Establishing Inter Rater Reliability of the National Early Warning Score

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Abstract

The complexity of the health care system poses challenges to patients and staff alike. Advanced technologies and processes are designed to keep patients safe but the human aspects of care are variables to consider. Those variables can include delays in recognizing patient decompensation, miscommunication between caregivers, or failures to act. Adjuncts to care that can predict patient decompensation, clinical outcomes, and severity of illness are known as early warning scoring systems. In an effort to standardize these systems, the Royal College of Physicians established the National Early Warning Score in 2012. The purpose of this study was to establish inter rater reliability of the National Early Warning Score by comparing Registered Nurses and Patient Care Assistants practicing in a long term acute care hospital.
Establishing Inter Rater Reliability of the National Early Warning Score

The complexity of the health care system poses challenges to patients and staff alike. It is well known that our modern day system “is fragmented, bureaucratic, siloed, and characterized by gross systemic failure to protect the patient from harm” (James, 2010, p. 138). Advanced technologies and processes are designed to keep patients safe but the human aspects of care are variables to consider. Those variables can include a delay in communication where the caregiver does not call for assistance when a change in patient condition is noted (Schein, Hazday, Pena, Ruben, and Sprung, 1990). Delays in treatment that occur are attributed to communication failures (Wyatt, 2014). Also, “timing and appropriateness of treatment” contribute to the delivery of substandard care (Meeks, Meyer, Rose, Walker, & Singh, 2014). Suboptimal care impacts admissions to the Intensive Care Unit (ICU), along with morbidity and mortality rates (McQuillan et al., 1998). Failure to recognize subtle changes in patient condition can result in negative patient outcomes.

**Background and Significance of the Problem**

A change in patient condition is a dynamic process. Failure to recognize changes in vital signs or a failure to communicate between caregivers can delay necessary interventions (Institute for Healthcare Improvement, 2008). Failure to rescue occurs when caregivers fail to notice a decline in patient condition (Institute for Healthcare Improvement, 2015). Changes in patients’ pulse, blood pressure, temperature, and others, had been observed in 79% of in-hospital cardiac arrests, as well as in 54% of in-hospital deaths and emergency admissions to ICU (Smith, Prytherch, Schmidt, Featherstone, Knight, Clements, & Mohammed, 2006).

Reluctance to report what the caregiver may suspect as a change in condition is not uncommon (Franklin and Mathew, 1994). When a change in condition is suspected, one
resource available to the caregiver is the Medical Emergency Team (MET) or Rapid Response Team (RRT). The RRT brings experts to the bedside of a patient to intervene with the intent of improving patient outcome and preventing death (Tarassenko, Hann, & Young, 2006). The concept of a RRT evolved in response to concerns about the hours preceding admission to the Intensive Care Unit (ICU) (Tarassenko, et al, 2006). Changes in patients’ physiological parameters exist over a substantial period of time before arrest occurs (Winters and DeVita, 2011). This led to the development of a tool that could assist the caregiver in determining risk and when to call for additional resources to the bedside of a patient.

This quantitative, risk assessment tool was established in 1997 and was referred to as the Early Warning Scoring System (EWSS). Multiple modifications have been made to the original tool over the last 18 years and are known as Modified Early Warning Scoring (MEWS) systems. These modified versions use a variety of physiologic parameters, but lack consistency and standardization. In addition, the trigger threshold for summoning additional resources varies between tools and organizations using it.

In an effort to standardize the physiologic parameters, trigger thresholds and response, the Royal College of Physicians (RCP)(2012) convened a work group which established the National Early Warning Score (NEWS). The NEWS is a slight adaptation of a recent modification called VitalPAC Early Warning score (ViEWS) (Smith, Prytherch, Meredith, Schmidt, & Featherstone, 2013). The ViEWS did perform better than other previous scoring systems and was tested on a large data base of vital signs.

While many of the early warning scoring tools used over the years may be accurate in predicting patient decompensation, they are only as reliable and accurate as the person obtaining and documenting the parameters. In the United States health care systems, most of the
parameters included in the early warning system are data collected by non-professional health care workers such as Patient Care Assistants (PCA). Validation of their ability to recognize and report changes in patient condition have not always been documented. Likewise, the comparison of data gathered byRegistered Nurses (RN) and PCA have not been reported. The purpose of this study is to establish inter rater reliability of the NEWS by comparing RN to PCA practicing in a long term acute care hospital.

**Review of the Literature**

Long Term Acute Care Hospitals (LTCH) exist to provide long term, comprehensive care to complex patients who require an extended hospital stay, often transferred directly out of an ICU ("What are long-term," 2012). Fifty percent of patients discharge to an LTCH have extreme severity of illness levels (“Factsheet: Long-term care,” 2014). The average length of stay (LOS) is 27.2, compared to a 6.7 day LOS in Intensive Care (“Factsheet: Long-term care,” 2014). In fiscal year 2012, nine of the top 25 diagnosis related groups (DRG) at discharge were respiratory related with mechanical ventilation greater than 96 hours, pulmonary edema and respiratory failure, and others (“Chapter 11-Long-term care,” 2014). In addition to complex respiratory problems, additional patient problems include pressure ulcer management or severe sepsis (“Chapter 11-Long-term care,” 2014). Statistics about DRG and patient outcomes related to pressure ulcers, central line associated blood stream infections (CLABSI), and catheter associated urinary tract infections (CAUTI) are tracked. Metrics such as the number of codes called in response to cardiopulmonary arrests and outcomes are not reported at this time but frequently tracked internally by an individual organization.

The phenomena of arrests, and the resulting codes, have been studied in and out-of-hospital settings (Meaney et al. 2013). The incidence of arrests in hospitals is estimated at
200,000 per year (Merchant et al. 2011). Survival to discharge after experiencing a code is impacted by the time of day the in-hospital arrest occurred. Less than 20% of patients who arrest between 7:00 AM and 11:00 PM survive compared to 15% who arrest between 11:00 PM to 7:00 AM (Meaney et al. 2013). For hospitalized patients who sustain an arrest, the average survival rate to discharge is 17% (Peberdy et al. 2003). An American Heart Association (AHA) Consensus Statement (2013) indicates that while statistics vary between studies, the metric of survival to discharge has not changed over many decades (Morrison et al. 2013).

When changes in patient condition are recognized, the caregiver or even family members can call the Rapid Response Team (RRT). The RRT evolved in the early 1990s in response to questions about what happened to patients in the hours that preceded transfer to an ICU (Winters & DeVita, 2011). RRT were designed to bring resources to the bedside of a patient outside the ICU who is experiencing symptoms of altered physiologic state (Leach & Mayo, 2013). Buist, et al. (2002) advised that with early intervention, unexpected arrest can be reduced by 50% and ultimately reducing mortality.

Early detection and mobilization of resources to the bedside of patients is key to patient rescue (Sarani & Scott, 2010). Hillman et al. (2001) noted that changes in the basic functions of airway, breathing, and circulation produced physiologic abnormalities seen before preventable hospital deaths. Franklin & Mathew (1994) noted that 99 of 150 arrests had documented a change in patients’ physiologic state within six hours of their arrest. In 25 cases, the nurse failed to notify the physician of a change in condition, which often included a change in mental status (Franklin & Mathew, 1994). Tarassenko, Hann, & Young (2006) noted that 80% of ward patients had changes in their physiologic parameters outside normal ranges in the 24 hours that preceded admission to the ICU. These abnormal physiologic parameters include tachypnea, tachycardia,
change in mental status, arterial hypotension, and hypothermia (Tarassenko, Hann, et al., 2006). Before arrest, hypotension and a fall in Glasgow Coma Scale were cited as precursors (Kause et al., 2004). Schein et al. (1990) found that physiologic alterations before arrest included respiratory changes in 38% of their sample.

Failure to recognize or report changes in physiologic condition, can affect patients and their subsequent outcomes. An Early Warning Scoring System (EWSS) was developed in 1997 to identify patients at risk for changes in their physiologic condition. The EWSS incorporated physiologic parameters of systolic blood pressure, pulse rate, respirations, temperature, and level of consciousness (Page, Blaber, & Snowden, 2008). Multiple variations of the initial tool have evolved and are referred to as the Modified Early Warning Scoring System (MEWS).

In all tools, each physiologic variable is assigned a numeric value. Most tools use a score of zero as the established normal range for the physiologic parameters. Scores of 1-3 indicate how far from the norm, a physiologic value is. Some tools include negative scores from 0 to -3 (Whittington, White, Haig, & Slock, 2007). The numbers for each measured physiologic parameter are added together to yield a single, summative score that can determine patient risk for an altered physiologic state (Johnstone, Rattray, & Myers, 2007). Few studies have tested and validated what variables should be tracked and at what summative score should prompt a call to the RRT. Subbe, Kruger, Rutherford, & Gemmel (2011) states that a summative score of five or greater was associated with an increased risk of death.

While the EWSS and MEWS have been widely used, criticism centers on the lack of documented validity and reliability (Morris and Davies, 2010, p. 1181). Despite that, one study by Cuthbertson, Boroujerdi, McKie, Aucott, & Prescott (2007) concluded that the EWSS possessed predictive accuracy overall. Subbe, Gao & Harrison (2007) addressed inter-rater
reliability of the physiologic variables, total scores, and triggering events. Subbe et al. (2007) found variations in reproducibility with better agreement on the individual physiologic parameters, rather than when using a summative score.

Another early warning score was developed and described by Prytherch, Smith, Schmidt and Featherstone (2010). The authors reviewed previous tools and literature to develop the ViEWS. It was applied to large vital sign observation sets obtained from 35,585 medical admissions. In-hospital mortality rate within 24 hours of the observation set was analyzed using area under the receiver-operating characteristics curve (AUROC) (Prytherch et al., 2010). AUROC at 95% confidence interval was 0.888 (0.880-0.895) (Prytherch et al., 2010).

The existence of 70 different EWSS systems makes it challenging for staff that move between organizations (Sprinks, 2013). It is noted that many modifications to the EWSS tools were made in various organizations and the data documented in a variety of ways (RCP, 2012). In addition, considerable variation in the physiologic parameters monitored and the subsequent scoring, were based on “clinical experience and intuition” (Prytherch et al. 2010, p. 932). Given those realities, the Royal College of Physicians convened a work group charged with the goal of developing one scoring system that could improve patient care through standardization and clinical response across the National Health Service (RCP, 2012). The National Early Warning Score (NEWS) was developed in response to this need for standardization.

The process used to formulate the standardized tool began with small group discussions to review existing systems and associated literature (RCP, 2012). It is acknowledged “that the evidence base to guide the formulation of NEWS was somewhat limited and certainly not optimal” (RCP, 2012). A draft was developed and reviewed by national stakeholders such as the Royal College of Nursing, British Thoracic Society, and others, for their input. Identifying the
physiologic parameters to be measured along with the appropriate weightings and performance of the many systems was reviewed. It was determined that six physiologic parameters would serve as the basis for the tool. Oxygen saturation, along with the additional scoring of supplemental oxygen drew much discussion but was included in the final NEWS. The RCP (2012) workgroup believed that scoring the use of supplemental oxygen contributed to the precision of being able to detect illness severity.

Early warning scoring systems may have predictive ability related to cardiac arrest, death, ICU admission and utilization, along with length of stay (Alam, Hobbelink, van Tienhoven, van de Ven, Jansma, & Nanayakkara, 2014). Whether using EWS, MEWS, or NEWS the tools are only as accurate as the caregiver completing it. Effective training on the various tools, along with accurate and competent practice obtaining vital signs is essential for all caregivers involved. One cannot ignore the human element involved and its impact on the data. Omission of data or incorrect calculations of individual or summative scores can impact the use and workflow of clinicians and the care patients receive.

Omission of data can produce an inaccurate individual and summative score. This can result in triggering additional resources or a missed opportunity to intervene. Hammond et al. (2013) described a statistically significant increase in obtaining complete sets of vital signs 24 hours after transfer from the ICU once MEWS was implemented. A recent systematic review by Smith et al. (2014) indicates that accuracy and completion in scoring can be an issue with early warning scoring systems. A 2011 study by Jones et al. cite that 81% of the EWS used was calculated correctly. Errors found either overestimated or underestimated with some missed opportunities for a clinical response per protocol (Jones, 2011). Smith & Oakey (2006) compared the recorded EWS by nursing staff and found that 21.9% were incorrect. Additionally,
the respiratory rate had the highest error rate almost 10% of the time. The “more abnormal the primary observation, the more likely it was to be misscored” (Smith & Oakey, 2006, p. 225).

The use of computerized technology plays a role in accuracy of scoring. Continuous monitoring of some parameters automatically downloads, while others require the expert assessment of the nurse when evaluating level of consciousness and manual input. Prytherch, Smith, Schmidt, Featherstone, Stewart, Knight, & Higgins (2006) compared the calculations of EWS by pen and paper compared to a personal digital assistant (PDA). They found the automated approach had a 10% rate of omission or incorrect entries, compared to the manual method at 29% with paper/pen (Prytherch et al., 2006). While automation has its advantages, a loss of connectivity and disruption in the flow of information can impact patient care and frustrate care givers.

**Theoretical Framework**

General systems theory has its origins in European philosophy. Philosophers such as Aristotle noted that the whole is more than the sum of its parts (von Bertalanffy, 1972). Ludwig von Bertalanffy formulated General Systems Theory in the 1930s related to biological systems. The theory also applies to other disciplines such as math, computer, and social sciences.

General systems theory is characterized by models, principles, laws and the relationship between them and the environment (von Bertalanffy, 1972). His description of open systems formulates the basic areas of physiology as they relate to metabolism, excitation, cell growth and regulation, among others (von Bertalanffy, 1972). A feature of an open system is one that is “exchanging matter with the environment” (von Bertalanffy, 1972, p. 412).

Living organisms have a hierarchy of open systems that maintain a steady state in the body (von Bertalanffy, 1951). An open system can reach equilibrium from different initial
conditions and in different ways which is different than a closed system (von Bertalanffy, 1951). Despite impairments in a system, demand on that same system will increase in an attempt to compensate (von Bertalanffy, 1951).

In order to compensate and maintain a steady state, an organism is also an active system (von Bertalanffy, 1951). A flow of processes allow for ongoing automatic functions to occur. Laws of order integrate the parts and processes to produce a response. In low circulating volume states, vasoconstriction drives blood pressure up along with an increase in heart rate. Achieving stability and a steady state can then be realized after this physiologic process.

**Methods**

This study was conducted on the clinical units of a 104-bed, LTCH system in Northeast Ohio. The system is comprised of four units across a 60-mile radius. These four units are imbedded in an acute care, host hospital. Patients admitted to these clinical units are frequently direct transfers from Intensive Care Units across the geographic area. Diagnoses include complex medical and surgical problems and can include ventilator weaning, extensive wound care, post transplantation, cardiac management and others. Case mix index ratio is 1.10-1.25 and the average length of stay is 28 days. The population is diverse in ethnicity, culture, and includes insured and non-insured patients.

The convenience sample was comprised of 22 RN and six PCA employed on these long term acute care units. The nurse-patient ratio on the units is one RN for four patients. PCA provide care to an average of 12 patients. RN and PCA from all shifts were asked to participate in this study. One Registered Nurse agency staff was included in the sample.
**Instrument**

The NEWS is a quantitative tool developed by the Royal College of Physicians, National Early Warning Score Development and Implementation Group (NEWSDIG). This standardized tool is comprised of six physiologic parameters consistent with the recommendation made in 2007 by the National Institute for Health and Clinical Excellence (NICE) (Prytherch et al., 2010). Those parameters include respiratory rate, oxygen saturation, temperature (measured in Centigrade), systolic blood pressure, heart rate, and level of consciousness. A seventh scored parameter, not included in previous versions of the EWSS, includes the use of supplemental oxygen.

This seven parameter tool was tested to determine its ability to discriminate between patients with and without adverse outcomes at 24 hours post vital signs observation (Smith et al., 2013). Outcome end-points were death, cardiac arrest, and unanticipated ICU admission (Smith et al., 2013). Smith et al. (2013) documented that area under the receiver-operating characteristic curve (AUROC) was performed resulting in reasonable discriminatory ability with values between 0.722-0.894 for outcome end-points.

Content validity of the NEWS was established by the NEWSDIG. This expert panel was comprised of physicians, nurses, and other key stakeholders in determining the physiologic parameters to be utilized in the new tool (RCP, 2012). In order to test for inter rater reliability, both the RN and PCA read an unfolding, three part case study which portrayed a typical patient on the unit. The case scenario provided physiologic data that matched each of the seven parameters on the NEWS. Subjects circled the individual score for each parameter on the tool that matched the case scenario data and provided a summative score (see Appendix A). For
example, a heart rate of 41-50 beats per minute, received a score of 1. Total scores range from 0-20.

The RN and PCA determined the patient’s level of consciousness based on the data presented in the scenario. It is acknowledged that assessing level of consciousness is within the scope of the RN only. The initials of A, V, P, or U was circled. The initial “A” represents a patient who is alert and fully awake. Alert does not solely imply orientation and can include patients who are confused (RCP, 2012). The initial “V” is selected if the patient is able to make some kind of response whether eye movement, voice, or motor activity (RCP, 2012). If the patient is not alert and does not respond to voice, the initial “P” is selected once a pain response is elicited and is positive (RCP, 2012). The initial “U” refers to the unconscious patient without eye, voice, or motor response (RCP, 2012). Once all individual parameters were circled, the RN and PCA added each individual score to produce a summative score.

Data Collection

Education of the RN and PCA day and night shift staff was critical to operationalizing this study. Two educational sessions at each clinical site were held to educate all RN and PCA working on the days of data collection. A total of eight, 30 minute sessions were provided before the implementation of the study. Information about the NEWS scale and why it could be a supportive tool in evaluating patients was included in the sessions. The sessions presented the method used to complete the instrument using a case scenario, followed by an explanation of the study. Staff was advised that their participation is voluntary and they could choose not to participate. Informed consent was obtained for those who wanted to participate. Staff choosing not to participate returned to the unit.
Participating staff were given an envelope. The envelope contained an unfolding case scenario with three parts that would be applied to three NEWS tools that the participant labeled 1, 2, and 3. The outside of the envelope was coded with a number that represented the clinical unit the data was from and a participant number, noted in the right upper corner of the envelope. A demographic summary page was included in the envelope to document participants’ academic preparation, years of experience, gender, age and role (RN or PCA). Subjects were instructed to place all documents back into the envelope, seal it closed, and place it in the box on the counter where the education took place. The investigator stepped away from the central station while the subjects were completing the documents.

Quantities of 200 NEWS tools were colored copied per copyright restrictions. No appreciable costs were incurred with this study, except for the cost of copying the documents.

**Ethical Considerations**

Institutional guidelines for conducting human subject research were followed according to guidelines set by Walsh University and the institution where data collection occurred. Informed consent was obtained from all RN and NA who agreed to participate in this study. Consent forms were retained by the researcher and all completed tools stored in a fireproof lock box.

**Data Analysis**

Measures of central tendency were applied to the data using SPSS Predictive Analytics Software Statistics 22.0 (SPSS IBM). Mean, mode, range, and frequencies were determined for three parts of the case scenario. The completed NEWS tools were reviewed for individual missing parameters. The data was considered missing when the subject skipped over a
parameter and did not circle the correct range. Also, accuracy in scoring individual parameters and the summative scores were reviewed.

Inter rater reliability was determined using Krippendorff’s alpha. Krippendorff’s alpha measures agreement among raters when there is more than two observers, incomplete or missing data, and no minimum sample size (Krippendorff, 2011). It allows us to see agreement among multiple raters on interval scales where if the values were not exact matches, how close were they? This statistical method is not available in SPSS and required the use of R open source statistical software for calculation. An alpha value greater than or equal to .80 was considered to demonstrate good reliability reflecting how often raters agreed with each other.

Results

Demographic data about the characteristics of the subjects were analyzed. The age range of subjects was 26-60 years old. Three subjects did not document age. Ten percent of the sample was 32 years old which comprised the largest group. Average age from Unit 1 was 48 years old, Unit 2 was 44 years old, Unit 3 was 46 years old and Unit 4 was 40 years old. Largest sample came from Unit 2. Average age of the RN was 45 years old compared to PCA average age of 37 years. Fifty five percent of the RN sample holds an Associate’s Degree in Nursing. Remaining RN subjects held a variety of degrees such as one is MSN prepared five BSN and 3 Diploma graduates. Eighty six percent of the subjects were female. Years of experience for 28 subjects were 15.4 years. The RN in the study had an average of 16.5 years of experience compared to PCA with 10.8 years experience.

A review of the three parts of the case scenario indicates that about one-third RN and one-third of PCA scored all parts correctly. The RN and PCA who were greater than 45 years old scored all three parts of the case scenario correctly.
There were 28 subjects in this sample with multiple parameters not evaluated. Some subjects skipped over a parameter and did not circle the correct range. Part one had missing data totaling 25%. Missed parameters included supplemental oxygen, systolic blood pressure, level of consciousness, heart rate, and temperature. Part two had 14% missing data and included level of consciousness and heart rate. Part three had 25% missing data with level of consciousness missed exclusively.

The alpha value obtained to determine inter rater reliability was 0.94 demonstrating a high level of agreement among the raters who examined the three segments of the case scenario.

Discussion

The NEWS and its predecessors provide clinicians with a quantitative tool for predicting and identifying altered physiologic states. It cannot be the sole source for determining decompensation and the trigger for summoning assistance at the bedside. It can serve as an adjunct to the provision of safety and quality that is paramount to the mission of any organization but it is only as good as the person completing it.

Incidences of failure to rescue and subsequent codes impact the quality of care being provided in an organization. In addition, an organization’s financial bottom line is impacted by transfers back to acute care, increased length of stay and loss of reimbursement. Further research is needed to determine the impact of NEWS on clinical outcomes. Randomized control trials can be useful in determining how the use of the NEWS can impact the mortality rate, number of rapid response team calls or the number of codes in an organization.

Limitations

Limitations of this study include the use of only one level of care: the long term acute care hospital. Use of the tool in a different clinical setting such as Acute Care or Long Term
Care may produce different results. Results may also differ if operationalized on Medical-Surgical units or in an Emergency Department.

It is acknowledged that there were only six PCA in this study. More PCA would be needed in future studies as often times they are the persons responsible for performing and collecting vital signs on patients. Also, PCA do not assess level of consciousness. This assessment is within the scope of the RN. In this study, PCA made a determination of level of consciousness based on the printed information provided in the scenario. Interestingly, one RN and one PCA scored this parameter incorrectly.

**Implications for Practice**

There are multiple implications for practice related to the use of the NEWS from a clinical patient outcomes perspective and the human factor associated with the tool. Continuing to collect data on large vital sign data sets continues to strengthen evidence for prediction of mortality, clinical outcomes, length of stay, and transfers back to Acute Care and ICU. An increase in calls to the RRT may be the result of increased vigilance and surveillance. The NEWS tool may be an adjunct to determining appropriate levels of care for an admitted Emergency Room patient.

Manual completion of vital signs for use with the NEWS poses questions about validating competency of providers in accurate completion. In absence of an electronic medical record (EMR), the accuracy of recording vital signs with pen/paper is important. If attainment of vital signs is automated, along with downloading features into the EMR, how robust is the infrastructure to avoid connectivity issues and loss of valuable data? Whatever method chosen, workload and workflow of the direct caregivers are important.
Conclusion

The NEWS can be a reliable adjunct to care. It can identify patients at risk and assist in the clinical decision making process. While the NEWS and its predecessors are able to predict clinical outcomes, the human factor is an essential consideration. Leaders must be mindful of the impact of adding another task to the workload of the direct caregivers and the benefit automation can bring. This additional task is balanced by early identification of decompensation, timely intervention, and a positive patient outcome.
References


doi:10.1097/01CCM.0000254826.10520.87


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Establishing inter rater reliability

Australia and New Zealand, and the United Kingdom- the ACADEMIA study.


### National Early Warning Score (NEWS)*

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*The NEWS initiative formed from the Royal College of Physicians’ NEWS Development and Implementation Group (NEDIG) report and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation.

Please see next page for explanatory text about this chart.
National Early Warning Score (NEWS)

Standardising the assessment of acute-illness severity in the NHS

Report of a working party July 2012
Appendix C

The Royal College of Physicians

The Royal College of Physicians is a registered charity that aims to ensure high-quality care for patients by promoting the highest standards of medical practice. It provides and sets standards in clinical practice and education and training, conducts assessments and examinations, quality assures external audit programmes, supports doctors in their practice of medicine, and advises the government, public and the profession on healthcare issues.

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