will ensure nursing work can be performed without impediment, thus minimizing staff turnover.

Keywords: nurse, hospital, turnover, intention to leave, work satisfaction, Herzberg's theory, data mining, decision tree.

Introduction

The demographic situation in the member states of the European Union is changing, as it is throughout the developed world. The average age of their populations is now higher due to a drop in natality and higher life expectancy (UN 2009; OECD, 2011; EU, 2011). Besides improvements in infrastructure and treatment, and technological advances, the ageing population is one of the most important factors behind the recent trend of increasing reliance on healthcare, and the increased costs thereof (CSO, 2014). Healthcare costs show a long-term increase worldwide (OECD, 2012; CMMS, 2012). It necessitates adaptation and the development of innovation in healthcare systems (Aslani, Zolfagharzadeh, Naaranoja, 2015).

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After the onset of the global financial crisis in 2008, many European countries cut their health care expenses (OECD, 2012). One available solution to the problem of depleted financial resources in the health care system is the freezing or reduction of healthcare professionals' salaries (Mladovsky et al., 2012). Freezing nurses' wages in combination with the demanding nature of the job, entailing many physical, psychological, and health risks, can lead to a reduction in job satisfaction among nurses and, consequently, an increase in staff turnover rates.

Turnover intention is defined as a conscious and deliberate willingness to leave an organization (Tett, Meyer, 1993). Turnover can be voluntary (employees choose to leave the organization) or involuntary (employees are made redundant). Voluntary turnover has an adverse impact on organizational effectiveness, efficiency, and productivity (Koys, 2001; Shaw, Gupta, Delery, 2005).

For nurses, turnover can have two forms: institutional, i.e., the intention of leaving the

organization for the same type of organization; or professional, i.e., the intention of leaving the nursing profession (Simon, Müller, Hasselhorn, 2010). Research into nursing turnover only rarely distinguishes between leaving an organization and leaving the profession itself (Simon, Müller, Hasselhorn, 2010). Higher staff turnover can have a seriously detrimental effect on the quality of the healthcare system and can result in increased patient care costs (Borda, Norman, 1997a; Borda, Norman, 1997b).

The causes of staff turnover are often contradictory and it is difficult to extrapolate from them or to make comparisons (Tai, Bame, Robinson, 1998). Hayes et al. outlined different reasons nurses report for leaving their job (organizational, personal, career-related, financial, or benefit-related) (Hayes et al., 2012). Alexander at al. and Takase conceptualize nurses' tendency to change jobs as a multi-level process consisting of psychological, cognitive and behavioral factors in combination with their social and experiential orientation, their view of their own work, and the decision-making process, resulting in an active desire to leave their current employment (Alexander et al., 1998; Takase 2010). This may be due to general dissatisfaction with working conditions, persistent staff shortages, and disillusionment with the career structure (Cheung, 2004). Predictors of the intent to leave nursing may include the "professional satisfaction" and the "reasons for working" items assessing the importance of work to the respondent; in addition to "satisfaction with intrinsic rewards", and the respondents' "financial situation" (Lynn, Redman, 2005). Professional commitment is suggested to be predictive of "intent to leave the profession" (Lu et al., 2002). Sociodemographic factors such as age, education and specialization also play a role in the decision to quit nursing (Ingersoll et al., 2002).

High turnover among nurses brings additional costs to healthcare providers. These can be both visible (direct) costs such as advertising, human resources, and employee orientation costs, and losses caused by lower quality of healthcare provided, which can sometimes be difficult to recognize (Jones, Gates 2007). The cost of nursing staff turnover in the USA ranges between $10,098 and $88,000 (Li, Jones, 2013). Considering the number of nurses currently working in the care system, a deficit could hamper the functioning of the system as a whole, since they form the largest professional group of healthcare workers.

This study identifies factors of the work environment which are crucial to nurses' decision whether or not to leave their current employer. As all employers seek ways to motivate their employees without additional costs, we concentrate on factors employers can influence even during a period of financial crisis.

Aim

The aim of this study is to identify those factors of the work environment which are subjectively important for general nurses when deciding whether or not to leave their current employer (the healthcare provider) or to leave their profession.

Basic research questions: 1. What are the reasons for turnover of general nurses? 2. Which work environment factors are crucial to the nurses' decision to stay with or leave their current employer?

Methods

Design

The research consists of an observational and cross-sectional study.

Sample

The survey was carried out between 2011 and 2012. The field research was conducted by means of a structured interview. Respondents were informed of the aims of the research and presented with a questionnaire. Participation in the research was voluntary and informed consent was obtained before the interview. The research itself did not contain any contentious ethical questions. We approached 2,223 nurses working in 74 hospitals and 23 healthcare institutions. 231 nurses refused to participate in the research, mostly on the grounds of lack of time.

The majority of nurses were female (1,913; 96.0%). 344 worked in an outpatient department (17.3%), 1,295 in inpatient wards (65.0%), 160 in a combination of inpatient and outpatient wards (8.0%), 109 in surgical wards (5.5%), and 84 (4.2%) in other settings. 361 nurses worked in the position of sister/charge nurse; the remainder worked as line staff (staff nurses). Most nurses worked full-time 1,829 (91.8%), 163 (8.2%) worked part-time. 1,438 (72.20%) worked in a three-shift operation, and 554 (27.80%) in a single-shift operation.

Data collection

Data were gathered by means of a structured interview conducted by 398 trained interviewers from the Czech Republic. Data collection and a representative sample of nurses was procured by the organization INRES – SONES. The statistical population of the nurses was constructed so as to be representative.

We considered the number of nurses in different regions of the Czech Republic as the prime representative indicator. The representation of nurses corresponds to the structure of the statistical population. Respondents were selected randomly using a quota. In the first step, healthcare providers were selected from the basic set based on the quota for the given region. In the next stage, nurses were selected randomly according to the age quota. The deviation from the statistical population did not exceed 0.3%. Another factor which required equal representation was the age of the nurses. The structure of the sub-population sorted by age shows that its deviation from the statistical population did not exceed 0.4%. Other sociodemographic indicators covered by the survey were not determined to be representative due to lack of additional official sociodemographic data.

There are many factors influencing motivation and job satisfaction, and it is necessary to monitor their influence by a multifactorial approach. This approach is possible with Herzberg's Two Factor Motivation Theory, which was chosen as the methodological framework of the survey (Herzberg, Mausner, Snyderman, 2003). Factors defined by Herzberg's theory were modified based on focus group results of a multidisciplinary team consisting of healthcare professionals, healthcare management, and human resources specialists, in order that the factors better reflect conditions in today's inpatient health care facilities (see Table 1). Table 1 shows abbreviations of work environment factors (column "Abbreviation") later used in Figure 1.

Table 1 Work environment factor

Abbreviation	Marking of the factor in the questionnaire
Image	Public "image" (respectability, reputation) of your health care facility
WoCo	Working conditions (OSH, spatial organization of the work place, work organization)
Technology	Availability of modern technical equipment and instruments
Education	Availability of further professional education (courses, training, workshops and further study).
Information	Information (easy access to information and provision of information)
POG	Possibility of career advancement
InRe_SU	Work relations with supervisors
Prestige	Job prestige
InRe_AP	Cooperation with other professionals (doctors, non-doctors, others...).
Recognition	Non-monetary rewards for your personal work output, such as praise, appreciation of your work in front of colleagues
Benefits	Social perks provided by the employer (personal accounts, vitamins, meal tickets, etc.)
Care	Patient care itself
InRe_PE	Cooperation between workers in the department
WoClimate	Work climate (atmosphere in the workplace)
Job_sec	Stability – certainty of guaranteed work
Salary	Salary/wages

On this basis a questionnaire and structured interview were created, previously tested in a study between 2004 and 2006 (Vévoda at al., 2010). Nurses were asked to rate the factors subjectively from 1 to 16, whereby 1 was the most important and 16 the least important. Each number could only be used once.

In order to determine the nurse's willingness to leave their employer (if a good opportunity arose), the nurses were asked a question which was added to the list of factors on a three point scale – "Yes, I am going to leave my employer if a good opportunity arises." – "I don't know, I have not decided yet." – "No, I am going to stay with my employer even if a good opportunity arises." A 'good opportunity' was not specified, it was left to the discretion of the respondent.

All respondents were informed of the nature of the survey and signed an informed consent before the study commenced. A confidentiality clause was stipulated in the interviewers' contracts. They were forbidden to disclose any data they obtained in connection with the survey. All data gathered was anonymized. The data was digitalized without feedback from the interviewers. After the data was digitized, the original questionnaire papers were shredded.

Data analysis

Statistical analysis was facilitated using the SPSS 22.0 Base software. (SPSS Inc., Chicago, IL USA).

To compare groups of nurses wishing to leave their employer ("Yes, I am going to leave my employer if a good opportunity arises") and nurses who wish to

stay ("No, I am going to stay even if a good opportunity arises"), a non-parametric Mann-Whitney test was used. For the purposes of this test, the group of nurses who answered "I don't know, I haven't decided yet" was excluded from this study. A total of 459 respondents were excluded due to their ambivalent opinion/attitude. Nurses without a strong opinion would increase data 'noise' (Krosnick, Holbrook, 2002).

A decision tree was used to determine crucial factors behind turnover. The following decision tree was compiled based on the ranking of singular work environment factors of personal importance to nurses in their leave.

Datamining techniques make it possible to ascertain important behavioral patterns from electronic data so that they can be used for optimum decision-making. Decision trees have become a common datamining algorithm due to their transparency and robustness, and are a tool widely-used for classification and prediction. A decision tree is made up of a set of related hierarchical rules. The classification is based on the following principle: all existing data records (the ranking of environmental factors) are assigned with a target attribute, in our case the binary decision nodes "Yes, I am going to leave my employer" versus "No, I am going to stay with my employer". The research data were classified using the CHAID algorithm, which is a fast statistical algorithm based on the optimum chi-squared and F-test values, creating segments and profiles in the sequence of steps, dividing groups into a statistically suitable number of homogeneous sub-groups. The optimum step is defined with the maximum significance. A decision tree is divided into nodes, branches and leaf nodes, which have mutually exclusive assignment rules. The decision tree shows which combinations of environmental factors lead to nurses' decision either to leave their job or stay. A tree designed using this data can then be readily used to predict which nurses are most likely to leave. The multiple variable analysis capability of a decision tree makes it possible to see beyond simple one-cause, one-effect relationships and to reveal decisions in the context of multiple influences. (Rokach, Maimon, 2007).

The tests were carried out at a 5 % significance level.

Results

Descriptive statistics were used to answer the first survey question regarding nurses' tendency to turnover (i.e., change employer) if a good opportunity arises. It was found that the largest group (842 nurses, i.e.; 42.3%) wants to stay with their employer even if a good opportunity to leave arises. Conversely, 691 (34.7 %) nurses are going to leave their employer. 459 (23 %) general nurses were undecided.

Fig. 1 gives a depiction of the decision tree showing the sequence of personal priorities of nurses, answering the second research question: "Which factors are most important for nurses' turnover tendencies?" The decision tree model draws on the largest group of nurses, i.e., nurses who do not wish to leave their employer. In this model, we can identify three basic decision situations.

The first decision situation

If the nurse finds "Patient care" (rating <= 3) and "Salary" important (rating <=2), and her estimation of "Job prestige" receives a rating >= 8, the majority of nurses have a tendency to fluctuate. If "Salary" is rated >= 3, the majority of nurses do not tend to fluctuate.

The second decision situation with nurses is as follows

If a nurse considers "Patient care" important (rating <= 3), gives "Non-monetary rewards for work results" a rating <= 12 or <= 14, and gives "Job prestige" a high rating <= 8, the majority of nurses do not have a tendency to fluctuate. If the "Non-monetary rewards for work results" is rated >14, the majority of nurses are inclined to fluctuate.

In the third decision situation

If the "Patient care" factor is ranked the third or fourth most important personal priority (=> 3), then the nurse tends to fluctuate regardless of the other factors. The "Patient care" factor is crucial in the decision whether to stay with or leave the current employer.

The answer to research question 1 can be found in Table 2. Table 2 clearly shows that nurses willing to leave their employer prioritize "Salary", "Availability of modern technology and instruments", and "Social benefits" provided by the employer. Conversely, nurses who wish to stay with their current employer even if another good job opportunity arises significantly prioritize "Patient care", "Job prestige", and "Work atmosphere".

Discussion

Nursing work has long been the domain of women. We can see that men account for 4% of all nurses in the Czech Republic. In the USA, the figure is 6.6%, but this percentage is continuing to grow (U.S. Department of Health and Human Services Health Resources and Services Administration, 2008).

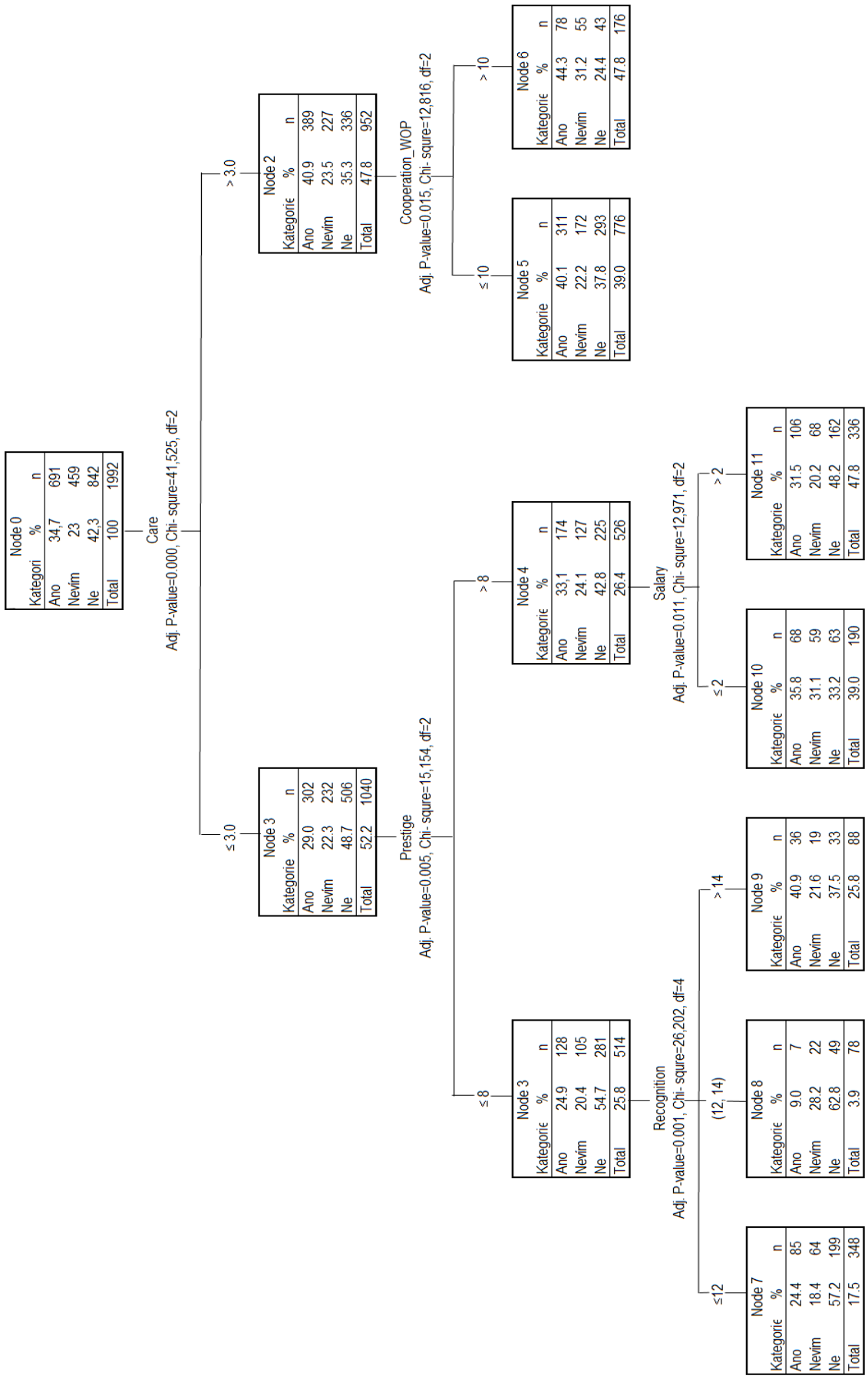

Figure 1 Decision tree of turnover behavior amongst nurses

Table 2 Statistically significant differences between groups of nurses who wish to leave their employer and nurses who wish to stay.

Answer	Salary	Availability of modern technical equipment and instruments	Non-monetary benefits - employee/social perks	Patient care	Work prestige	Work climate
Yes, I am going to leave my employer.	p = 0.000*	p = 0.005*	p = 0.006*			
No, I am going to stay with my employer				p = 0.000*	p = 0.006*	p = 0.006*

*$\alpha = 0.05$

Unlike in some other OECD member states, part-time work contracts are rare (8%) in the Czech Republic. In the Netherlands, more than half of all nurses and midwives are employed on part-time contracts (Organisation for Economic Co-operation and Development, 1997). In the USA 21% of registered nurses work on part-time contracts (U.S. Department of Health and Human Services Health Resources and Services Administration, 2008).

From the gathered data we can see that 34.7% of nurses are considering leaving their current employer if a good opportunity to do so arises. Similar findings were reached by Gurková et al., who note that 13.5 % of nurses from the Czech Republic are considering changing their profession, 21.2 % are considering leaving their current workplace, and 7.8 % are considering working abroad. They also mention that the situation is similar in Slovakia. (Gurková et al, 2013b). More frequent experience of negative emotions is connected with more frequent thoughts of leaving the job, which in turn is connected with more frequent thoughts of leaving the nursing profession completely or of pursuing a career abroad (Gurková et al., 2013a).

The first factor determined by both the decision tree and the Mann-Whitney test was “Patient care”, that is, a factor of the job itself, of the nurse’s profession as such. Nursing involves emotional and physical stress, which might be linked to intentions of leaving (Hasselhorn et al., 2005). The data mining technique of the decision tree determined that the “Patient care” factor was the first and most important decisive factor when considering whether to stay with or leave an employer. If nurses prioritize this factor, they are not usually interested in leaving their current employer. The importance of this factor was also confirmed by a non-parametric test, which divided, with statistical significance, groups of nurses who want to stay with their current employer and those who want to leave. This finding conforms to the findings of NEXT study which suggests that the incidence of intent to leave the profession is in relation to changes in job strain (Hasselhorn, 2008). Patient care is the most common reason for satisfaction or dissatisfaction with work (McNeese-Smith, 1999).

The second factor that was confirmed by both statistical tests is “Job prestige”. In June 2011, the Public Opinion Research Centre discovered a significant change in the prestige ranking of selected jobs by the Czech Republic (Tuček, 2012). Out of 26 selected jobs, nurses ranked third after doctors and scientists in 2011. Nurses possess a similar level of prestige to university lecturers (Tuček, 2012), whereas in 1976 nurses ranked 40th out of 70 selected professions. With changes in the education system, their essential role in multi-disciplinary teams, and their crucial role in the healthcare system, nurses are becoming more and more aware of their own prestige.

The third factor both tools identify is “Pay/wages”. In 2012, the average monthly salary of nurses paid according to the pay scale was 29,158 CZK, out of which the pay grade was 18,179 CZK. The average monthly salary of nurses was 23,567 CZK. The average nurses’ salary in state healthcare was 28,706 CZK per month (1,467 USD), the average salary in the private sector was 25,314 CZK per month (1,293 USD). In 2013, the average monthly salary dropped by 0.5% compared to 2012 (Institute of Health Information and Statistics of the Czech Republic, 2014).

From the survey results it was also apparent that the group of nurses who consider “Patient care” more important than “Job prestige”, but who find “Pay/wages” very important, have a tendency to leave. “Pay/wages” is a frequently mentioned and well-researched phenomenon in connection with “Work satisfaction” (Best, Thurston, 2004; Apostolidis, Polifroni, 2006; Bjork et al., 2007; Curtis, 2007). Nevertheless, contrary to expectations, “Pay/wages” occupies one of the lowest levels of the

decision nodes for nurses' decision to leave their employer, (See Fig. 1). Other conditions must be met and interactions with other factors (such as low priority for the "Job prestige" factor) must occur before nurses consider "Pay/wages" to be the decisive factor in leaving his/her employer.

According to the decision tree, other decisive work environment factors influencing the decision to leave a current employer are "Cooperation with other professions" and "Recognition".

"Cooperation with other professions" is not a negligible factor for nurses when deciding to leave their current employer. The profession topping the list of "other professions" that nurses cooperate with is that of doctor. A closely connected factor is "Recognition". For nurses it is important to receive appreciation and praise from doctors. Almost 66% of doctors express appreciation for nurses' work, and 55% of them consider nurses to be equal partners in patient care (Bártlová, Trešlová, 2010). On the other hand, more than 60% of nurses encountered a doctor they disliked working with because of his or her superior attitude, unprofessional behavior, or mutual antipathy.

Of other interpersonal factors included in the research, "Interactions with co-workers in the department" and "Relationships with superiors" had no significant influence on the nurses' decision to leave. This finding could indicate good managerial work on the part of ward nurses and head nurses, as nurses who most often leave their employers are those dissatisfied with the fairness of working conditions (Abraham, 1999), and also those dissatisfied with the level, form and frequency of feedback (Jawahar, 2006).

The Mann-Whitney test, in contrast to the decision tree, identified the "Work climate" factor to be a priority for nurses wishing to stay with their current employer. It is mostly the responsibility of managers to help create a pleasant work climate and thus stimulate their co-workers' performance. Work climate has a great influence on a company's effectiveness, and it comprises the employees' attitudes to the organizational setup (organizational structure, mutual trust, support, discussing problems, etc.) (Cejthamr, Dědina, 2010).

On the other hand, the "Social benefits provided by the employer" factor is characteristic of nurses inclined to leave their employer. As indicated in the Nurse Benefits Survey in the USA, the most common benefits are health insurance, covering medical, dental and ophthalmological care, supplementary pension insurance, paid holidays, and "sick days" (Fraleigh, 2009). It is possible to include benefits which are still perceived as innovative, such as flexible shift planning, parking spaces, company kindergartens, etc. When choosing which benefits to offer, the employers should not decide on their own. On the contrary, the employees should be involved in this process (Muse, 2008). Interesting benefits can become a tool to attract and retain skilled nurses, especially in times of work-force shortage (Spetz, Adams, 2006).

Another important factor was the "Availability of modern technical equipment and instruments", which characterized the group of nurses wishing to leave their employer. Nurses encounter both psychological and physical stress, with manipulation of patients being one of the most frequent causes of physical stress. If modern, adjustable beds enabling easy positioning of the patients are not available, a nurse may consider leaving her employer, as he/she is unable to cope with such a high level of physical stress.

Groups of factors in which a difference of outcomes with different statistical tools was noted will require further research to explain their roles in nurses' decision-making process.

Conclusion

The decision-making process of general nurses regarding whether they stay with or leave their employer is complex and multidimensional. It entails motivational factors as well as job satisfaction factors. Monitoring the satisfaction of employees is only required in accredited hospitals. (Joint Accreditation Commission of the Czech Republic, 2014). The decision tree technique could help both HR managers and line manager identify the preferred work environmental factors which nurses take into consideration when deciding whether or not to leave their job.

An important aspect of ensuring employee satisfaction is the hiring of a skilled manager who is able to establish a relationship with each of their employees and who can adapt their managerial style and communication to each member of the team. A healthy work environment is directly linked to employee retention (Utriainen, Kyngas, 2009) and enhances patient safety outcomes (Kirwan, Matthews, Scott, 2013).

It is crucial not only to be aware of current levels of work environment satisfaction among nurses, but also to focus on factors that are stable over time and do not require increases in staffing costs in periods of financial crisis. Factors which have been important in the past remain important today and can be the basis for anticipated future motivational factors.

Nursing itself – the fundamental basis of a nurse's work – remains one of the most motivating factors for nurses. The nurses' daily scope of work is critical in their decision to leave their current employment. It is crucial to use the potential of these findings to create organizational conditions in which nurses can perform to their highest potential. Work itself is one of the most important motivational factors over time. However, if nurses are highly motivated to give quality care but do not receive support from their management, staff will tend to fluctuate (Muse, Wadsworth, 2012).

Limitations

The data were collected from general nurses in the Czech Republic and do not reflect the opinions of nurses in other regions. Herzberg's Two Factor Motivation Theory – as the methodological basis of the study – explicitly defines work environment factors, but these were modified by a multidisciplinary team. Thus, the research methodological groundwork was laid together with the resulting limitations. The research tool used was constructed as a managerial tool in which each of the environmental factors is seen as being in competition. For this reason, the reliability was checked by test/re-test instead of Cronbach's alpha. The tool validity is given by the content validity of the theory used. In addition, the respondents who did not answer might have given a different priority to the environmental factors, or mentioned other factors not included in this theory.

Ethical aspects and conflict of interest

The authors are unaware of any conflict of interests.

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Author contribution

Conception and design (JV, SV, KI), data collection, data analysis and interpretation (JV, SV, KI), manuscript draft (KI), critical revision of the manuscript (HK), final approval of the manuscript (HK, SV), final approval of the references (ŠB).

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