The Richmond Agitation–Sedation Scale

Validity and Reliability in Adult Intensive Care Unit Patients

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Sedative medications are widely used in intensive care unit (ICU) patients. Structured assessment of sedation and agitation is useful to titrate sedative medications and to evaluate agitated behavior, yet existing sedation scales have limitations. We measured inter-rater reliability and validity of a new 10-level (+4 "combative" to −5 "unarousable") scale, the Richmond Agitation–Sedation Scale (RASS), in two phases. In phase 1, we demonstrated excellent ($r = 0.956$, lower 90% confidence limit = 0.948; $\kappa = 0.73$, 95% confidence interval = 0.71, 0.75) inter-rater reliability among five investigators (two physicians, two nurses, and one pharmacist) in adult ICU patient encounters ($n = 192$). Robust inter-rater reliability ($r = 0.922$–0.983) ($\kappa = 0.64$–0.82) was demonstrated for patients from medical, surgical, cardiac surgery, coronary, and neuroscience ICUs, patients with and without mechanical ventilation, and patients with and without sedative medications. In validity testing, RASS correlated highly ($r = 0.93$) with a visual analog scale anchored by "combative" and "unresponsive," including all patient subgroups ($r = 0.84$–0.98). In the second phase, after implementation of RASS in our medical ICU, inter-rater reliability between a nurse educator and 27 RASS-trained bedside nurses in 101 patient encounters was high ($r = 0.964$, lower 90% confidence limit = 0.950; $\kappa = 0.80$, 95% confidence interval = 0.69, 0.90) and very good for all subgroups ($r = 0.773$–0.970, $\kappa = 0.66$–0.89). Correlations between RASS and the Ramsay sedation scale ($r = -0.78$) and the Sedation Agitation Scale ($r = 0.78$) confirmed validity. Our nurses described RASS as logical, easy to administer, and readily recalled. RASS has high reliability and validity in medical and surgical, ventilated and nonventilated, and sedated and nonsedated adult ICU patients.

Keywords: sedation; agitation; mechanical ventilation; validation; scale

Sedative and analgesic medications are administered to many patients who are critically ill in intensive care units (ICUs) throughout the world (1–3). The consequences of inadequate sedation and analgesia can be substantial, including self-removal of important intralumenal tubes and vascular catheters, aggressive behavior by patients against care providers, and poor patient–ventilator synchrony (4–11). Therapeutic sedation has inherent risks, however, particularly when excessive or prolonged (11–16). The increasing recognition that the use of sedative medications can have substantial impact on duration of ICU length of stay and complications (14–16) has raised the awareness of the value of structured sedation evaluation. Reliable sedation tools can enhance communication among caregivers (17–19), improve consistency in drug administration (20, 21), be used in sedation protocols (15, 22), and improve precision of medication titration as patient needs change over time (11, 12, 23–25). The routine use of a sedation scale, including frequent adjustment of the sedation target as needed, is strongly endorsed in a recent evidence-based guideline (11). Unfortunately, surveys indicate that sedation scales are underused in ICUs (1, 3, 26).

In a recent review of sedation scoring systems, De Jonghe and colleagues (25) identified 25 instruments designed to measure consciousness in the ICU setting; however, only three had been tested for reliability and validity in adult ICU patients. Furthermore, desirable features of sedation instruments such as multidisciplinary development, simplicity and ease of use, ease of recall, precise discriminating criteria for each level, sufficient levels for sedative medication titration, measurement of agitation, and rigorous testing of inter-rater reliability and validity in relevant patient populations (1, 24, 25, 27) are lacking in many published instruments.

The Richmond Agitation–Sedation Scale (RASS) was developed in a collaborative effort with practitioners representing critical care physicians, nurses, and pharmacists. RASS is a 10-point scale, with four levels of anxiety or agitation (+1 to +4 [combative]), one level to denote a calm and alert state (0), and 5 levels of sedation (−1 to −5) culminating in unarousable (−5). The values and definitions for each level of agitation and sedation are displayed in Table 1, as are the instructions for assessment, as previously described (12). The purpose of this investigation was to rigorously test inter-rater reliability and validity of RASS in a broad spectrum of adult ICU patients. These studies include testing of reliability among nurses after implementation of RASS in a medical ICU.

METHODS

The research protocol was approved by the Virginia Commonwealth University Committee on the Conduct of Human Research. The requirement for obtaining written informed consent was waived, as this noninterventional study posed no added risk to subjects. Testing of validity and inter-rater reliability was performed in two phases at the Medical College of Virginia Hospitals, the 750-bed tertiary-care urban teaching hospital of the Virginia Commonwealth University Health Systems. Before formal testing, investigators pilot tested RASS in approximately 20 patients, resulting in minor modifications.

Phase 1

Consecutive patients from the medical respiratory ICU, neuroscience ICU, coronary ICU, surgical trauma ICU, and cardiac surgery ICU were evaluated. Patients with the following characteristics were excluded: (*1*) concurrent neuromuscular blockade or quadriplegia, (*2*) contact or airborne isolation precautions, (*3*) impaired hearing, (*4*) non-English speaking, or (*5*) impaired visual acuity such as blindness or facial or eye trauma. The bedside nurse was contacted regarding these and any additional reasons for exclusion. The time of day, day of week, and

(*Received in original form July 25, 2001; accepted in final form August 15, 2002*)

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This article has an online data supplement, which is accessible from this issue's table of contents online at www.atsjournals.org

Am J Respir Crit Care Med Vol 166. pp 1338–1344, 2002
DOI: 10.1164/rccm.2107138
Internet address: www.atsjournals.org

TABLE 1. RICHMOND AGITATION–SEDATION SCALE

Score	Term	Description
+4	Combative	Overtly combative or violent; immediate danger to staff
+3	Very agitation	Pulls on or removes tube(s) or catheter(s) or has aggressive behavior toward staff
+2	Agitated	Frequent nonpurposeful movement or patient–ventilator dyssynchrony
+1	Restless	Anxious or apprehensive but movements not aggressive or vigorous
0	Alert and calm	
−1	Drowsy	Not fully alert, but has sustained (more than 10 seconds) awakening, with eye contact, to voice
−2	Light sedation	Briefly (less than 10 seconds) awakens with eye contact to voice
−3	Moderate sedation	Any movement (but no eye contact) to voice
−4	Deep sedation	No response to voice, but any movement to physical stimulation
−5	Unarousable	No response to voice or physical stimulation

Procedure

1. Observe patient. Is patient alert and calm (score 0)?
   Does patient have behavior that is consistent with restlessness or agitation (score +1 to +4 using the criteria listed above, under DESCRIPTION)?
2. If patient is not alert, in a loud speaking voice state patient's name and direct patient to open eyes and look at speaker. Repeat once if necessary. Can prompt patient to continue looking at speaker.
   Patient has eye opening and eye contact, which is sustained for more than 10 seconds (score −1).
   Patient has eye opening and eye contact, but this is not sustained for 10 seconds (score −2).
   Patient has any movement in response to voice, excluding eye contact (score −3).
3. If patient does not respond to voice, physically stimulate patient by shaking shoulder and then rubbing sternum if there is no response to shaking shoulder.
   Patient has any movement to physical stimulation (score −4).
   Patient has no response to voice or physical stimulation (score −5).

sequence of ICUs were intentionally varied for testing, which was done on six separate occasions from May to September 1999.

To begin RASS testing, five investigators (two physicians [C.N.S. and M.S.G.], two nurses [M.J.G. and P.V.O.], and one pharmacist [G.M.B.]) observed the patient's level of alertness and presence of agitated behavior for 30 seconds (step 1) (Table 1). If the patient did not meet criteria for levels 0 through 4, the principle investigator (PI) (C.N.S.) spoke loudly to the patient, instructing him or her to open his or her eyes and look at the PI, as all investigators observed closely (step 2). If the patient did not sustain eye contact for more than 10 seconds, this step was repeated. If no patient movement was observed, the PI physically stimulated the patient while calling his or her name, by gently shaking the shoulder, followed by rubbing the sternum if no patient movement to shaking was observed. The PI marked a 10-cm visual analog scale anchored by the terms "combative" and "unresponsive." All investigators independently recorded a RASS score.

Phase 2

This validation study evaluated inter-rater reliability after implementation of RASS into a medical ICU in December 1999. All medical respiratory ICU bedside nurses had previously attended in-services on RASS and had previously administered RASS to ICU patients while being supervised by a nurse educator (K.A.K.). The same exclusion criteria as in the first study applied, except isolation patients were included. In consecutive medical respiratory ICU patients, the bedside nurse performed RASS testing and recorded a score, whereas the nurse educator observed and recorded a RASS score. Within 15 minutes of RASS testing, the bedside nurse recorded a Glasgow Coma Scale score (28) using routine medical respiratory ICU policy, and the PI assessed a Ramsay sedation scale score (29) and Sedation–Agitation Scale (30) score. Specific criteria for Glasgow Coma Scale, Ramsay sedation scale, and Sedation–Agitation Scale are displayed in the appendix and in recently published reviews (11, 24, 25).

Data Collection

Clinical data, including age, gender, use of mechanical ventilation, and dosage and route of administration of sedative and analgesic medications within 8 hours of RASS testing, were recorded. Clinical and laboratory data were collected for the 24-hour period preceding each patient encounter, and an Acute Physiology and Chronic Health Evaluation II severity of illness score (31) was calculated.

Statistical Analysis

RASS data are displayed with mean ± SD, as well as median and interquartile range. Although RASS is ordinal, it has 10 defined levels and, consequently, could be treated as continuous data. The interclass correlation coefficient is used to measure the amount of agreement between raters for continuous data, and the weighted κ is used for ordinal or categorical data. We used both the interclass correlation coefficient and weighted κ to test inter-rater reliability (32). Generally, the interclass correlations are significantly larger than the κ. A κ of more than 0.8, more than 0.6, and more than 0.4 is considered to have "almost perfect," "substantial," and "moderate" agreement, respectively (33). The lower 90% confidence limit for interclass correlations is displayed in parenthesis. The 95% confidence intervals for κ values are displayed in parenthesis. Because the RASS data are not normally distributed, the association between RASS and the visual analog scale, Sedation–Agitation Scale, Ramsay sedation scale, and Glasgow Coma Scale score is done using Spearman's ρ. Comparisons of RASS values for *a priori* identified subgroups are done using the nonparametric Wilcoxon rank sum test; $p < 0.05$ was accepted as statistically significant. JMP version 4.0.5 and SAS version 8.02 (both from SAS Institute, Inc., Cary, NC) statistical programs were used to perform statistical analyses.

RESULTS

Phase 1

A total of 246 consecutive ICU patient encounters were evaluated for enrollment, and 54 patient encounters were excluded (17 medical respiratory ICU, 22 surgical trauma ICU, 12 neuroscience ICU, 3 coronary ICU, and 0 cardiac surgery ICU patients) for the following reasons: 42 patients had airborne or contact precautions, 3 had impaired vision, 4 were receiving a neuromuscular blocking agent or were quadriplegic, and 5 were deemed to be poor candidates in the judgment of the bedside nurse. One hundred ninety-two patient encounters in 172 patients (age 56.0 ± 16.4 years, 102 men and 70 women) were evaluated. The characteristics of the 192 adult ICU patient encounters are displayed in Table 2. The 958 RASS scores (two missing values) ranged from −5 to +3. Forty-three percent of RASS scores were in the sedation range (−5 to −1); 44% were

TABLE 2. PHASE 1 STUDY RICHMOND AGITATION–SEDATION SCALE SCORES, INTER-RATER RELIABILITY TESTING, AND VALIDITY TESTING ACROSS PATIENT ENCOUNTER SUBGROUPS

Population	Number	RASS				Inter-rater Reliability		Correlation of RASS and VAS‡
		Mean ± SD		Median IQR		ICC*	κ†	
All	192	−0.96	1.67	−0.1	−1.8, 0	0.956 (0.948)	0.73 (0.71, 0.75)	0.93
Age, yr								
< 40	36	−1.04	1.92	0	−2.7, 0	0.973 (0.960)	0.74 (0.69, 0.79)	0.94
40–64	91	−0.98	1.59	−0.2	−1.4, 0	0.963 (0.952)	0.76 (0.73, 0.80)	0.97
> 64	65	−0.88	1.65	0	−1.9, 0.1	0.937 (0.914)	0.67 (0.63, 0.71)	0.95
Sex								
Male	114	−1.06	1.84	−0.1	−1.2, 0	0.970 (0.962)	0.76 (0.73, 0.78)	0.97
Female	78	−0.81	1.40	−0.1	−2.2, 0	0.922 (0.898)	0.68 (0.65, 0.72)	0.91
APACHE II (14.7 ± 7.0)§								
< 10	47	−0.38	1.25	0	−1, 0	0.962 (0.946)	0.78 (0.73, 0.84)	0.84
10–14	51	−0.77	1.38	−0.2	−1.2, 0	0.950 (0.929)	0.74 (0.69, 0.78)	0.89
15–18	44	−0.86	1.58	−0.4	−1.7, 0	0.950 (0.929)	0.70 (0.65, 0.74)	0.97
> 18	50	−1.77	2.06	−1.6	−4, 0	0.951 (0.931)	0.67 (0.63, 0.71)	0.98
Intensive Care Unit‖								
MRICU	39	−1.31	1.75	−1	−2, 0	0.976 (0.965)	0.81 (0.76, 0.86)	0.96
NSICU	51	−1.54	1.94	−1.2	−3.6, 0	0.943 (0.921)	0.64 (0.60, 0.68)	0.97
STICU	23	−0.33	1.45	0	−1, 0.2	0.952 (0.922)	0.76 (0.69, 0.82)	0.97
CSICU	28	−1.11	1.65	−0.2	−2.5, 0	0.951 (0.924)	0.67 (0.61, 0.73)	0.97
CICU	51	−0.30	1.07	0	−0.4, 0	0.937 (0.913)	0.73 (0.67, 0.78)	0.84
Service								
Surgical	81	−1.07	1.75	−0.6	−2.4, 0	0.956 (0.943)	0.76 (0.73, 0.78)	0.94
Nonsurgical	111	−0.87	1.67	0	−1.8, 0	0.956 (0.945)	0.69 (0.66, 0.72)	0.93
Mechanical ventilation¶								
Present	67	−1.67	1.89	−1.8	−3.6, 0	0.955 (0.940)	0.68 (0.65, 0.71)	0.97
Absent	125	−0.58	1.41	0	−1, 0	0.949 (0.937)	0.74 (0.71, 0.77)	0.89
Sedative or analgesic medication								
Administered	91	−1.07	1.80	−0.4	−2.2, 0	0.970 (0.961)	0.76 (0.73, 0.79)	0.94
Not given	101	−0.86	1.55	0	−1.2, 0	0.940 (0.924)	0.69 (0.66, 0.72)	0.92
Sedative or analgesic infusion‖								
Administered	25	−2.25	2.20	−3	−4, −0.5	0.983 (0.972)	0.82 (0.77, 0.88)	0.97
Not given	166	−0.77	1.50	0	−1.2, 0	0.943 (0.931)	0.70 (0.68, 0.73)	0.96

Definition of abbreviations: CICU = coronary ICU; CSICU = cardiac surgery ICU; ICC = intraclass correlation coefficient; MRICU = medical respiratory ICU; NSICU = neuroscience ICU; RASS = Richmond Agitation–Sedation Scale; STICU = surgical trauma ICU; VAS = Visual Analogue Scale.

One hundred nineth-two patient encounters in 172 patients.

* Interclass correlation coefficient with lower 90% confidence limits in parentheses.

† Weighted κ with upper and lower 95% confidence intervals in parentheses.

‡ Spearman's rank sum ($p < 0.0001$ for all comparisons).

§ $p < 0.05$, Wilcoxon rank sum test.

‖ $p < 0.001$, Wilcoxon rank sum test.

¶ $p < 0.0001$, Wilcoxon rank sum test.

zero, and 10% were in the agitation range (+1 to +3). The distribution of the RASS scores from 192 patient encounters is displayed in Figure 1. RASS scores are displayed for important subgroups of adult ICU patients in Table 2. RASS scores were lower for mechanically ventilated than nonventilated patients ($p < 0.0001$) and for patients receiving continuous infusion sedative or analgesic medication ($p < 0.001$). Lower RASS scores were found as Acute Physiology and Chronic Health Evaluation II scores increased ($p < 0.05$). RASS scores varied among ICUs ($p < 0.001$). There was no difference for RASS scores based on age, gender, clinical service, or use of any sedative or analgesic medication.

Excellent inter-rater reliability was demonstrated for RASS among the entire adult ICU population (intraclass correlation = 0.956 [0.948]) (κ = 0.73 [0.71, 0.75]). Similarly, inter-rater reliability was high (r = 0.922–0.983) (κ = 0.64–0.82) for all subgroups (Table 2). Inter-rater reliability was high for all pair-wise comparisons between investigators (r = 0.944–0.973) (κ = 0.65–0.80) (Table E1). All five investigators selected the same score in 60.4% of cases, four of five investigators in 21.4%, and three of five investigators in 15.1%; thus, there was agreement among the majority of investigators in 97% of cases (Figure 1). All five investigator scores were within one RASS point in 95% of the

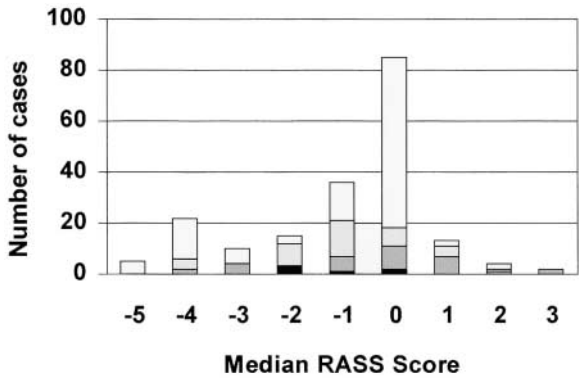

Figure 1. Investigator agreement in RASS scoring for 192 patient encounters. RASS score is displayed as the median value of the five investigators' scores for each individual patient encounter. *Shaded stacked columns* correspond to number of cases with the stated level of investigator agreement for the same RASS score (*box with white fill* = five of five investigators, *light gray fill* = four of five investigators, *dark gray fill* = three of five investigators, and *black fill* = two of five investigators). Total column height corresponds to the total number of patient encounters with the specified median RASS score.

TABLE 3. PHASE 2 RICHMOND AGITATION-SEDATION SCALE SCORES AND INTER-RATER RELIABILITY TESTING AFTER RICHMOND AGITATION-SEDATION SCALE IMPLEMENTATION IN A MEDICAL INTENSIVE CARE UNIT

		RASS				Inter-rater Reliability	
Population	Number	Mean ± SD		Median IQR		ICC*	κ†
All	101	−1.18	1.69	−0.5	−2, 0	0.964 (0.950)	0.80 (0.69, 0.90)
Age‡							
< 40	29	−0.45	1.17	0	−1, 0	0.910 (0.827)	0.75 (0.55, 0.96)
40–64	45	−1.51	1.74	−0.5	−3.75, 0	0.972 (0.953)	0.76 (0.60, 0.91)
> 64	27	−1.35	1.83	0	−4, 0	0.975 (0.948)	0.89 (0.68, 1.00)
Sex							
Male	48	−0.88	1.53	0	−1, 0	0.941 (0.904)	0.76 (0.60, 0.91)
Female	53	−1.42	1.77	−0.5	−3.25, 0	0.980 (0.967)	0.82 (0.69, 0.96)
APACHE II§ (16.0 ± 6.2)							
< 12	24	−0.29	0.99	0	−0.75, 0	0.886 (0.773)	0.78 (0.53, 1.00)
12–15	26	−0.33	1.03	0	−0.625, 0	0.916 (0.837)	0.69 (0.48, 0.89)
16–20	29	−1.41	1.57	−1	−2.5, 0	0.948 (0.900)	0.77 (0.59, 0.96)
> 20	22	−2.77	1.78	−4	−4, −0.875	0.987 (0.970)	0.85 (0.60, 1.00)
Mechanical ventilation§							
Present	63	−1.74	1.80	−1.5	−4, 0	0.965 (0.946)	0.82 (0.60, 0.94)
Absent	38	−0.21	0.79	0	−0.5, 0	0.883 (0.801)	0.66 (0.44, 0.88)
Sedative or analgesic medication‖							
Administered	46	−1.63	1.61	−1	−3, 0	0.960 (0.934)	0.81 (0.67, 0.95)
Not given	55	−0.77	1.63	0	−1, 0	0.965 (0.943)	0.76 (0.60, 0.92)
Sedative or analgesic infusion‖							
Administered	42	−1.64	1.62	−1.25	−3, 0	0.957 (0.927)	0.79 (0.65, 0.94)
Not given	59	−0.82	1.63	0	−1, 0	0.967 (0.947)	0.78 (0.63, 0.94)

Definition of abbreviations: APACHE II = acute physiology and chronic health evaluation; ICC = intraclass correlation coefficient; IQR = interquartile range; RASS = Richmond Agitation–Sedation Scale.

One hundred one patient encounters in 30 patients.

* Correlation between RASS scores by nurse educator and bedside nurses (n = 27) by intraclass correlation coefficient with lower 90% confidence limits in parentheses.

† κ with upper and lower 95% confidence intervals in parentheses.

‡ $p < 0.05$, Wilcoxon rank sum test.

§ $p < 0.0001$, Wilcoxon rank sum test.

‖ $p < 0.01$, Wilcoxon rank sum test.

cases. As a measure of validity, the mean RASS score recorded for four investigators correlated highly ($r = 0.93$, $p < 0.0001$) with a sedation–agitation visual analog scale score measured by the PI. Strong correlations ($r = 0.84$–0.98, all $p < 0.0001$) between investigator RASS and visual analog scale score confirmed validity of RASS for all ICU subgroups (Table 2). RASS scores recorded by individual physician, nurse, and pharmacist investigators correlated highly with the PI's visual analog scale score ($r = 0.91$–0.93, all $p < 0.0001$) (Table E1).

Phase 2

The characteristics of 101 medical respiratory ICU patient encounters are displayed in Table 3. Thirty patients (age 52 ± 15 years, 18 men and 12 women) were studied. Mean RASS measured by the nurse educator was −1.18 ± 1.69 and by the bedside nurses was −1.14 ± 1.69. The averages of the RASS scores recorded by the nurse educator and bedside nurse are displayed for subgroups in Table 3. Lower RASS scores were demonstrated for patients receiving mechanical ventilation ($p < 0.0001$), receiving sedative or analgesic medication ($p < 0.01$), with higher Acute Physiology and Chronic Health Evaluation II scores ($p < 0.0001$), and with an age of more than 40 years ($p < 0.05$). As a measure of inter-rater reliability after implementation of RASS into clinical practice within the medical respiratory ICU, the correlation between the nurse educator and the trained bedside nurses (n = 27) was 0.964 (0.950) (κ = 0.80 [0.69, 0.90]). The agreement was high for all subgroups tested, ranging from 0.883 to 0.987 (κ = 0.69–0.90) (Table 3). Data for RASS performed by the nurse educator and RASS performed by the bedside nurses (n = 27) in patient encounters (n = 101) are displayed in Figure 2. Validity of RASS after implementation is demonstrated by strong correlations between RASS and the Sedation–Agitation Scale score (30) ($r = 0.78$, $p < 0.0001$), Ramsay sedation scale score (29) ($r = -0.78$, $p < 0.0001$), and Glasgow Coma Scale score (28) ($r = 0.79$, $p < 0.0001$). Individual data for paired observations of RASS with the Sedation–Agitation Scale score and Ramsay sedation scale score in medical ICU patient encounters (n = 101) are displayed in Figures E1 and E2.

DISCUSSION

Our goals in the multidisciplinary development and validation of RASS were to establish a clinically useful tool to assess the level of consciousness and agitated behavior in ICU patients that might guide sedation therapy and improve communication among healthcare providers. We placed emphasis on ease of use

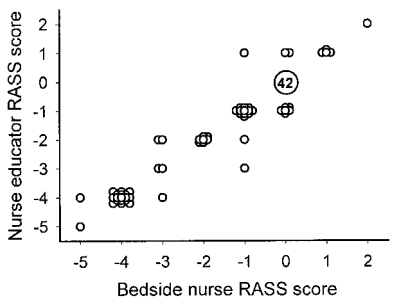

Figure 2. Display of concomitant RASS scores by a nurse educator and by bedside nurses (n = 27) in medical ICU patient encounters (n = 101). *Open circles* represent each individual patient encounter. The number within *large open circles* represents the total number of observations when greater than 20 observations are present.

and clarity. RASS has a single-item numerical structure, avoiding the complexity of summing multiple subscale scores (28, 34, 35). In contrast to some scales, no intervention that requires equipment, such as tracheal suctioning, is done (35–37). RASS can be administered in 30–60 seconds, using three sequential steps: observation, response to auditory stimulation, and response to physical stimulation. Although two different conditions, sedation and agitation, are evaluated in a single scale, the sequential approach establishes a single score by first assessing agitation and then assessing sedation. Furthermore, the use of positive numbers for agitation and negative numbers for sedation offers a logical approach to enhance recall while permitting a robust 10 levels for evaluation of response.

RASS was designed to have precise, unambiguous definitions for levels of sedation that rely on an assessment of arousal, cognition, and sustainability using common responses (eye opening, eye contact, physical movement) to common stimuli (spoken voice, physical stimulation) presented in a logical progression. This approach is patterned in part after Ramsay (29) sedation scale testing in which the response to voice or physical stimulation (light glabellar tap) is subjectively assessed (brisk, sluggish, no response). This is in contrast to the Sedation–Agitation Scale and the Motor Activity Assessment Scale tools (19, 30) in which each sedation level requires a combination of several responses and/or the selection of one criterion from as many as four criteria. The use of multiple or compound criteria increases the likelihood that patient behavior satisfies multiple levels (23).

An important goal of RASS development has been to establish sufficient levels of sedation to permit more precise medication titration. Recent successful sedation management protocols have used specific sedation targets, that is, Ramsay = 3 or 4 (22) and Ramsay = 3 (15) for all patients. Newer guidelines recommend that the benefit of protocols might be enhanced by using patient-specific sedation targets, as the relative need for sedation can vary widely among patients as well as over time for an individual patient (11, 12). RASS has five levels of sedation in addition to level 0 that corresponds to a calm, alert state. The Ramsay sedation scale (29) has three "asleep" levels and three "awake" levels, whereas the Sedation–Agitation Scale (30) and the Motor Activity Assessment Scale (19) have three sedation levels plus one level for a calm state. Because a target of light to moderate sedation is common for mechanically ventilated patients (15, 22), RASS was designed to offer multiple levels (0 to −3) within this range. This important range of responses is condensed into one or two sedation levels in other scales (19, 29, 30). Although RASS correlated well with Ramsay score, the 39 patients who had a Ramsay score of three ("patient responds to commands only") had six different RASS scores ranging from +1 to −4 (Figure E1). Similarly, despite the good correlation between RASS and the Sedation–Agitation Scale, the patients who had a Sedation–Agitation Scale score of three (sedated, "difficult to arouse, awakens to verbal stimuli or gentle shaking but drifts off again, follows simple commands") received RASS scores ranging from +1 to −4 (Figure E2). Thus, RASS offers broader discrimination in the commonly used mild-to-moderate sedation range.

A perceived limitation of the widely used Ramsay sedation scale (29) is the lack of sufficient measure of agitation (24). Similar to recently developed scales (19, 30), RASS contains several levels of agitation. RASS has a logical progression from "restlessness" (+1), which has no immediate impact on patient outcome, to "agitated" (+2), which includes patient–ventilator dyssynchrony, to "very agitated" (+3), with immediate risk to patient or staff through tube or catheter removal or aggressive behavior. The highest agitation level is "combative" (+4), which although rare denotes immediate danger for staff from violent patient behavior and has important implications for care of such patients. Documentation of agitated behavior can help guide evaluation for treatable causes of agitation and delirium (38, 39), as well as assess response to therapy (10, 11).

We performed rigorous testing of inter-rater reliability and validity in nearly 300 patient encounters with more than 1,100 RASS measurements. Good inter-rater reliability has also been demonstrated in adult ICU patients for the Ramsay sedation scale (30), the Sedation–Agitation Scale (30, 40–42), the Motor Activity Assessment Scale (19, 43), and the New Sheffield Sedation Scale (44). In contrast to most other studies that used two raters, we demonstrated reliability among five investigators, including critical care physician, nurse, and pharmacist investigators, illustrating the multidisciplinary applicability of RASS.

Inter-rater reliability of RASS was very good for all important subgroups of adult ICU patients tested, including patients from medical, surgical, cardiac surgery, coronary, and neuroscience ICUs. We demonstrated very good reliability for mechanically ventilated patients and patients breathing without ventilatory support, answering criticisms of validation testing of other tools (27). Furthermore, RASS has high inter-rater reliability for patients who received sedative medications, including by infusion, and for nontherapeutically sedated patients. Thus, RASS has high inter-rater reliability for virtually all categories of adult ICU patients. Although the Sedation–Agitation Scale has also been tested in multiple ICU populations, most other sedation scales have been validated in only mechanically ventilated patients in a medical or surgical ICU (19, 40–43, 45). In our phase 2 study, we extended our evaluation of reliability to include bedside nurses after implementation of RASS in our medical ICU. These findings are confirmed by Ely and colleagues who in preliminary studies demonstrated high inter-rater reliability of RASS ($r = 0.96$) for medical ICU nurses (46). Similar results after implementation are reported for the Sedation–Agitation Scale (40).

Because no reference standard exists for sedation, validation of RASS was performed by correlating it with a visual analog scale anchored by "combative" and "unresponsive" and with previously published instruments to measure level of consciousness in ICU patients. The correlation between RASS and the visual analog scale was excellent for all investigators. The correlation between RASS and the visual analog scale was high for patients from all ICUs, patients who were ventilated and nonventilated, and patients who were sedated and nonsedated. When tested in 101 medical ICU patients, RASS correlated highly with the Ramsay sedation scale, the Sedation–Agitation Scale, and the Glasgow Coma Scale scores offering additional support for construct validity of RASS. In work published in abstract form, Ely and colleagues also demonstrated a strong correlation between RASS and the Glasgow Coma Scale ($r = 0.93$) as well as modified bispectral array electroencephalography ($r = 0.70$) (46, 47). The Sedation–Agitation Scale has also been validated against visual analogue scale (40), the Ramsay sedation scale and the Harris scale (41), and with bispectral array electroencephalography (48). The Motor Activity Assessment Scale correlated significantly with the visual analog scale as well as changes in blood pressure and heart rate and agitation events (19).

There are several potential limitations of RASS and our validation studies. First, RASS relies on patient auditory and visual acuity and is not suitable for patients with severe impairments. Second, some patients may be sleeping or sedated but respond to auditory or physical stimulation violently. Although such patients would receive a RASS score in the sedation range, our nurses also note the excessive response and consider it in their medication titration. In validation testing, we recognize that there were relative few patient encounters for which agitation

was demonstrated. Nevertheless, there was majority agreement among five investigators for all 19 phase 1 cases and complete agreement for the 5 phase 2 cases in which median RASS was +1 to +3. We *a priori* treated each patient encounter as an independent observation, but recognize that measures of association (interclass correlation, κ, Spearman's ρ) could be upwardly biased by using repeated observations of some patients. However, when recalculated using only each patient's first encounter ($n = 172$ in phase 1, $n = 30$ in phase 2), these measures of association were essentially unchanged from the full data set. Finally, responsiveness, or the extent to which an instrument can detect important changes in sedation (25), was not tested. Responsiveness has not, to our knowledge, been tested for any sedation scale in an ICU population (25).

In summary, RASS is an instrument to assess sedation and agitation of adult ICU patients that is simple to use and has discrete criteria and sufficient levels for sedative medication titration and agitation evaluation. We have demonstrated very good inter-rater reliability and validity across a broad spectrum of adult ICU patients, including after implementation of RASS. Our multidisciplinary approach to development and validation should enhance acceptance by ICU physicians, nurses, and pharmacists.

Acknowledgment: The authors are grateful for the enthusiastic support of the staff nurses of the medical respiratory ICU at the Virginia Commonwealth University Health System.

References

1. Hansen-Flaschen JH, Brazinsky S, Basile C, Lanken PN. Use of sedating drugs and neuromuscular blocking agents in patients requiring mechanical ventilation for respiratory failure: a national survey. *JAMA* 1991;266:2870–2875.
2. Christensen BV, Thunedborg LP. Use of sedatives, analgesics and neuromuscular blocking agents in Danish ICUs 1996/97: a national survey. *Intensive Care Med* 1999;25:186–191.
3. Magarey JM. Sedation of adult critically ill ventilated patients in intensive care units: a national survey. *Aust Crit Care* 1997;10:90–93.
4. Carrion MI, Ayuso D, Marcos M, Paz Robles M, de la Cal MA, Alia I, Esteban A. Accidental removal of endotracheal and nasogastric tubes and intravascular catheters. *Crit Care Med* 2000;28:63–66.
5. Fraser GL, Prato BS, Riker RR, Berthiaume D, Wilkins ML. Frequency, severity, and treatment of agitation in young versus elderly patients in the ICU. *Pharmacotherapy* 2000;20:75–82.
6. Boulain T. Unplanned extubations in the adult intensive care unit: a prospective multicenter study: association des Reanimateurs du Centre-Ouest. *Am J Respir Crit Care Med* 1998;157:1131–1137.
7. Sessler CN, Rutherford L, Best A, Hart R, Levenson J. Agitation in a medical intensive care unit: prospective analysis of incidence and risk factors [abstract]. *Chest* 1992;102:192S.
8. Sessler CN, Glass C, Grap MJ. Unplanned extubation: incidence, predisposing factors, and management. *J Crit Illness* 1994;9:609–619.
9. Marcy TW, Marini JJ. Respiratory distress in the ventilated patient. *Clin Chest Med* 1994;15:55–73.
10. Cohen IL, Gallagher TJ, Pohlman AS, Dast JF, Abraham E, Papadakos PJ. The management of the agitated ICU patient. *Crit Care Med* 2002; 30:S97–S125.
11. Jacobi J, Fraser GL, Coursin DB, Riker RR, Fontaine D, Wittbrodt ET, Chalfin DB, Masica MF, Bjerke HS, Coplin WM, *et al.* Clinical practice guidelines for the sustained use of sedatives and analgesics in the critically ill adult. *Crit Care Med* 2002;30:119–141.
12. Sessler CN, Grap MJ, Brophy GM. Multidisciplinary management of sedation and analgesia in critical care. *Semin Respir Crit Care Med* 2001; 22:211–225.
13. Nasraway SA. Use of sedative medications in the intensive care unit. *Semin Respir Crit Care Med* 2001;22:165–174.
14. Kress JP, Hall JB. Cost considerations in sedation, analgesia, and neuromuscular blockade in the ICU. *Semin Respir Crit Care Med* 2001;22: 199–209.
15. Brook AD, Ahrens TS, Schaiff R, Prentice D, Sherman G, Shannon W, Kollef MH. Effect of a nursing-implemented sedation protocol on the duration of mechanical ventilation. *Crit Care Med* 1999;27:2609–2615.
16. Kollef MH, Levy NT, Ahrens TS, Schaiff R, Prentice D, Sherman G. The use of continuous i.v. sedation is associated with prolongation of mechanical ventilation. *Chest* 1998;114:541–548.
17. Slomka J, Hoffman-Hogg L, Mion LC, Bair N, Bobek MB, Arroliga AC. Influence of clinicians' values and perceptions on use of clinical practice guidelines for sedation and neuromuscular blockade in patients receiving mechanical ventilation. *Am J Crit Care* 2000;9:412–418.
18. Bair N, Bobek MB, Hoffman-Hogg L, Mion LC, Slomka J, Arroliga AC. Introduction of sedative, analgesic, and neuromuscular blocking agent guidelines in a medical intensive care unit: physician and nurse adherence. *Crit Care Med* 2000;28:707–713.
19. Devlin JW, Boleski G, Mlynarek M, Nerenz DR, Peterson E, Jankowski M, Horst HM, Zarowitz BJ. Motor activity assessment scale: a valid and reliable sedation scale for use with mechanically ventilated patients in an adult surgical intensive care unit. *Crit Care Med* 1999; 27:1271–1275.
20. Costa J, Cabre L, Molina R, Carrasco G. Cost of ICU sedation. *Clin Intensive Care* 1994;5:17–21.
21. Devlin JW, Holbrook AM, Fuller HD. The effect of ICU sedation guidelines and pharmacist interventions on clinical outcomes and drug cost. *Ann Pharmacother* 1997;31:689–695.
22. Kress JP, Pohlman AS, O'Connor MF, Hall JB. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med* 2000;342:1471–1477.
23. Hansen-Flaschen J, Cowen J, Polomano RC. Beyond the Ramsay scale: need for a validated measure of sedating drug efficacy in the intensive care unit. *Crit Care Med* 1994;22:732–733.
24. Riker RR, Fraser GL. Monitoring sedation, agitation, analgesia, neuromuscular blockade, and delirium in adult ICU patients. *Semin Respir Crit Care Med* 2001;22:189–198.
25. De Jonghe B, Cook D, Appere-De-Vecchi C, Guyatt G, Meade M, Outin H. Using and understanding sedation scoring systems: a systematic review. *Intensive Care Med* 2000;26:275–285.
26. Murdoch S, Cohen A. Intensive care sedation: a review of current British practice. *Intensive Care Med* 2000;26:922–928.
27. Lieberman J, Tremper KK. Sedation: if you do not know where you are going, any road will get you there. *Crit Care Med* 1999;27:1395–1396.
28. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. *Lancet* 1974;2:81–84.
29. Ramsay MA, Savege TM, Simpson BR, Goodwin R. Controlled sedation with alphaxalone-alphadolone. *BMJ* 1974;2:656–659.
30. Riker RR, Picard JT, Fraser GL. Prospective evaluation of the sedation-agitation scale for adult critically ill patients. *Crit Care Med* 1999;27: 1325–1329.
31. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med* 1985;13:818–829.
32. Fleiss JL. The design and analysis of clinical experiments. New York; John Wiley and Sons; 1986.
33. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–174.
34. Macnab AJ, Levine M, Glick N, Susak L, Baker-Brown G. A research tool for measurement of recovery from sedation: the Vancouver Sedative Recovery Scale. *J Pediatr Surg* 1991;26:1263–1267.
35. Hartwig S, Roth B, Theisohn M. Clinical experience with continuous intravenous sedation using midazolam and fentanyl in the paediatric intensive care unit. *Eur J Pediatr* 1991;150:784–788.
36. O'Sullivan G, Park G. The assessment of sedation in critically ill patients. *Clin Intensive Care* 1990;1:116–122.
37. Harris C, O'Donnell C, Macmillan R, Mostafa S. Use of propofol by infusion for sedation of patients undergoing haemofiltration: assessment of the effect of haemofiltration on the level of sedation and on blood propofol concentration. *J Drug Dev* 1991;4:37–39.
38. Hart RP, Levenson JL, Sessler CN, Best AM, Schwartz SM, Rutherford LE. Validation of a cognitive test for delirium in medical ICU patients. *Psychosomatics* 1996;37:533–546.
39. Ely EW, Inouye SK, Bernard GR, Gordon S, Francis J, May L, Truman B, Speroff T, Gautam S, Margolin R, Dittus R. Delirium in mechanically ventilated patients: validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). *JAMA* 2001;286:2703–2710.
40. Brandl KM, Langley KA, Riker RR, Dork LA, Quails CR, Levy H. Confirming the reliability of the sedation-agitation scale administered by ICU nurses without experience in its use. *Pharmacotherapy* 2001;21: 431–436.

41. Riker RR, Fraser GL, Cox PM. Continuous infusion of haloperidol controls agitation in critically ill patients. *Crit Care Med* 1994;22:433–440.
42. Riker RR, Fraser GL, Simmons LE, Wilkins ML. Validating the sedation-agitation scale with the bispectral index and visual analog scale in adult ICU patients after cardiac surgery. *Intensive Care Med* 2001;27: 853–858.
43. Hogg LH, Bobek MB, Mion LC, Legere BM, Banjac S, VanKerkhove K, Arroliga AC. Interrater reliability of 2 sedation scales in a medical intensive care unit: a preliminary report. *Am J Crit Care* 2001;10:79–83.
44. Olleveant N, Humphris G, Roe B. A reliability study of the modified new Sheffield Sedation Scale. *Nurs Crit Care* 1998;3:83–88.
45. Riker RR, Fraser GL, Richen P. Movement disorders associated with withdrawal from high-dose intravenous haloperidol therapy in delirious ICU patients. *Chest* 1997;111:1778–1781.
46. Ely EW, Gautam S, May L, Truman B, Francis J, Margolin R, Dittus B, Speroff T, Bernard G, Sessler C. A comparison of different sedation scales in the ICU and validation of the Richmond Agitation Sedation Scale (RASS) [abstract]. *Am J Respir Crit Care Med* 2001;163:A954.
47. Ely EW, Truman B, May L, Nielsen-Bohlman L, Gautam S, Dittus R, Speroff T, Bernard G. Validating the bispectral EEG for ventilated ICU patients [abstract]. *Am J Respir Crit Care Med* 2001;163:A899.
48. Simmons LE, Riker RR, Prato BS, Fraser GL. Assessing sedation during intensive care unit mechanical ventilation with the Bispectral Index and the Sedation-Agitation Scale. *Crit Care Med* 1999;27:1499–1504.