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Implementation of an intravenous medication infusion pump system: implications for nursing

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Implementation of an intravenous medication infusion pump system: implications for nursing

Aim To assess perceptions of nurses regarding the implementation of intravenous medication infusion system technology and its impact on nursing care, reporting of medication errors and job satisfaction.
Background Medication errors are placing patients at high risk and creating an economic burden for hospitals and health care providers. Infusion pumps are available to decrease errors and promote safety.
Methods Survey of 1056 nurses in a tertiary care Magnet hospital, using the Infusion System Perception Scale. Response rate was 65.43%.
Results Nurses perceived the system would enhance their ability to provide quality nursing care, reduce medication errors. Job satisfaction was related to higher ratings of the management team and nursing staff. Perceptions verified the pump was designed to promote safe nursing practices.
Conclusions It is important to consider relationships with job satisfaction, safe nursing practice and the importance of ratings of nursing staff and management teams when implementing infusion technology.
Implications for nursing management Infusion pumps are perceived by nurses to enhance safe nursing practice. Results stress the importance of management teams in sociotechnological transformations and their impact on job satisfaction among nurses.

Keywords: intravenous infusion pump technology, job satisfaction, medication error reduction

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Introduction

Medication errors are placing patients at high risk while at the same time creating an economic burden for hospitals, health care providers, patients/families and governmental and insuring agencies. The costs for adverse drug events in the United States have been estimated in the millions of dollars every year for any

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given hospital (Bates *et al.* 1997), exclusive of immeasurable patient harm. The annual benefit of preventing adverse events because of medication errors could reach nearly $4 billion dollars (HHS 2003). Intravenous medication errors create some of the most critical problems because of the nature of the drugs themselves as well as their rapid rates of absorption, and it is widely accepted that medication errors are significantly underreported (Cullen *et al.* 1995, Taylor *et al.* 2004). One of the solutions currently being used is intravenous infusion pumps which deliver medications through the use of technology.[1] While this technology is highly promising, little is known about nurses' perceptions of its use, its impact on their job satisfaction and ultimately, on the quality of nursing care they provide.

Literature review

Medication errors not only pose significant threats, but they occur frequently in hospital settings (Lesar *et al.* 1997, Reeves 2003). Errors compromise positive health care outcomes and contribute to the anxiety and concerns of nurses, doctors, pharmacists, patients and their families.[2] The Agency for Healthcare Research and Quality estimates that as many as 7000 people die each year from medication errors in the United States (Medical Errors 2000).

Medication administration has changed dramatically over the past decade primarily as a result of the technology revolution. While infusion pumps were introduced over 30 years ago, they have now evolved into highly sophisticated, therapy-specific devices. In 2003, an infusion system or 'smart pump' was unveiled by a corporate manufacturer with the alarming statement that '61% of the most serious and life-threatening potential adverse drug events are IV drug-related' (High Beam Research 2003). These infusion devices are defined as technology with '…software that incorporates institution-established dosage limits, warnings to the clinician when dosage limits are exceeded, configurable settings by patient type, and access to transaction data' (Wilson & Sullivan 2004).

A number of studies have now been conducted on the outcomes of using these devices. The Primary Children's Medical Center in Salt Lake City, Utah, Larsen *et al.* (2005) carried out a study to determine if combining standard drug concentrations with smart pump technology would reduce reported medication-infusion errors. Reported errors dropped by 73% (3.1 to 0.8/1000 doses) and preparation errors decreased significantly. Vanderbilt University Medical Center reported that using an independent variable (IV) medication safety system averted 99 potential infusion errors in 8 months (Hatcher *et al.* 2004).

Problems still continue, however, in that bypasses of the drug library occur and medications can still be administered without documented doctor prescriptions (Rothschild *et al.* 2005). These problems can not currently be prevented by the infusion systems. Husch *et al.* (2005) noted that of the 426 medications observed infusing through traditional IV pump, 285 (66.9%) had one or more errors associated with their administration. Problems exist with the research as well, in that self-reported medication errors prior to implementation of infusion pumps and technology-reported medication errors after implementation of infusion pumps are quite different, and more importantly, the data are not comparable when used for research purposes.

The tremendous changes with technology have created new learning needs and challenges for nurses. It is unclear how such changes impact nurses' perceived job satisfaction and their perceptions of the care they provide. To date, no research has been found that addresses these important issues.

Job satisfaction has at least three common denominators: (1) factors inherent in the work environment, (2) professional factors and (3) factors involved in patient care (Kuokkanen *et al.* 2003). The authors found that job satisfaction, job commitment and level of professional activity strongly correlated with feelings of empowerment, an essential factor in nursing practice. In a pilot study of Australian nurses, autonomy was reported as the most important job component for job satisfaction among registered nurses (Finn 2001). When technology is introduced, it is important to include these issues and involve the staff in organizational decision-making. This was supported in Khowaja *et al.* (2005) study in which high workloads, stress associated with workloads and rigid attitudes of nursing management impacted their willingness to remain at the hospital. The Herzberg Dual Factor Theory of Job Satisfaction was used to study job satisfaction of nurse practitioners (Kacel *et al.* 2005) and findings indicate that nurses were only minimally satisfied to satisfied. Job satisfaction then declined as the number of years of experience increased. The impact of new technology on older or 'seasoned' nurses is yet unclear; however, findings of one study suggest that age may be a factor to consider (Lupoli & Rizzo 2003). They suggest that the use of telehealth technology by older nurses in home care settings could improve job satisfaction and retention in this important setting. These findings may or may not hold true for hospital nurses. Assessment of nurses' age when introducing new technology could

1. **Intravenous medication errors create some of the most critical problems because of the nature of th...**
Anchor Name: Effective *[Agency FCB Halesway Olga Kooi]*

2. **Medication errors not only pose significant threats, but they occur frequently in hospital settings ...**
Anchor Name: Consistent efficacy with the right dose *[Agency FCB Halesway Olga Kooi]*

reveal additional information. In a landmark study published in the **Journal of the American Medical Association** (Aiken *et al.* 2002), job dissatisfaction was associated with high patient-to-nurse ratios and patient mortality rates. These factors have also been related to medication errors.

The Magnet Recognition Program® was developed by the American Nurses Credentialing Center, a subsidiary of the American Nurses Association, to recognize health care organizations that provide the very best in nursing care [ANCC (website)]. It began in the 1980s in an attempt to address the nursing shortage. The American Academy of Nursing's task force on nursing practice conducted a study that 'identified and described variables that created an environment that attracted and retained well-qualified nurses'. Differences in the job satisfaction of nurses at Magnet Hospitals have been reported in the literature (Havens & Aiken 1999, Scott *et al.* 1999, Upenieks 2002). The administrative team of the Magnet Hospital in this study is highly motivated to continue striving for excellence through a better understanding of the impact of technology on nurses and the care they provide.

Conceptual frameworks

The primary theoretical premise used for this study (Figure 1) is based on Sociotechnical Systems (STS) which incorporates the technical aspects of the infusion pump system and the social subsystem or personal beliefs of nurses. The STS Theory (Trist & Bamforth 1951, Emery & Trist 1960, Fox 1995) is based on open systems theory (von Bertalanffy 1967, 1968) and states that effective work sites have joint optimization of both social and technological systems. It is technology-facilitated and indicator-driven with the purpose to ground quality assurance in medical practice and provide meaning to care providers (Harteloh 2003) and has been applied in nursing research (Le Blanc *et al.* 2001). As in any open systems theory, the parts of the organization are interrelated so that changes in any one part affect all other parts. The social system is composed of the people who work in the organization and the relationships among them, and is represented in this study by responses elicited on life patterns, reporting errors and job satisfaction. The technical system is the tools, techniques, procedures, skills, knowledge and devices that are used by the members of the social system to accomplish the tasks that are prescribed (Pasmore *et al.* 1982) and is represented by the intravenous infusion pump. Joint optimization suggests that the social and technical dimensions are interdependent, and outcomes, such as job satisfaction and performance, can only be optimized by jointly considering the two dimensions (Davis & Taylor 1986). More recent developments of this model are reflected in the Structurational Model of Technology (Orlikowski 1992). This model explicates the duality of technology, in which technology enables and constrains human action, while simultaneously, human action develops, appropriates and changes technology.

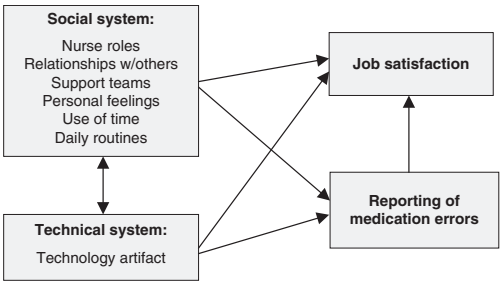

Figure 1
Conceptual model.

The Life Patterns Model which includes roles, relationships, support groups, self-esteem, use of time and life structure (Rosenkoetter *et al.* 1997, 2001, Rosenkoetter & Garris 1998, 2001, Peters 2006) is used to frame the questions of the social or personal factors of the instrument, while incorporating the interaction of the technical nature of the infusion system. This model stems from an open systems framework in that changes in each of the life patterns cause changes in each of the others patterns. If a person changes roles, it is predictable that there will be changes in relationships, use of time and life structure. With changes in use of time, there are likely changes in roles which could ultimately impact self-esteem. The infusion system will involve nurses changing their roles to incorporate technology in the administration of intravenous medication and in an environment that allows access to a medication library with dosage limits. It is anticipated that nurses will decrease the phone calls to hospital pharmacists and that this change will foster relationships among health care professionals. The pump will change the use of the nurses' time and nursing routines. The potential for decreased medication errors provides the potential for greater self-esteem among nurses who are less likely to commit them, and are more likely to work within a less punitive reporting system. Each of these factors could foreseeably impact nurses' satisfaction, patient care and, hence, satisfaction with their jobs.

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Purpose

The first purpose of this study was to assess the perceptions of nurses regarding the implementation of an intravenous medication infusion system technology and its perceived impact on associated nursing care, reporting of medication errors and job satisfaction. The second purpose is to explore the association of demographic variables and nurses' perceptions of pump implementation to ratings of the management team and job satisfaction. This is Phase I of an overall study. The second phase is in progress and focuses on a preimplementation and postimplementation analysis of the perceptions of the nursing staff and nurse managers.

Definitions

Intravenous medication infusion pump system
A modular technological device designed for the delivery of intravenous medications that includes drug libraries, volume and rate calculations, dose limits, soft and hard alerts, continuous quality improvement reports, clinical advisories and bolus dose limits within the context of wireless connectivity in a medication safety system.

Nursing care
The perceptions of nurses roles, relationships, support groups (interpreted as teams), self-esteem (interpreted as personal feelings), use of time and life structure (interpreted as daily routines) as measured by the Infusion System Perception Scale (ISPS).

Reporting of medication errors
Perceptions of inaccuracies in the administration of IV medications as measured by ISPS.

Job satisfaction
The perceptions of social factors associated with work and employment as measured by the ISPS.

Variables

Perceptions of nurses regarding the impact of the intravenous medication infusion pump system technology independent variable (IV) on the social factors of:

- nursing care, dependent variable (DV);
- reporting of medication errors (DV) and
- job satisfaction (DV).

Association of demographic variables, perception of pump implementation with:

- ratings of the management team (IV) and
- job satisfaction (DV).

Methods

Sampling

All registered nurses and licensed practical nurses (n = 1056) employed by a major tertiary care hospital located in the south-eastern United States were contacted and asked to participate in the study. Those who agreed to participate comprised the sample. There were 691 completed questionnaires for a response rate of 65.44%.

Human subjects approval and consent

The study was approved by the Human Assurance Committee of the primary researcher's university and the Institutional Review Board of the hospital prior to the study implementation. Consent letters explained the purpose of the study, advised participants of each of their rights as human subjects and solicited their participation in the study. Return of the questionnaire provided consent.

Instrumentation

The instruments were developed by the primary researcher in consultation with the co-investigators. The Dillman Method (Dillman & Christian 2002) using symbols, graphical, verbal and numerical entries was used to formulate the instrument and enhance the response rate. The first section of the questionnaire pertained to demographic characteristics. The second section, 30 questions on a 5-point Likert scale (strongly disagree to strongly agree), was based on melding STS Theory and the Life Patterns Model conceptual framework. This melding aided in assessing participants' perceptions regarding changes that could occur with the pump implementation, namely in (1) roles, (2) relationships with others, (3) support teams, including nurse and management (groups), (4) personal feelings (self-esteem), (5) use of time, (6) daily routines (life structure), (7) reporting of medication errors and (8) job satisfaction.

The instrument was evaluated for validity and reliability. The research team, including the nurse administrative team of the hospital, reviewed and revised the instrument. Prior to implementation, 28 registered nurses who would not be a part of the final study were

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asked to complete the questionnaire. Each was provided with a consent letter advising them of their rights as human subjects and was asked to complete the questionnaire during a meeting and again 2 weeks later. A Cronbach's alpha coefficient of 0.756 was established for the pre–post test comparison. Further reliability testing was carried out on the total number of questionnaires completed (n = 691) and is described in the section that follows. Responses were coded into SPSS 13.0 and systematically rechecked by researchers.

Results

Data analysis

Methods of data analysis included the use of SPSS™ software to analyse demographic and other variables using inferential statistics and regression analysis. Results are presented based on the changes that could result from pump implementation in the life patterns and sociotechnical relationship, including the reporting of medication errors and job satisfaction. Missing data were deleted and total reported values were used in calculations.

Demographic data

Of the participants reporting demographic information, 61.7% (n = 441) were ages 31–50 years; 41.5% (n = 281) had an associate degree or diploma in nursing; 38.8% (n = 263) had baccalaureate degrees in nursing; 71.6% (n = 484) reported no previous experience with the pump. Slightly over 48% (n = 328) had been on their nursing unit for five or more years; and 58.5% (n = 400) had been at that hospital for 5 or more years.

Life patterns

Roles

Table 1 provides frequencies, modes, χ^2 for each of the life pattern statements. Over 93% (n = 573) of those reporting, indicated the pump was designed to promote safe and effective nursing care. For 90.2% (n = 618) it would increase safe medication administration, and for 65.1% (n = 436) it would not take away the nurse's control. There was a significant difference in the mean job satisfaction using the ratings of the management team (F = 22.285, df = 661, P < 0.000), and the nursing staff (F = 11.665, df = 660, P < 0.000), highest degree earned (F = 3.041, df = 658, P = 0.006) and promotion of safe nursing practice (F = 28.812, df = 599, P < 0.000). The prevailing tendencies are for higher job satisfaction given higher ratings of the senior management team and of the nursing staff, higher education attained and higher perception of the infusion pump being designed to promote safe nursing practices.

Relationship with others

Nearly 50% (n = 330) responded that the pump would decrease patient concerns about medications; however, there was a high neutral response (33.5%, n = 227) to this question as well, demonstrating considerable uncertainty. Over 60% (n = 421) responded that the pump would increase the confidence that patients had in the care that was provided.

Support teams

Responses indicated that 43.2% (n = 293) perceived nurses would rely less on pharmacy staff, yet nearly one-third were neutral (32.1%, n = 218). While 37.8% (n = 253) reported they would rely less on other nurses for advice, 36.2% (n = 242) were neutral. For 83.4% (n = 569) the drug library and limits would enhance their ability to provide high quality nursing care. When asked to rate the nursing and management teams, 89.7% (n = 609) rated the nursing staff as above average or excellent, and 75.3% (n = 512) rated the management team as above average or excellent.

Personal feelings (self-esteem)

The strongest significant effect by coefficient results was from 'personal feelings', which has the highest coefficient and is significant in the model (see Table 2). For this construct, 51.3% (n = 355) indicated that the pump would increase their self-confidence, and 54.3% (n = 372) responded that using the pump would make them feel less anxious about making medication errors.

Use of time and daily routines

The second strongest influence on job satisfaction was reflected in use of time and daily routines. Of particular interest is that only 6.8% (n = 46) of respondents perceived they would have to override the alerts too often, and nearly 50% (n = 336) reported that the pump would make their daily routines easier. The two variables of use of time and daily routines seemed to have very similar results and interpretations. ANOVA was then used to determine whether there was any difference in the nurses' mean job satisfaction based on their age, their years of service on the nursing unit or their use of time. The results from ANOVA indicate that there was no significant difference in the mean job satisfaction using

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Table 1
Likert Scale Frequencies and χ^2 with Job Satisfaction Rating

	Strongly disagree (1)		*Disagree (2)*		*Neutral (3)*		*Agree (4)*		*Strongly agree (5)*		*Total (mode)*	χ^2	*df*	*P*-value
	n	%	*n*	%	*n*	%	*n*	%	*n*	%				
Nurse roles														
1. The 'pump'* is designed to promote safe and effective nursing practice	13	2.1	1	0.2	26	4.2	228	37.2	345	56.3	613 (5)	118.924	16	0.000
2. The 'pump' will increase the safe administration of medications	15	2.2	4	0.6	48	7.0	289	42.2	329	48.0	685 (5)	138.575	16	0.000
3. I like using technology to administer medications	16	2.4	17	2.5	101	15.1	302	45.1	234	34.9	670 (4)	98.689	16	0.000
4. The 'pump' will take away my control over giving medications	103	15.4	333	49.7	158	23.6	58	8.7	18	2.7	670 (2)	69.417	16	0.000
5. The technical aspects of the 'pump' will limit my ability to make autonomous nursing decisions	94	14.1	341	51.0	146	21.8	67	10.0	21	3.1	669 (2)	53.333	16	0.000
6. I am concerned that the 'pump' may not always be accurate, causing more errors	95	14.0	295	43.4	205	30.1	76	11.2	9	1.3	680 (2)	69.304	16	0.000
Relationships with others														
7. The 'pump' will cause concern about safety among the nurses with whom I work	107	15.8	351	51.8	138	20.4	68	10.0	14	2.1	678 (2)	97.667	16	0.000
8. The 'pump' will decrease patient concerns about medications	17	2.5	103	15.2	227	33.5	253	37.4	77	11.4	677 (4)	182.878	16	0.000
9. The 'pump' will increase the confidence that patients or families have in the care that I provide	12	1.8	45	6.6	201	29.6	304	44.8	117	17.2	679 (4)	256.214	16	0.000
Support teams														
10. The 'pump' drug library and medication limits will enhance my ability to provide high quality nursing care	9	1.3	25	3.7	79	11.6	374	54.8	195	28.6	682 (4)	160.412	16	0.000
11. I will need to rely less on the pharmacy staff for assistance with medication administrations	26	3.8	142	20.9	218	32.1	224	33.0	69	10.2	679 (4)	129.911	16	0.000
12. I will need to rely less on my other nurses for advice when giving medications	28	4.2	146	21.8	242	36.2	204	30.5	49	7.3	669 (3)	168.499	16	0.000
Personal Feelings														
13. The 'pump' will increase my self-confidence	12	1.8	58	8.5	256	37.6	278	40.8	77	11.3	681 (4)	427.736	16	0.000
14. I believe reporting of medication errors will be less punitive	37	5.5	132	19.7	302	45.1	162	24.2	37	5.5	670 (3)	197.653	16	0.000
15. I will feel less anxious about making medication errors	20	2.9	96	14.0	197	28.8	311	45.4	61	8.9	685 (4)	310.577	16	0.000
16. The 'pump' will feel like someone is always watching me when I give medications	36	5.3	185	27.1	171	25.1	248	36.4	42	6.2	682 (4)	154.448	16	0.000
17. The 'pump' technology will cause anxiety among patients or families	77	11.5	384	57.1	171	25.4	33	4.9	7	1.0	672 (2)	135.941	16	0.000
Use of my time														
18. The 'pump' will increase my workload	47	7.0	300	44.7	191	28.5	104	15.5	29	4.3	671 (2)	226.636	16	0.000
19. My time is too busy to add the 'pump' to what I have to do	81	12.0	365	54.0	177	26.2	38	5.6	15	2.2	676 (2)	215.154	16	0.000
20. The 'pump' will be easy to learn to use	13	1.9	45	6.7	196	29.2	337	50.1	81	12.1	672 (4)	216.121	16	0.000
21. I will have to override the alerts too often	56	8.3	327	48.4	246	36.4	39	5.8	7	1.0	675 (2)	163.629	16	0.000
Daily routines														
22. The 'pump' will make my daily routines easier	10	1.5	53	7.8	283	41.5	273	40.0	63	9.2	682 (3)	506.481	16	0.000
23. It will take too much time and effort to add the 'pump' to my work schedule	64	9.4	361	53.2	207	30.5	40	5.9	6	0.9	678 (2)	132.577	16	0.000
Reporting of medication errors														
24. I feel that I can **now** be very honest about reporting medication errors on the unit where I work	12	1.8	43	6.5	285	42.9	264	39.7	61	9.2	665 (3)	229.804	16	0.000
25. I believe nurses are very honest about reporting medication errors	16	2.4	126	18.6	216	31.8	261	38.4	60	8.8	679 (4)	145.947	16	0.000

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Table 1
(Continued)

	Strongly disagree (1)		*Disagree (2)*		*Neutral (3)*		*Agree (4)*		*Strongly agree (5)*		*Total (mode)*	χ^2	*df*	*P*-value
	n	%	*n*	%	*n*	%	*n*	%	*n*	%				
26. If I report a medication error **now**, I will be formally reprimanded for making the errors	33	5.0	196	29.6	273	41.2	139	21.0	21	3.2	662 (3)	66.192	16	0.000
27. I believe there are many more medication errors that are ***made***, than are ***reported***	6	0.9	50	7.4	194	28.6	333	49.1	95	14.0	678 (4)	74.353	16	0.000
Job satisfaction														
28. The 'pump' will increase how satisfied I am with my job	15	2.2	92	13.5	339	49.9	197	29.0	36	5.3	679 (3)	–	–	–
29. The 'pump' will increase how satisfied I am with the nursing care that I provide	15	2.2	79	11.7	271	40.1	266	39.3	45	6.7	676 (3)	1537.029	16	0.000
30. Training in the use of the 'pump' was adequate for me to use the equipment effectively	12	1.8	14	2.1	137	20.3	392	58.1	120	17.8	675 (4)	267.614	16	0.000

*Name of manufacturer replaced with 'pump'.

Table 2
Regression analysis results – modified constructs *vs.* job satisfaction (significant values in bold – unstandardized coefficients)

	Job satisfaction construct			
	Coefficient	*Significance*	*Coefficient*	*Significance*
Model		**0.000**		**0.000**
Constant	**0.605**	**0.000**	**0.646**	**0.000**
Nurse roles	0.029	0.505		
Relationships	**0.073**	**0.016**	**0.090**	**0.002**
Support teams	0.052	0.127		
Personal feelings	**0.327**	**0.000**	**0.353**	**0.000**
Daily routines	**0.179**	**0.000**	**0.172**	**0.000**
Use of time	**0.158**	**0.002**	**0.193**	**0.000**
Adjusted R^2	0.476		0.487	

the age or years on the nursing unit as factors. There was a significant positive correlation between use of time/daily routines and job satisfaction, perhaps indicating that as use of time was more efficient, job satisfaction increased.

Medication errors and job satisfaction

Once again, for 83.4% (n = 569) the drug library and limits would enhance their ability to provide high quality nursing care; and for 54.3% (n = 372), they would feel less anxious about making errors. Nearly 43% (n = 325) felt they could be honest about reporting errors, yet 63.1% (n = 428) indicated that they agreed or strongly agreed that there are more medication errors made than are reported. Slightly over one-third (n = 233) reported that the pump would increase how satisfied they were with their jobs but 49.9% were neutral (n = 339). This could be related to the large number (71.6%, n = 484) of nurses who had no experience with the pump and could have been unsure of its impact.

When the demographic characteristics were related to 'job satisfaction' (item #28), ratings of the nursing staff (χ^2 = 36.091, df = 12, P < 0.000) and ratings of the management team (χ^2 = 67.437, df = 12, P < 0.000) were significant. Each of the Likert scale items were also significant (<0.000; see Table 1) and warranted considerably more analysis. It is noteworthy that the implementation of the pump system was perceived to have significant effects within each of the areas of the six life patterns, the delivery of nursing care, the reporting of medication errors and job satisfaction.

Regression analysis: results and implications for nursing practice

Regression analysis was carried out for dependent variables on job satisfaction and the group of items within that category. This analysis was used in an attempt to further understand the relationship between job satisfaction and the six aggregate constructs for nurse roles, relationships, support teams, personal feelings, daily routines and use of time. By using these aggregate constructs, more relevant comparisons could be made to these higher order constructs rather than to the individual items. Three items (#7, #16 and #17) were eliminated and #14 was moved to the grouping of 'Reporting of medication errors' to improve convergent validity and reliability of the constructs. After these changes were made, Cronbach's alpha for 'Relationships with others' increased from 0.525 to 0.693, 'Personal feelings' increased from 0.439 to 0.713 and 'Reporting of medical errors' increased from 0.324 to 0.379.

Life patterns

The results of the regression analysis are shown in Table 2. In this section, we discuss these results and their implications with respect to each of the constructs described above.

Roles
There were no significant effects of roles on job satisfaction, which lead us to believe that the subjects were nurses who chose to be in their current roles and on their current units.

Relationships with others
Increased job satisfaction occurs with higher ratings of fellow staff members and nursing management and the perception that pumps are designed for safe nursing practice. If a new technology is therefore to be implemented effectively, management needs to concentrate on nurses' perceptions of not only that technology, but of the perceptions of fellow staff members and management teams.

Support teams
Although support teams were highly rated and associated with job satisfaction, they did not have a significant effect on job satisfaction in the regression analysis. This adds evidence to the multiplicity of factors in the environment that are related to job satisfaction in clinical nursing, and the fact that there are no linear single factors associated with it but rather a cluster of factors.

Personal feelings (self-esteem)
The pump technology was perceived to increase the nurses' self-confidence and decrease anxiety about making medication errors. Medication errors are, unfortunately, an everyday clinical reality that requires constant monitoring and aggressive prevention. Personal Feelings had a positive impact on job satisfaction. This suggests that nurses' job satisfaction is associated with heightened self-esteem, and the pump technology may help nurses feel more confident in the accuracy of their medication administration.

Use of time and daily routines (life structure)
Time and daily routines had a significant influence on job satisfaction, indicating that the pump may have helped nurses better manage their time. Moreover, perceptions of improved use of time may foster increased perceptions of job satisfaction.

Medication errors and job satisfaction
Responses included the following perceived attributes of the pumps: the pumps increase safety, do not take away the nurse's control and decrease anxiety about making errors. As in other studies, nurses perceive that more medication errors are made than are reported. Job satisfaction was significantly related to ratings of nursing staff and management teams, which suggests that professional interactions and management may be key in the successful implementation of new technologies in the arena of clinical nursing.

Conclusions

Interface of the social and technical aspects of infusion pump implementation is clearly evident. Participants indicated it would have an impact on nursing care provided and about one-third indicated it would impact job satisfaction. While one-third does not seem like a significant percentage, when placed in the context of the number of nurses employed in large hospitals, this represents a considerable number of people.

The pump was perceived to increase safe medication administration and decrease anxiety without taking away control or autonomy. A number of nurses seemed unsure about the impact of the pump, but there was a relationship between their perceptions of life pattern changes and job satisfaction, and their ratings of both the nursing staff and management team. This is consistent with Magnet status and higher educational levels. This also demonstrates the importance of both the management teams and the quality of nursing care provided in the implementation of new technology. In this Magnet hospital study, high ratings of clinical/department managers and nursing staff equated to higher nursing education and job satisfaction. Technological advances now need to be studied with regard to nurse retention. A considerable majority indicated that there were more medication errors made than reported, and although the pump will provide for greater safety, creating a 'safe atmosphere' for error reporting continues to warrant serious attention.

Generalizations cannot be made based on this single study; however, the findings give credence to the importance of technological changes in present day clinical nursing practice. Perhaps in the future we need to analyse the degree to which technology affects the environment, patient acuity as well as overall nursing satisfaction. The study now needs to be replicated in other types of hospitals and in non-Magnet hospitals.

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It is also noteworthy that not all hospitals, especially rural ones, may have the economic resources to undertake such a technological change. It is clear, however, that organizations must be aware of nurse-to-nurse relationships and management-to-nurse relationships when implementing new technology.

The next phase of the study involves an assessment of perceptions 3 months after implementation and a comparison of those findings to their initial perceptions as well as an analysis of the perceptions of nurse managers. A further limitation of this study is that the management team felt that placing hospital or other identifying code numbers on questionnaires would limit responses because of the sensitive nature of some questions, hence no identifiers were available on the data collection tool. Only group data will therefore be compared; however, findings will help us to determine whether perceptions have changed since implementation, and the extent to which the new technology has impacted the life patterns of nurses and the sociotechnical relationship.

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Conflict of interest/disclosure

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References

Aiken L., Clarke S., Sloane D., Sochalski J. & Silber J. (2002) Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA* **288** (16), 1987–1993.

ANCC (website) *ANCC Magnet Recognition Program®* – Recognizing Excellence in Nursing Services. American Nurses Credential Center. Available at: http://www.nursingworld.org/ancc/magnet, accessed on 10 June 2006.

Bates D., Spell N., Cullen D. *et al.* (1997) The costs of adverse drug events in hospitalized patients (Abstract). *JAMA* **277** (4). Available at: http://jama.ama.assn.org/cgi/content/abstract/277/4/307, accessed on 2 June 2006

von Bertalanffy L. (1967) *Robots. Men and Minds: Psychology in the Modern World*. George Braziller, Inc., New York, NY.

von Bertalanffy L. (1968) *General Systems Theory*. George Braziller, Inc., New York, NY.

Cullen D., Bates D., Small S., Cooper J., Nemeskal A. & Leape L. (1995) The incident reporting system does not detect adverse drug event: a problem for quality improvement. *Joint Commission Journal on Quality Improvement* **21** (10), 541–548.

Davis L. & Taylor J. (1986) Technology, organization and job structure. In *Handbook of Work, Organization, and Society* (R. Dubin ed.). Rand McNally, Chicago, IL.

Dillman D. & Christian L. (2002) *The Influence of Words, Symbols, Numbers and Graphics on Answers to Self-Administered Questionnaires. Results from 18 Experimental Comparisons*. Available at: http://survey.sesrc.wsu.edu/dillman/papers/single_space_fig_table.pdf, accessed on 20 May 2006

Emery F. & Trist E. (1960) Socio-technical systems. In *Management Sciences, Models and Technique* (C. Churchman & M. Verhulst eds). Pergamon, London.

Finn C. (2001) Autonomy: an important component for nurses' job satisfaction. *International Journal of Nursing Studies* **38** (3), 349–357.

Fox W. (1995) Sociotechnical system principles and guidelines: past and present. *Journal of Applied Behavioral Science* **31** (1), 91–105.

Harteloh P. (2003) Quality systems in health care: a sociotechnical approach. *Health Policy* **64** (3), 391–398.

Hatcher I., Sullivan M., Hutchison J., Thurman S. & Gaffney F. (2004) An intravenous medication safety system. *JONA* **34** (10), 437–439.

Havens D. & Aiken L. (1999) Shaping systems to promote desired outcomes: the Magnet hospital model. *Journal of Nursing Administration* **29** (2), 14–20.

HHS (2003) *News Release. FDA Proposals For Medication Bar Coding and Safety Reporting Will Improve Patient Safety*. 13 March 2003. US Department of Health & Human Services, Washington, DC.

High Beam Research (2003) *Alaris Medical Systems Unveils IV Medication Harm Index; Experts Gathered at Company's Third Sponsored Medication Safety Conference. Business Wire 11/20/2003*. Available at: http://www.highbeam.com/library/docfreeprint.asp?docid=1G1:110333497, accessed on 26 April 2006

Husch M., Sullivan C., Rooney D. *et al.* (2005) Insights from the sharp end of intravenous medication errors: Implications for infusion pump technology. *Quality & Safety in Health Care* **14**, 80–86. Available at: http://qhc.bmjjournals.com, accessed on 26 April 2006.

Kacel B., Miller M. & Norris D. (2005) Measurement of nurse practitioner job satisfaction in a midwestern state. *Journal of the American Academy of Nurse Practitioners* **17** (1), 27–32.

Khowaja K., Merchant R. & Hirani D. (2005) Registered nurses perception of work satisfaction at a tertiary care university hospital. *Journal of Nursing Management* **13** (1), 32–39.

Kuokkanen L., Leino-Kilpi H. & Katajisto J. (2003) Nurse empowerment, job-related satisfaction, and organizational commitment. *Journal of Nursing Care Quality* **18** (3), 184–192.

Larsen G., Parker H., Cash J, O'Connell M. & Grant M. (2005) Standard drug concentrations and smart-pump technology reduce continuous-medication-infusion errors in pediatric patients. *Pediatrics* **116** (1), e21–e25.

Le Blanc P., de Jonge J., de Rijk A. & Schaufeli W. (2001) Well-being of intensive care nurses (WEBIC): a job analytic approach. *Journal of Advanced Nursing* **36** (3), 460–470.

Lesar T., Briceland L. & Stein D. (1997) Factors related to errors in medication prescribing. *JAMA* **277** (4), 312.

Lupoli J. & Rizzo V. (2003) The impact of technology on the "older" nurse. *Home Healthcare Nursing* **21** (10), 691–692.

[no notes on this page]

Medical Errors (2000) *The Scope of the Problem. Fact Sheet, Publication No. AHRQ00-P037*. Agency for Healthcare Research and Quality, Rockville, MD. Available at: http://www.ahrq.gov/qual/errback.htm, accessed on 9 May 2006.

Orlikowski W. (1992) The duality of technology: rethinking the concept of technology in organizations. *Organization Science* **3** (3), 398–427.

Pasmore W., Francis C. & Haldeman J. (1982) Sociotechnical systems: a North American reflection on empirical studies of the seventies. *Human Relations* **35** (12), 1179–1204.

Peters Q. (2006). *A Study of Life Satisfaction and the Quality of Life for Senior Citizens After Retirement* (Thesis, Union). Kean University, New Jersey, NJ.

Reeves J. (2003) ''Smart Pump'' technology reduces errors. *Newsletter, Anesthesia Patient Safety Foundation* **18** (1), 1–16.

Rosenkoetter M. & Garris J. (1998) Psychosocial changes following retirement. *Journal of Advanced Nursing* **27** (5), 966–976.

Rosenkoetter M. & Garris J. (2001) Retirement planning, use of time, and psychosocial adjustment. *Issues in Mental Health Nursing* **22** (7), 703–722.

Rosenkoetter M., Garris J. & Hendricksen S. (1997) Perceptions of retirees: depression in retirement. *Journal of Nursing Science* **2** (1–6), 142–152.

Rosenkoetter M., Garris J. & Engdahl R. (2001) Postretirement planning, use of time: implications for preretirement planning and postretirement management. *Activities, Adaptation, and Aging* **25** (3/4), 1–18.

Rothschild J., Keohane C., Cook E. *et al.* (2005) A controlled trial of smart infusion pumps to improve medication safety in critically ill patients. *Critical Care Medicine* **33** (3), 533–540.

Scott J., Sochalski J. & Aiken L. (1999) Review of magnet hospital research: findings and implications for professional nursing practice. *Journal of Nursing Administration* **29** (1), 9–19.

Taylor J., Brownstein D., Christakis D. *et al.* (2004) Use of incident reports by physicians and nurses to document medical errors in pediatric patients. *Pediatrics* **114** (3), 729–735.

Trist E. & Bamforth K. (1951) Some social and psychological consequences of the long-wall method of coal-getting. *Human Relations* **4**, 3–38.

Upenieks V. (2002) Assessing differences in job satisfaction of nurses in magnet and nonmagnet hospitals. *Journal of Nursing Administration* **32** (11), 564–576.

Wilson K. & Sullivan M. (2004) Preventing medication errors with smart infusion technology. *American Journal of Health-System Pharmacy* **61** (2), 177–183.Available at: http://www.medscape.com/viewarticle/467525, accessed on 5 May 2006.

[no notes on this page]