Nurse Dose as a Concept
Dorothy Brooten, JoAnne M. Youngblut

Purpose: To describe the concept of Nurse Dose.
Methods: The concept of nurse dose has been identified from decades of clinical research as
a concept essential in the delivery of safe and high quality health care. The components of
nurse dose were conceptualized through review of the literature from nursing, medicine,
and health services research.
Findings: Nurse dose is conceptualized as having three equally essential components: dose,
nurse, and host and host response. Dose in the macro view includes the number of nurses
per patient or per population in cities, states, regions, or countries. Dose in a micro view
includes the amount of nurse time and the number of contacts. The nurse component
consists of the education, expertise, and experience of the nurse. Host is represented by
an organization and its characteristics (culture, autonomy, practice control) in a macro
view and by the patient and characteristics (beliefs, values, culture) in a micro view. Host
response includes response to the autonomy and acceptability of the nurse.
Conclusions: Greater nurse dose has been associated with decreases in patient mortality,
morbidity, and healthcare costs.


[Key words: nurse dose, nurse-patient ratio, nurse time, nurse staffing, healthcare quality]

A
n increasing body of evidence indicates the existen
tce and importance of nurse dose as an impor-
tant concept in the delivery of high quality health
care. Differing nurse doses have been associated with both
increases and decreases in patient mortality, morbidity, and
healthcare costs. Clarifying the concept requires analysis,
synthesis, and derivation of nurse dose as a concept (Walker
& Avant, 1983). Analysis of the literature from nursing and
other databases reveals little definition, use, or meaning of
the term. Although it has not been referred to as a concept,
nurse dose has been identified in decades of clinical research
(Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aydelotte,
1962; Brooten et al., 1986; Brooten et al., 2002 Brown &
Grimes, 1992; Burgess et al., 1987; McCorkle et al., 1989;
Naylor et al., 1994; Pozen et al., 1977).

Dose is defined in Webster’s dictionary of the English lan-
guage as “the measured quantity of a medicine or other ther-
apeutic agent to be taken at one time or in a period of time,”
as “a measure or portion of some experience to which one
is exposed or subjected,” and as “a standard increment of
labor and capital conceived as being applied to land to mea-
sure changes in its productiveness at different intensities of
cultivation” (Grove, 2002). Analysis of the healthcare litera-
ture indicates dose most commonly refers to an amount of
something (e.g., chemicals, radiation), but most commonly
a medicine. The literature also includes extensive informa-
tion about the roles and functions of nurses and research on
the effects of nursing care (Brooten, Youngblut, Kutcher, &
Bobo, 2004; Shamian, 1997).

Nurse dose is conceptualized as having three equally nec-
essary components (Figure): dose (number of nurses or
amount of care by nurses), nurse (education, expertise, and
experience), and host response (organizational or patient re-
ceptiveness).

Concept of Dose

Dose in Macro View
In the macro view, the dose component of nurse dose refers
to the number of nurses represented by nurse-patient ratios
in hospitals or healthcare agencies as well as the number
of nurses per population in cities, states, regions, or coun-
tries. The power of this concept can be seen in the research
of Aiken and colleagues (2002) whose work has shown that
lower nurse dose (more patients per nurse) contributed
to higher patient morbidity and mortality. Recent research

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by Aiken and colleagues (2002) included cross-sectional analysis of linked data from 10,184 nurses and 232,342 surgical patients. Because nurses constitute the major monitoring system for early detection of complications and problems in care, the investigators measured risk-adjusted patient mortality and failure to rescue within 30 days of admission. Results indicated that when nurses had eight or more patients per shift, the risk of death was 30% higher than when nurses had four or fewer patients per shift. Each additional patient added to the average workload of registered nurses increased the risk of patient death following common surgical procedures by 7%.

Results of Aiken’s research are consistent with research in this area by other investigators. In their meta-analysis, Lang, Hodge, Olson, Romano, and Kravitz (2004) found that decreased staffing was related to increased failure to rescue in surgical patients and increased inpatient mortality. More recently, attempts to provide adequate nurse patient ratios in areas of nursing shortages have resulted in increasing the number of hours nurses are forced to work. This situation has decreased the quality of the dose and resulted in medication errors, among other undesired outcomes (Rodgers, Hwang, Scott, Aiken, & Dinges, 2004).

Efforts to maintain a safe nurse dose (nurse-patient ratio) have resulted in legislation in California to mandate safe nurse-patient ratios with the number of nurses differing by type and acuity of the patient. The California legislation requires one nurse to six medical surgical patients, one to four pediatric patients, one to four mother-baby couples, one to two laboring patients, and one to one trauma patient (Spetz et al., 2000). Similar legislation is also being proposed in Florida. Although data are available on the number of nurses per state or region, the association between the number of nurses and effects on health are unclear.

**Dose in Micro View**

In a micro view, the dose component of nurse dose includes the amount of nurse time in minutes or hours and the number of contacts. The latter is a common measure of dose used in home care where the number of visits or contacts is an important unit examined in relation to patient outcomes. As in the macro view, the amount of nurse time or contacts might differ by patient diagnosis, condition, level and type of complication, or patient age (Hays, 1995; Paul, Phillips, Widome, & Hollebneak, 2004; Payne, Thomas, Fitzpatrick, Abdel-Rahman, & Kayne, 1998).

**Dose-Time-RNs**

The dose effect of nurse time is well documented in the work of several research teams. Research by Kovner and Gergen (1998) showed that by increasing registered nurse time with patients each day and thus allowing time for catheter care and ambulation of patients, hospitals could cut cases of urinary tract infections in postoperative surgery patients by 4.5%, cases of pneumonia by 4.2%, and cases of blood clots by 2.6%. Kovner, Jones, Zhan, Gergen, and Basu (2002) found that greater number of RN hours per adjusted inpatient day was related to decreased pneumonia for routine and emergency surgical patients. Needelman, Buerhaus, Mattke, Stewart, and Zelevinsky (2002) found that an increase in number of RN hours was related to decreased length of stay and incidence of nosocomial urinary tract infections and gastrointestinal bleeding for medical patients. Increased number of RN hours was also related to a decrease in the incidence of failure-to-rescue situations. Cho, Ketefian, Barkauskas, and Smith (2003) found that for each 1 hour increase in registered nurse (RN) hours per patient day, odds of pneumonia decreased by 8.9%.

Greater proportion of RNs also shows better patient outcomes. Hartz et al. (1989) and Krakauer et al. (1992) found that a greater proportion of registered nurses in hospitals was associated with lower inpatient mortality rates. Needelman et al. (2002) found that greater proportion of RN hours was predictive of decreased length of stay and lower incidence of nosocomial urinary tract infections and gastrointestinal bleeding for medical patients, and decreased incidence of nosocomial urinary tract infections in surgical patients.

**Dose-Time-Advanced Practice Nurses**

Examing results from randomized clinical trials, Brooten, Youngblut, Dearrick, Naylor, and York (2003) reported on patients’ problems, patients’ outcomes, advanced practice nurses (APNs) interventions, time and contacts of the APN in five patient groups receiving a model of APNs transitional care, including comprehensive discharge planning and home follow-up. The five groups consisted of very low birth-weight (VLBW) infants (Brooten et al., 1986), women with unplanned cesarean births (Brooten et al., 1994), women with high-risk pregnancies (York et al., 1997), women after abdominal hysterectomy (Hollingsworth & Cohen, 2000), and elders with medical and surgical cardiac conditions (Naylor et al., 1994). The high-risk pregnancy group, the cesarean birth group, and the hysterectomy group were cared for by APNs for similar
times, from diagnosis of high-risk pregnancy or surgical event to 8 weeks postpartum or post operative event. The VLBW infant group was followed by APNs for 18 months after discharge. Elders were followed by APNs for 2 weeks after discharge. The intervention protocol for all except the elder groups included comprehensive discharge planning and a minimum number of home visits and telephone contacts. However, the APNs used their clinical judgment if a patient required more than the minimum number of contacts. The elder groups had APN intervention (health teaching and discharge planning) while in the hospital and telephone follow-up by the APNs for 2 weeks after discharge. In the process of providing care, APNs documented almost verbatim recordings of the process of care with patients and any healthcare provider, APN time, and number of contacts.

Analysis of 333 of these interaction logs indicated that patient groups with greater mean APN time and contacts per patient had greater improvements in outcomes and greater healthcare cost savings (Brooten et al., 2003). The predominant APN function was surveillance in all five intervention groups. Results across groups showed either significantly fewer rehospitalizations for the APN intervention groups or shorter rehospitalizations at less healthcare cost compared to the control groups. These results indicated “success in rescue,” earlier detection of complications, and earlier intervention by the APNs. These results are consistent with the work of Aiken and colleagues (2002) and others indicating the association between fewer patients per staff nurse and greater success in rescue or detection of complications.

In the Brooten et al. research (1996), the unplanned cesarean birth group women with morbidity (infection) required a mean of 20 more minutes of APN time during the hospital intervention phase and a mean of 40 more minutes of APN time during home visits, compared to those women without infections being followed by APNs. In that study, APNs were able to vary nurse dose based on clinical judgment and patient condition. In comparing charges for health care, control group women with infections had a mean charge of $14,513 compared to $9,728 for women with infections followed by the APNs (Brooten et al., 1994). This is a reduction of 33% in healthcare charges for the APN-followed group and shows evidence of healthcare cost savings when master's educated advanced practice nurses have the autonomy to act on their knowledge and clinical judgment.

To further illustrate the power of the dose component, Naylor and colleagues (1994) used a randomized clinical trial with APNs to examine comprehensive discharge planning and 2-week telephone follow-up with elders with medical and surgical cardiac conditions. Results showed reduced rehospitalizations in the medical intervention group from discharge to 6 weeks after discharge. However, in the 7-12 week period, rehospitalizations occurred in the APN group so that by 12 weeks after discharge, both intervention and control groups were similar in numbers of rehospitalizations. Naylor and colleagues, in the next study (1999), added the home visit portion of the APN Transi-

Dose-Contacts

The micro view of the dose component of nurse dose also includes the number of contacts. Here as in the amount of time, dose might need to differ by patient age, diagnosis and condition to achieve safe or optimal outcomes. The research of Payne, Thomas, Fitzpatrick, Kayne, & Abdel-Rahman (1996) is illustrative. Payne et al., in a survey of 12 home-care agencies in Massachusetts, reported on home health resource use (mean number of home visits) in several patient diagnostic groups. In examining the number of contacts over a period of 1 year, AIDS patients required 33.3 visits, infants and pregnant women required 25.1 visits, and medical-surgical patients required a mean of 8.1 visits.

Hays (1995) studied the consumption of nursing resources (home visits and telephone calls) in three groups: frail elders, high-risk perinatal patients, and high-risk infants. Frail elders had the most visits with a mean of 28.3 (SD = 21.6), followed by high-risk infants with a mean of 11.4 (SD = 8.9), and high-risk perinatal patients with a mean of 4.6 (SD = 2.1). The wide standard deviation in number of home visits indicates the wide variations required by differing patient type and diagnosis.

Brooten and colleagues (Brooten, Brooks, Berry, Madigan, & Youngblut, 1998; Brooten, Youngblut, Finkler, Neff, & Madigan, 2001), in a randomized clinical trial to provide prenatal care and home follow-up to women with high-risk pregnancies, found that in accomplishing improved outcomes compared to control-group women, mean numbers of visits differed by diagnosis. Women in the intervention group received APN care prenatally (home visits, contacts in the hospital, and telephone contacts) from the time of their high-risk diagnosis to 8 weeks postpartum. Women with pregestational diabetes required the highest mean number of contacts (M = 109.8, SD = 47.86), followed by women with chronic hypertension (M = 99.8, SD = 29.65), women at risk of preterm labor (M = 84.5, SD = 33.65), women with gestational diabetes (M = 64.5, SD = 27.09), and women with diagnosed preterm labor (M = 54.8, SD = 20.99).

Concept of Nurse

While the dose component (the number of nurses, amount of nurse time and contacts) can result in different patient outcomes and healthcare costs, so too can the nurse component which consists of education, expertise, and experience. The work of Aiken, Clarke, Cheung, Sloane, & Silber (2003) to examine the effects of nurses with bachelor's education on mortality and the research of others are illustrative.
Aiken et al. (2003) examined whether the proportion of registered nurses with baccalaureate degrees or higher was associated with risk-adjusted mortality and morbidity and failure to rescue (deaths in surgical patients with serious complications). The sample consisted of 232,342 general, orthopedic, and vascular surgery patients from 168 hospitals in Pennsylvania. The team measured risk-adjusted patient mortality and failure to rescue within 30 days of admission. The hospital data were adjusted for patient characteristics, hospital structural characteristics, nurse staffing, nurse experience, and whether patients’ surgeons were board certified. Study results indicated that a 10% increase in the proportion of nurses with baccalaureate degrees was associated with a 5% decrease in the likelihood of patients dying within 30 days of admission.

Aiken and colleagues found experience had little effect on outcomes, but Hall et al. (2004) found an increase in number of wound infections associated with less experience of nurses. Others have found changing the staff mix to include greater proportions of RNs on staff have had similar results. Cho et al. (2003) found that a 10% increase in proportion of RNs was associated with a 9.5% decrease in odds of pneumonia. Hall and colleagues (2004) also found that decreases in the proportions of RNs were associated with decreases in number of medication errors and wound infections. Mark, Harless, McCue, and Xu (2004) found that increased RN staffing was related to decreased mortality ratios, decreased total complication ratios, and decreased pneumonia complications.

In addition, the research was conducted by several teams to test a model of APN transitional care over seven patients’ groups using randomized clinical trials (Brooten et al., 2002). In each trial the intervention group APNs were master’s-educated with specialty education to match the patient group being followed. Study results have shown consistently improved patients’ outcomes and reduced healthcare charges across groups. Even in groups in which differences in numbers of rehospitalizations during the follow-up phase did not reach statistical significance, the APN-followed groups, compared to controls, were rehospitalized for less time at less cost. Consistent with other findings about the APN function of surveillance resulting in successful rescue, early detection, and intervention, a similar model of RN generalists (educational level not defined) provided home follow-up to high-risk pregnant women with hypertension, preterm labor, and at risk for low birthweight reported by Kitzman et al. (1997) did not show similar results. Fewer women followed by the nurses during pregnancy had pregnancy-induced hypertension, but no effects were found on preterm delivery or low birthweight.

Host and Host Response

The effectiveness of nurse dose depends not only on the dose and nurse components, but on the host and response of the host as well. In a macro view, host is an organization and its characteristics (culture, autonomy, practice control). In a micro view, host is the patient and characteristics of the patient (beliefs, values, culture). The host response for both organizations and patients is the autonomy and acceptability of the nurse. In both, effectiveness of nurse dose depends on the autonomy and acceptability of the nurse.

Host in Macro View

The dose of the nurse in patient staff ratios, amount of nurse time and contacts, and the nurse’s education and expertise might be ineffective in an organization (host) unwilling to provide adequate doses of the nurse or to acknowledge and use the expertise of the nurse. Magnet hospitals are prime examples of positive organizational host and host responses. Magnet hospitals are characterized by levels of autonomy of the nurses on staff, good working relationships between physicians and nurses, and good quality patient outcomes (Laschinger, Almost, & Tuer-Hodes, 2003). One study indicated that magnet hospitals had a 4.6% lower mortality rate than did comparable nonmagnet hospitals (Aiken, Smith, & Lake, 1994).

A major study of magnet hospitals indicated common characteristics among these hospital organizations (American Academy of Nursing, 1983). These characteristics included: quality of nursing leadership (high standards, visible, and accessible), organizational structure (horizontal, decentralized), management style (participative, seeks and acts on input), personnel policies and programs (competitive salaries and benefits, staff-initiated programs), professional models of care (decisions at unit and organization level), quality care (identified by nurses as most important aspect of nurses’ practice), quality improvement (ongoing), consultation and resources (available and accessible), level of autonomy (expected practice), community and hospital (strong positive relationships), nurses as teachers (important and satisfying), image of nursing (viewed as vital to organization), nurse-physician relationships (collegial with mutual respect), and professional development (evident in organizational activities). The hospitals had outcomes of excellent patient care quality, nurses with job satisfaction, and good recruitment and retention of nurses.

Good quality nursing care requires adequate host support in recognizing and assisting nurses in providing such care. The quality of nursing care, as rated by hospital staff nurses, is greatly affected by nurses’ ability to do their jobs. Sochalski (2004) reported on a survey of 8,670 inpatient staff nurses working in acute care hospitals in Pennsylvania. She found that nurses’ satisfaction with the quality of care they provided in their most recent shift was related primarily to the amount of unfinished patient care (patient teaching, skin and oral care, discharge planning, and so on), followed by safety problems (medication errors, patients’ falls and injuries) and workload (number of patients cared for per nurse).
Host in Micro View

Nurse dose also can be rendered ineffective by the patients (host) or patients' responses. Here the acceptability of the dose or of the nurse by the patient is paramount.

Research studies in nursing are lacking to assess the acceptability of the nurse to the patient, including the effects of race and ethnicity of the nurse on such relationships (Benkert, Pohl, & Coleman-Burns, 2004). The research of Loretta Sweet-Jennett (personal communication, January 2005) and the authors has shown that if nurses demonstrate caring, concern, and advocacy for patients, differences in race and ethnicity between patients and nurses disappear when evaluating patients' participation in care and satisfaction with care and their nurse provider. Indeed, results of one study, with a majority of minority patients and White APNs, showed that the scores of satisfaction with APN care were so significant that they raised the overall patient satisfaction score, masking the low level of satisfaction with physicians (Brookton & Roncoli, 1994).

In contrast, many studies have been focused on the acceptability of physicians to patients. Research on patient-physician relationships indicates that patients are more comfortable and better able to communicate with physicians from their own racial or ethnic group, but the findings from such studies are mixed (Ferguson & Candib, 2002; Garcia, Paterniti, Romano, & Kravitz, 2003). Garcia and colleagues in focus group interviews with African Americans, Caucasians, and Latinos, found that patients' views regarding concordance were varied and unrelated to gender or to racial or ethnic group. However, they found that women described gender concordance as important to their relationship with primary care physicians. Ferguson and Candib found that race, ethnicity, and language had a substantial influence on the quality of physician-patient relationships. Saha, Arbelaez, and Cooper (2003), analyzing data from the Commonwealth Fund’s 2001 Health Care Quality Survey, found satisfaction with and use of health services were lower for Hispanics and Asians than for Blacks and Whites. Tucker and colleagues (2003) conducted 20 focus groups with African Americans, European Americans, and Latino Americans. Results showed that these groups identified indicators of culturally sensitive health care to include people skills, individualized treatment, effective communication, and technical competence. In addition, characteristics of the physical environment (culturally appropriate artwork, reading materials) and behavior of the office staff were unique indicators of culturally sensitive health care for African Americans and Latino American study participants.

Nurse-Dose Outcomes

To date, outcomes most commonly used to measure nurse dose have been mortality, morbidity, patient satisfaction, and health care costs. Measures of mortality and morbidity have been used in the work of Aiken and colleagues (2002) and in randomized clinical trials with VLBW infants (Brookton et al., 1986), elders (Naylor, Brookton, Campbell, et al., 1999; Nylor, Brookton, Jones, et al., 1994) and women with high-risk pregnancies (Brookton et al., 2001; York et al., 1997). Measures of morbidity have included complications such as infections, gastrointestinal bleeding, medication errors, number and length of rehospitalizations, acute care or emergency room visits, and psychological measures of morbidity including anxiety and depression. Measures of health-care costs have included proportional healthcare charges between intervention and control groups and Medicare reimbursements. In addition, nurse satisfaction and burnout have been used in the research of the Aiken teams, and patient satisfaction and clinical measures specific to the patient groups have been studied by research teams testing APN transitional care. Most important in outcome measures is the logical conceptual link between the nurse dose components and projected outcomes.

Conclusions

Research has repeatedly shown that improving patients' outcomes and controlling healthcare costs requires having adequate numbers of nurses. However, simply adding more nurses might have little effect if they do not have the education and experience needed to provide the complex care required of patients in today's hospital and home care settings. Optimal patients' outcomes and healthcare cost savings can only be achieved with the appropriate nurse dose, which consists of three equally essential components: dose (number of nurses or amount of care by nurses), nurse (education, expertise, and experience), and host and host response (organizational or patient receptiveness). Further work is needed in communicating these distinctions to healthcare administrators, healthcare policymakers, insurers, and the general public. Further research is needed on what mix of education, expertise, and experience of nurses with patients of differing ages achieves the most improved outcomes, patient acceptability, willingness to follow nursing advice, and characteristics of the nurse that improve patient outcomes.

References


