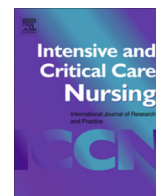




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Research article

The NASA Task Load Index as a measure of overall workload among neonatal, paediatric and adult intensive care nurses

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ABSTRACT

Introduction: The NASA Task Load Index (NASA-TLX) is a subjective workload assessment scale developed for use in aviation and increasingly applied to healthcare. The scale purports to measure overall workload as a single variable calculated by summing responses to six items. Since no data address the validity of this scoring approach in health care, we evaluated the single factor structure of the NASA-TLX as a measure of overall workload among intensive care nurses.

Methods: Confirmatory factor analysis of data from two studies of nurse workload in neonatal, paediatric, and adult intensive care units. Study 1 data were obtained from 136 nurses in one neonatal intensive care unit. Study 2 data were collected from 300 nurses in 17 adult, paediatric and neonatal units. Nurses rated their workload using the NASA-TLX's paper version.

Results: A single factor model testing whether all six items measured a single overall workload variable fit least well (RMSEA = 0.14; CFI = 0.91; TLI = 0.85). A second model that specified two items as outcomes of overall workload had acceptable fit (RMSEA = 0.08; CFI = 0.97; TLI = 0.95) while a third model of four items fit best (RMSEA = 0.06; CFI > 0.99; TLI = 0.99).

Conclusion: A summed score from four of six NASA-TLX items appears to most reliably measure a single overall workload variable among intensive care nurses.

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Implications for Clinical Practice

- Subjective workload measurement is important for making equivalent nurse workload comparisons in intensive care settings; understanding subjective workload can facilitate managerial decision-making related to resource allocation.
- The NASA-Task Load Index is a subjective workload measure developed for use in high-risk industries; we tested whether a single score adequately measures overall nurse workload in intensive care units.
- A four-item version of the instrument performs better at measuring overall workload than the original six-item version.
- The four-item NASA-TLX can be used to quickly and reliably measure overall workload of intensive care nurses.

Introduction

Nurse workload, loosely defined as “the amount of performance required to carry out nursing activities in a specified time period” (Morris et al., 2007), is typically measured using resource-based

measures (e.g., nurse-to-patient staffing ratios or nursing care hours per patient day), patient-based measures (clinical acuity), and operator-based measures that include physiologic indicators and subjective workload ratings (Carayon and Gurses, 2005). Resource and patient-based measures of nurse workload dominate in studies of nursing care and patient outcomes likely due to their ease of measurement using existing data sources and perceived utility for comparing similar variables across units and

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organisations. However, such measures have limitations for sense-making and intervention. Consider the following scenario. Nurse A cares for one unstable complex patient during the shift, a patient she does not know well. The patient requires vasopressor support but medications are not arriving as quickly as needed, so she pauses to make repetitive calls to the pharmacy. The pace of work is fast; she is continuously triaging needs and making in-the-moment decisions about what care must be given and what can be delayed or omitted. She perceives her workload as high although she has one patient. Nurse B is assigned two stable patients that he does not know. No emergent medications are needed and medication drawers are fully stocked. The pace of work is steady but manageable and he is able to meet all the demands placed upon him including family support needs; no care is omitted or delayed. He perceives his workload as moderate even though he is caring for twice as many patients as Nurse A.

In this fictitious scenario, one that realistically represents nurses' working conditions in intensive care unit (ICU) settings, an analysis of solely resource-based measures of nurse workload such as a staffing ratio could yield null or counter-intuitive results about the effects of workload on patient outcomes. Nurses' workload perceptions, or subjective workload, may be useful indicators of work system dysfunction that could both expand the current understanding of effects of nurse workload on patients beyond patient-to-nurse staffing ratios and offer new insights for intervention research. To advance this area of science, sound measures of subjective workload are needed.

One of the most widely used measurement tools to assess subjective workload of individuals operating in high-risk, time sensitive industries is the National Aeronautics and Space Administration Task Load Index (NASA-TLX). The NASA-TLX is a six-item scale that was initially developed to measure workload in laboratory-based aviation settings and has since been applied to workload measurement in other sectors such as nuclear energy, transportation, and increasingly in health care (Hart, 2006; Hart and Staveland, 1988; Hwang et al., 2008; Jacobson et al., 2011; Mazur et al., 2012). Each item purports to represent a different aspect of workload: Mental Demand (MD), Physical Demand (PD), Temporal Demand (TD) Effort (EF), Performance (PE) and Frustration (FR). To aid in interpretation and simplify use, the items are combined into a single summed unweighted score representing the latent construct of overall workload (OW) (Byers et al., 1989; Hendy et al., 1993). The OW sum score is intended to measure the totality of workload experienced by the individual during a specific time, event or situation (Hart, 2006).

The validity of conclusions based on a single summary score depends (in part) on the extent to which evidence supports the hypothesis that responses measure a single latent construct (Carle and Weech-Maldonado, 2012). If a set of questions measure more than one construct (e.g., two types of workload), a single summary score will conflate levels of the constructs and potentially lead to spurious conclusions. Despite increasing use of the NASA-TLX composite sum score as a measure of overall workload among nurses and other health care providers (Anders et al., 2012; Colligan et al., 2015; Hoonakker et al., 2011; Lopez et al., 2010; Young et al., 2008), we found no published data in health care evaluating the validity of the OW summary score using responses to the six NASA-TLX items. This is concerning given that two of the items, performance (defined as perceived success in accomplishing the task) and frustration (defined as feelings of discouragement or complacency while completing the task), can be theoretically considered outcomes of workload rather than characteristics of workload and possibly a separate factor or unrelated to the other items as has been demonstrated in studies of workers in non-health care sectors (Helton et al., 2014; Ramiro et al., 2010). Therefore, in this paper we evaluate the dimensionality and reliability of the NASA-TLX as a measure of overall workload among ICU nurses.

Methods

Design

We conducted a confirmatory factor analysis of de-identified data previously collected for two separate studies of nurse workload in intensive care settings. Data for Study 1 were collected in 2013 and 2014 for an observational longitudinal study examining relationships between nurse workload, missed nursing care, and neonatal safety outcomes in one neonatal intensive care unit (NICU) (Tubbs-Cooley et al., 2015). Data for Study 2 were collected as part of a 2004 cross-sectional study of relationships among nursing care performance obstacles and facilitators, nurse workload, quality of working life, and quality and safety of care in a mixed sample of ICUs (Gurses et al., 2009). The use of two independent data sources that differ in sample and time period affords a unique opportunity to test the stability and replicability of an instrument's factor structure.

Setting, sample, and data collection

Study 1. Neonatal ICU nurses (n = 136) in a 59-bed Level IV NICU completed the NASA-TLX at the end of each worked shift during multiple six-week continuous data collection cycles. Eligible nurses were those who had completed unit orientation and provided direct patient care. Approximately 80% of eligible Registered Nurses (RNs) enrolled in the study. In total, nurses completed 5584 NASA-TLX surveys over 332 12-hour shifts; we analysed the first completed scale (n = 136) to increase comparability with Study 2 data.

Study 2. Neonatal (n = 24), paediatric (n = 43), and adult ICU (n = 232) who participated in a multi-site cross-sectional study completed a survey on nurses' performance obstacles and facilitators, workload, quality of working life and quality and safety of care provided to patients; the NASA-TLX was one of the scales included in the survey. Eligible nurses were those who provided direct care to patients requiring intensive-care level services. Data were collected in 17 ICUs (three medical, two surgical, five medical/surgical, burn, cardiothoracic, neurosurgery, two paediatric, neuro-trauma, neonatal) from seven hospitals. Each participating nurse completed the survey once at the end of one shift. The nurse response rate per unit ranged from 40% to 100%; the overall response rate was 77%. In total, nurses completed 300 surveys representing an average of 17 surveys per unit (range: 4–55).

Measure

The NASA-TLX is a subjective workload measure that was developed in the 1970 s to assess pilot and air traffic controller workload (Hart, 2006; Hart and Staveland, 1988). The current version of the instrument (see Appendix) has six items marked on a twenty point scale (low = 1, high = 20) that purport to measure different aspects of workload: Mental Demand (MD), or the amount of mental and/or perceptual activity required such as thinking, calculating, deciding; Physical Demand (PD), or the amount of physical activity required such as pushing, pulling, turning, controlling; Temporal Demand (TD), or the amount of pressure felt due to the rate at which tasks or task elements occurred; Performance (PE), or perceived success in accomplishing the task; Effort (EF), or how hard one had to work to accomplish a certain level of performance; and Frustration (FR), or how discouraged versus content one felt while completing the task. Overall workload (OW) is calculated by taking a non-weighted (raw) summed numeric score of the items and ranges from a minimum of 6 to a maximum of 120 (Byers et al., 1989; Hart, 2006; Hendy et al., 1993).

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