

Identifying, Developing, and Quantifying Single-Day Quality Measures within the Neonatal ICU

Sara A. Lu, Robert E. Schumacher, Michelle Nemshak, and F. Jacob Seagull
University of Michigan

Assessing safety culture, while valuable, may neglect day-to-day variation in the experiences of individual care providers. Understanding day-to-day variation may be a key to understanding and improving the single-day quality (SDQ) of care providers. The goal of this study was to: (1) determine the variables that contribute to the quality of each day (SDQ), (2) determine the validity and perceived importance of each contributing variable, and (3) determine how well care providers can predict whether the variables will have an effect on their SDQ. Interviews of NICU nurses and literature reviews were used to identify six variables perceived to influence SDQ. A survey tool assessing the six variables and SDQ was developed. Nurses were then surveyed at the beginning and end of each shift, providing a prospective (pre) and retrospective (post) assessment of all six variables plus an overall SDQ rating. The results identified which variables predicted or contributed to SDQ. Although the predictive power of the six variables differed between prospective and retrospective estimations, environmental factors and patient acuity were consistent contributors to SDQ. Overall, understanding the contributors to day-to-day variation can be used to as means to improve the healthcare provider's SDQ and the safety of patient care.

INTRODUCTION

Anyone who has spent time working in a hospital care unit knows that there are good days and bad days. Experienced nurses seem to have a well-honed sense of day-quality, and it is not uncommon to hear a nurse at the start of a shift say, "It's going to be one of those days." Their sense, if accurate, has important implications. If it is possible to predict the quality of a day at its outset, actions could be taken to mitigate the bad days. Since nurse satisfaction with the workplace has been directly related to patient safety (Lin & Liang, 2007), determining what makes good and bad days is an important patient safety issue.

Patient safety and safety culture itself has been well researched over the past decade. Safety culture refers to the degree which individuals and groups within a system take responsibility for, strive towards, and monitor safety of a system (Weigman et al., 2004). Assessment of safety culture usually involves quantitative measures, typically using self-report surveys regarding perceptions of conditions like workloads, supervision, training, environment, and systems of communication (West et al., 2006; Yassi and Hancock, 2005). In addition, Grindel and colleagues (1996) found that quality patient care occurred in practice environments with high degrees of patient satisfaction, physician satisfaction with patient care, and nurse job satisfaction. Using a combination of assessment tools, patient, physician, and nurse satisfaction have been analyzed together to develop strategic initiatives for improvement of the overall practice environment and enhance the organization's safety level (Flin, 2007).

However, a shortcoming of safety culture assessments is that they are broad in scope, and culture generally is

conceptualized as relatively stable quality of an environment. "Patient safety" is a quality of an environment that is assessed across groups of people who share a workplace. The widely used Agency for Healthcare Research and Quality hospital Survey of Patient Safety (AHRQ-SOP) covers 14 aspects of patient safety in the broad categories of safety, teamwork, communication, organizational learning, staffing, management support of patient safety, and hospital handoffs and transitions. Likewise, the Safety Attitude Questionnaires (SAQs) (Sexton et al., 2006) assesses six dimensions of safety, including teamwork, safety climate, perceptions of management, job satisfaction, working conditions, and stress recognition. These assessments may take up to five weeks to complete and are typically administered on an annual basis (Sorra & Nieva, 2004). Because of their broad scope, such surveys do not consider the relationships of factors that may vary on an individual level and day-to-day basis. Benson (2005) and Kiel (1994) both suggest that often "the best results come not from large-scale efforts, but from small well-focused actions" (Kiel, 1994) which may be addressed by understanding how day-to-day activities have an effect on patient safety and care.

Existing measures of safety culture do not adequately address activities at this individual-day level. There are few, if any, survey tools to measure the variations for individual days and the variables that influence single-day quality (SDQ). By examining the relationship of these influences on the outcome, SDQ, we may be able to discover leverage points for safety that cannot be addressed by the existing safety culture assessments. Specifically, we needed to:

- Determine which variables contribute to SDQ.

- Examine the effects of each of these variables on SDQ.
- Understand the extent to which these variables are known *a priori* to care providers (i.e. how well care providers can predict good or bad days).
- Understand how *a priori* and *post-hoc* evaluations compare (i.e. are the variables in people's predictions different than the variables they use after the fact).

To address these questions, this study used a Neonatal Intensive Care Unit (NICU) environment as a test-bed for examining the variables that affect SDQ. The limited scope of initial work provides a preliminary investigation of a single, relatively homogeneous population, but can serve as a foundation for expanded investigations in the future.

METHODS

Survey Development

During the survey development, the goal was to identify the issues that could vary for nurses on a day-to-day basis and that influence the quality of their day, which we will call "daily variables." The survey development process centered around interviewing and observing the nurses in a NICU of a large academic medical center. We elicited the nurses' opinion regarding what was influencing their day at the time of the interview, and variables they viewed as contributing to the quality of their day. The nurses' interview data were used to identify themes for variables that influence SDQ. As described below, five themes emerged:

1. *Environmental Factors.* All the nurses interviewed indicated that the physical environment had an impact on the day-to-day quality — a basic tenet of human factors. The specific room assignment or relative proximity of their patients impacted variables such as the noise level, the workspace layout, and accessibility of equipment. The nurses' appreciation for these environmental influences is substantiated by the growing research interest in evidence-based design for medical environments (Bosch et al., 2012; Stevens et al., 2012; Trickey et al. 2012).
2. *Acuity.* Nurses universally mentioned that the particular patients they were assigned have a significant impact on the quality of their day. The nurses explained that sicker (higher acuity) patients result in a higher workload, while having (lower acuity) "feeders and growers," e.g. patients which require minimal medical interventions, usually result in lower workload. While workload is a common term in the literature (e.g. Sieveking et al., 1993) and can also be a function of staffing (Sorra & Dyer, 2010), the overarching themes was termed as "acuity" because the term (a) concisely communicated the concept to nurses

and (b) expressed aspects of workload that was cited by nurses as influencing SDQ.

3. *Team Composition.* Teamwork measures exist in almost all surveys of culture and safety (Smith et al., 2005; Larrabee et al., 2003; Shortell et al., 1991; Sexton et al., 2006; Sorra et al., 2010). The nurses' comments reinforced the conclusion that teamwork is an important contributor to day quality. While teamwork tends to be stable in a given setting, the individual members of the team were often cited as having an impact on the nurses' day quality. Comments such as, "When I see that [nurse X] is on my team, and I know that she is not a team player, it is going to be a bad day," or, "If Dr. Y. is on service, everything will go smoothly" were typical. Thus the term "team composition" was chosen to express the influence of the particular nurses, physicians, technicians, etc., who make up the team.
4. *Plans.* Communication was cited as a major contributor to day quality. Communication quality is a common theme across a number of culture surveys (Larrabee, 2003; Shortell, 1991). To operationalize the concept of communication in a way that would be relevant to nurses, we selected the aspect of communication that nurses most commonly cited as influencing their ability to work efficiently and have a good day. Many nurses mentioned that doctors often failed to inform them about plans of care, or they changed the plans of care in ways that impacted the nurse ability to adequately prepare for patient care activities. This would result in inefficient re-work or inconvenient schedules of care activities. This unitary concept of "communication of plans" was identified by nurses to consist of two components: (1) clear initial communication of plans and (2) whether or not the plans were expected to change through the course of the day. Therefore, this variable for our purposes was split into the themes of "plan clarity" and "plan stability."
5. *External Factors.* Nurses commented that there were issues outside of work that may impinge on the quality of their day. One nurse stated, "If I wake up before my alarm goes off, it will be a good day." These types of external influences have been acknowledged to affect the staffs' perceptions of work quality (Smith et al., 2005, 2009). Thus any considerations outside of the arena of patient care was deemed "external factors."

While there are many other factors that influence patient safety and quality, they were rarely if ever cited by nurses as influencing the quality of each day. Many commonly cited factors are stable over time, thus were not perceived as daily influences and were not included in this study. For example, the Safety Attitude Questionnaire (Sexton, 2006), includes factors of 'perceptions of management' and 'job satisfaction' — both of which are

measures of safety climate, but not expected to vary from day to day.

Our goal was to create a survey tool that could be used daily as barometer to measure the variables that contributed to SDQ. We used the themes identified by nurses and supported by literature, and generated a single question to represent each of the variables that could influence the nurses' daily experiences. The initial survey was piloted with a small number of nurses for clarity and format, and revised based on nurses' feedback.

Data Collection

Objective data regarding staffing levels, admissions, and discharges on each shift were collected from unit records during the data collection period. The survey data was collected over the span of 14 days in the aforementioned NICU. Participants were nurses working in the NICU on all shifts. Paper copies of the surveys (Table 1) were distributed to nurses at the beginning of each shift and completed surveys were collected at the end of each shift. On a 1-5 scale, the first six questions asked the nurses to rate the variables that influence their day and question 7 asked the nurses to provide an overall judgment of a day (SDQ).

Table 1: Seven question survey nurses completed at the beginning (pictured) and end (with retrospective language) of their shifts

Variables that may influence your day	Please circle a number for your prediction						
1. ENVIRONMENTAL FACTORS may make today...	Bad	1	2	3	4	5	Good
2. ACUITY of my patients may make today...	Chaotic	1	2	3	4	5	Smooth
3. TEAM composition might make today...	Harder	1	2	3	4	5	Easier
4. PLANS for today are...	Unclear	1	2	3	4	5	Clear
5. PLANS for today will likely...	Change	1	2	3	4	5	Remain stable
6. EXTERNAL FACTORS and demands for today may...	Interfere	1	2	3	4	5	Not interfere
7. OVERALL My prediction is that I will likely have a...	Bad day	1	2	3	4	5	Good day

The responses provided by the nurses at the beginning and end of each shift allowed us to examine three perspectives of the variables that contribute to SDQ:

1. *Prospective evaluation* compares pre-shift ratings of each variable to the pre-shift SDQ rating. This analysis will indicate which variables nurses believe will contribute to SDQ.
2. *Retrospective evaluation* compares post-shift estimations of each variable to the post-shift SDQ rating. This analysis will indicate which variables nurses perceived to have contributed to the SDQ.
3. *Predictive ability* compares (pre-shift) prospective estimations of the six variables to the (post-shift) retrospective rating of SDQ. This analysis will reveal the extent to which nurses' pre-shift perceptions of what contributes to SDQ are borne out at the end of the day.

The structure of the survey questions used to calculate each of the three types of relationships is depicted in Figure 1 below. The strengths of each relationship, mainly between each daily variable and SDQ, will be described in the Results section.

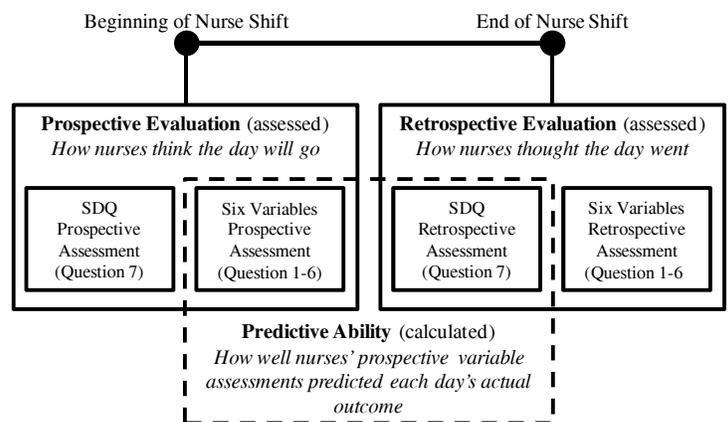


Figure 1: Three relationships examined in the study

RESULTS

There were 229 surveys completed during the course of two weeks. Note that each nurse could provide a survey for each day/shift worked. In order to assess the effect of the six variables on SDQ, we examined correlations between the 229 pre- and post-surveys. The effects of the six variables were analyzed using multiple regression analysis (least squares model). The regression models were used to: (1) identify which factors contributed to prospectively assessed SDQ, (2) determine which retrospectively judged variables had an effect on the SDQ (retrospective), and (3) determine whether the prospective estimates matched the day's actual SDQ assessment (predictive).

Overall Statistics

There was no significant correlation of the SDQ measures to objective quality or workload measures such as

staffing level or number of transfers/admits. The mean values for the six variables and the SDQ can be found in Figure 2 below.

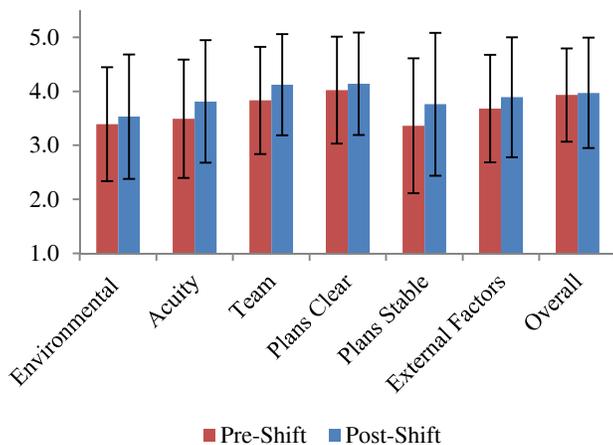


Figure 2: Pre-shift and post-shift means and standard deviations for each daily variable on a scale of 1-5

Nurse Demographics Contributing to Single Day Quality

We examined the effects of nursing experience and nursing role on SDQ. Participating nurses had varying levels of nurse experience. The mean overall SDQ was 4.2 for nurses with less than one of year of experience (n=30), 3.98 for nurses with 1-5 years of experience (n=30), and 3.93 for nurses with greater than 5 years of experience (n=126). The mean overall day score for patient care nurses was 4.0 (n=165), for float nurses it was 3.7 (n=10), and for charge nurses it was 4.5 (n=9). A two-way ANOVA showed that there were non-significant main effects of nurse experience ($F(3,177)=0.57, p=.98$) and nurse role ($F(3,177)=2.20, p=.09$) on SDQ.

When shift was taken into consideration, it was found that night nurses (n=64, mean=4.2) were significantly happier (i.e. higher SDQ) than day nurses (n=85, mean=3.7; $t(147)=2.48, p=.014$).

Nurse’s Perception of Variables Contributing to Single Day Quality

Prospective Evaluation. The regression model using prospective variables to predict prospectively assessed SDQ explained 62% of the variance in the data ($r^2=0.62, F(6,225)=56.05, p<.0001$). Five of the six daily variables (all but *plans changing*) were found to be significantly correlated to SDQ. The coefficients of these variables are shown in (Table 2).

Retrospective Evaluation. The regression model using retrospective assessment of each variable and the SDQ explained 67% of the variance in SDQ ($r^2=0.67, F(6,194)=66.74, p<.0001$). Four of the daily variables had significant coefficients, including *environmental factors*,

patient acuity, *team composition*, and *plans changing* (Table 2).

Predictive Ability. There was a significant relationship between the prospectively assessed variables and the actual (retrospective) SDQ, with the regression accounting for 30% of the variance ($r^2=0.30, F(6,189)=13.31, p<.0001$). Three of the daily variables that significantly contributed to SDQ included *environmental factors*, *patient acuity*, and *plan clarity* (Table 2).

Table 2: Correlation between the six daily variables and SDQ assessed through the prospective, retrospective, and predictive analyses. (* denotes $p<.05$)

Daily Variables	Relationship		
	Prospective Evaluation	Retrospective Evaluation	Predictive Ability
Environment	*0.12	*0.11	*0.18
Patient Acuity	*0.15	*0.21	*0.15
Team Composition	*0.25	*0.22	0.04
Plans Clear	*0.22	0.06	*0.23
Plans Changing	0.03	*0.24	0.08
External Factors	*0.15	0.08	-0.04

DISCUSSION & CONCLUSIONS

The goal of the present study was to identify daily variables that can affect the perceived and actual outcome each day. The developed survey tool was effective in identifying the measures that are perceived to impact daily quality. The SDQ measure itself showed sensitivity to perceived differences in SDQ, with significant differences detected between day and night shifts. The regression models also predicted large portions of the variance for each relationship.

The results of the prospective evaluation suggests that nurses have a strong mental model of the ways in which they expect the six variables to influence their day. The one variable that does not significantly contribute prospectively is *plans changing*, which may imply that nurses cannot foresee these changes in a predictable manner. However, in the retrospective evaluation *plans changing* had the strongest correlation to SDQ. The difference may be attributed to the inability to predict whether plans will change, but the strong influences such changes have on the outcome of each day. It was also found that three variables were significantly related to SDQ in both prospective and predictive relationships: *environment*, *patient acuity*, and *team composition*.

It is notable that *team composition* is part of both the prospective and retrospective model, but not part of the predictive model. This finding implies that nurses believe that they understand that team dynamics will influence their day, and that at the end of the day believe that team dynamics had a strong influence, yet these two team assessments are not correlated. Apparently, team composition does not influence SDQ in a predictable manner. For example, a nurse may believe that working

with certain teammates may result in bad day, and believe at the end of the day that their team made a big difference, however these predictions are not correlated to their judgment of how the day actually turned out. This implies that nurses, while they know that teams have an influence, may be surprised by the way in which teams actually influence SDQ.

Externals factors is the only variable with a prospective, but not retrospective or predictive relationship. This may due to the recency effects of “waking up on the wrong side of the bed” events when evaluating *external factors* at the beginning of the day. It could be viewed as reassuring that nurses seem able to overcome the influence of factors outside the workplace, as by the end of the shift there is no correlation to SDQ.

Two variables of the nurses’ mental model – *environment* and *patient acuity* – are judged to have a strong relationship with day quality in all three regression models. This suggests that optimizing these two variables may help improve SDQ. For example, preventative measures, such as careful consideration of layout to minimize crowding may also minimize the adverse effects of environment on SDQ. Similarly, effectively ensuring high acuity patients are distributed equitably amongst nurses may mitigate the effects of patient acuity on day quality

By fully understanding SDQ, we can better manage its latent, adverse implications. The current study is limited in scope by its focus on only one unit (the NICU), and focusing assessment of the subjective data on nurses. It nonetheless provides an important set of preliminary data on which to base further investigations. The current work could be strengthened by examination of additional objective measures such as patient outcomes to the identified variables affecting SDQ. Furthermore, it may be valuable to explore the reported correlations in other contexts of care (e.g. emergency departments, labor, and delivery), and different caregiver’s roles (doctors, technicians).

Since the completion of the study reported here, the NICU has relocated to a new building. Future reports will present data collected in the new environment and examine the ways in which this new environment influences our understanding of the relationship between the daily variables and SDQ.

ACKNOWLEDGMENT

The authors would like to thank the NICU nurses for their guidance, support, and participation in this study.

REFERENCES

Benson, H. (2011). Chaos and complexity: applications for healthcare quality and patient safety. *Journal for Healthcare Quality*, 27(5), 4-10.

- Bosch, S., Bledsoe, T., & Jenzarli, A. (2012). Staff Perceptions Before and After Adding Single-Family Rooms in the NICU. *HERD*, 5(4), 64-75.
- Flin, R. (2007). Measuring safety culture in healthcare: A case for accurate diagnosis. *Safety Science*, 45, 653-667.
- Grindel, C.G., Peterson, K., Kinneman, M., & Turner, T.,L. (1996). The Practice Environment Project. A process for outcome evaluation. *J. Nursing Admin.*, 26(5), 43-51.
- Kiel, L.D. (1994). Managing chaos and complexity in the government. San Francisco: Jossey-Bass.
- Larrabee, J.H., Janney, M.A., Ostrow, C.L., Withrow, M.L., Hobbs, G.R., & Burant, C. (2003). Predicting registered nurse job satisfaction and intent to leave. *J. Nursing Admin.*, 33(5), 271-283.
- Lin, L. & Liang, B.A. (2007). Addressing the Nursing Work Environment to Promote Patient Safety. *Nursing Forum*, 42(1), 20-30.
- Sexton, J.B., Helmreich, R.L., Neilands, T.B., et al. (2006). The Safety Attitudes Questionnaire: psychometric properties, benchmarking data, and emerging research. *BMC Health Services Research*, 6:44
- Shortell, S. M., Rousseau, D. M., Gillies, R. R., Devers, K. J., & Simons, T. L. (1991). Organizational assessment in intensive care units (ICUs): construct development, reliability, and validity of the ICU nurse-physician questionnaire. *Medical Care*, 709-726.
- Sieveking, N., W. Bellet, and R. C. Marston. (1993). Employees' views of their work experience in private hospitals. *Health Services Mgt. Research*, 6(2), 129-138.
- Smith, T. J., Clayton, S., & Schoenbeck, K. (2005). Transition from an Open Bay to a Private Room Neonatal Intensive Care Unit Design—A Human Factors Evaluation. *In Proceedings of HFES*, 49(11), 974-978.
- Smith, T. J., Schoenbeck, K., & Clayton, S. (2009). Staff perceptions of work quality of a neonatal intensive care unit before and after transition from an open bay to a private room design. *Work*, 33(2), 211-227.
- Sorra, J. S., & Dyer, N. (2010). Multilevel psychometric properties of the AHRQ hospital survey on patient safety culture. *BMC Health Services Research*, 10(1), 199.
- Sorra J.S. & Nieva V.F. (2004). *Hospital Survey on Patient Safety Culture*. AHRQ Publication No. 04-0041. Rockville, MD. September.
- Stevens, D. C., Helseth, C. C., Khan, M. A., Munson, D. P., & Reid, E. J. (2011). A comparison of parent satisfaction in an open-bay and single-family room neonatal intensive care unit. *HERD*, 4(3), 110-123.
- Trickey, A. W., Arnold, C. C., Parmar, A., & Lasky, R. E. (2012). Sound levels, staff perceptions, and patient outcomes during renovation near the neonatal intensive care unit. *HERD*, 5(4), 76-87.
- West, M., Guthrie, J., Dawson, J., Borrill, C., & Carter, M.. (2006). Reducing patient mortality in hospitals: The role of human resource management. *J. Org. Behavior*, 27, 983-1002.
- Wiegmann, D.A., Zhang, H., von Thaden, T.L., Sharma, G., & Gibbons, A.M. (2004). A Safety Culture: An Integrative Review. *IJAP*, 14(2), 117-134.
- Yassi, A. & Hancock, T. (2005). Patient safety – worker safety: Building a culture of safety to improve healthcare worker and patient well-being. *Healthcare Quarterly*, 8, 33-38.