

# The Norton scale is an independent prognostic marker for mortality in critically ill patients

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## Abstract

The Norton scale (NS) is a widely used instrument to estimate the risk for pressure ulcers in adult, hospitalized patients. Lower NS scores, with the cut-off less than 15, indicate higher risk for pressure ulcer development. The NS assesses 5 domains: mental condition, physical condition, mobility, activity in daily living and incontinence. However, its discriminatory power to predict pressure ulcers is rather low. Since the NS reflects the patients' daily functioning it might be an independent risk factor of outcome of patients in the Intensive Care Unit (ICU), apart from the severity of acute critical illness scores.

We therefore performed a single center retrospective study in critically ill patients who were admitted to a tertiary intensive care unit in 2021. NS scores and patients' characteristics and outcomes were collected from computerized databases. The primary outcome was 90-day mortality.

Of the 2271 patients who were admitted to the ICU in 2021, 1889 patients were included, of which the NS was measured upon admission (83%). In this cohort, the mean age was 64 years, the Apache III score 59 and the Charlson Comorbidity index 4.4. Increased risk for pressure ulcers (NS  $\leq$  14) was detected in 9.7% of patients. Patients with a NS  $\leq$  14 were older, more severely ill upon admission and had more comorbidities. The 90-day mortality was 32% in the NS  $\leq$  14 group and 11.6% in the NS of more than 14 group ( $p < 0.0001$ ). A reduction in one point in the NS score was inversely associated with a relative increase in mortality by 13%. Furthermore, when corrected for disease severity and comorbidity, NS  $\leq$  14 was still independently associated with lower survival (OR 0.47 (0.32-0.70)).

NS may be an independent prognostic marker for mortality in critically ill patients and could be used in prognostication for critically ill patients. These findings need to be confirmed in prospective, multicentric observational studies.

**Keywords:** Intensive Care Unit, Critical Illness, Predictive Value of Tests, Risk Assessment, Retrospective Studies.

## Introduction

Functional status and baseline health status have been recently identified as important independent prognostic baseline characteristics for outcome in critically ill patients<sup>1</sup>. Whereas the overall baseline functioning of the patient has long been recognized as an important prognostic factor for outcome in geriatric patients, a phenomenon called frailty, it has only been recently identified as an important independent determinant of prognosis in critically

ill patients. Therefore, ongoing awareness of frailty and the use of its scores upon admission to the intensive care unit (ICU) is gaining support. Specific frailty scores are available, but unfortunately not yet routinely implemented upon ICU admission.

The Norton Scale was a score developed in the 1960s and is widely used around the world to assess the risk for pressure ulcers in adult hospitalized patients<sup>2</sup>. It assesses 5 domains of global health and functioning, notably physical functioning, mental condition, activity level, mobility level and (in)

continence. Each domain is scored between 1 and 4 and subsequently added together for a total that ranges between 5 to 20. A lower Norton score indicates higher levels of risk for pressure ulcers (Norton 1962). A score of less than 15 is considered to be high risk<sup>2</sup>. The Nortons scale has been validated in the setting of intensive care and is used in many intensive care units to this day. Assessing the risk for pressure ulcers has also been included in quality initiatives in Belgium<sup>3-5</sup>.

Since the Norton scale combines several important subdomains of functional status and baseline health, it could potentially give information, besides the risk of pressure ulcers, to the intensivist about the functional status of the patient and hence the expected clinical outcomes. Indeed, several studies have shown that lower scores of NS are associated with increased mortality rates in various populations<sup>6-9</sup>. Integrating functional data on the patient, routinely and systematically collected by the nursing staff, could enrich the predictive models in the ICU, based only on medical data. Therefore, we aimed to assess whether the NS could be positioned as a prognostic marker for mortality in critically ill adults.

## Materials and methods

### Ethical Committee

Synaps Park 1, 3600 Genk. The study received protocol number Z-2025020 and was approved by the chairman Dr. Patrick Noyens on 19 March 2025.

### Study design

We performed a retrospective cohort study in all patients admitted to the 40-bed ICU of Ziekenhuis Oost-Limburg, a large tertiary teaching hospital between 1st of January 2021 until 31st of December 2021. Data have been collected in the framework of the MICA program and the legal framework of Zorginspectie. All electronic medical files of patients who were admitted in 2021 were analyzed. All patients who had a complete Norton Score were included in this study. The NS scores were collected upon admission by the nursing team from the patient or its family if the patient weren't able to answer the questions.

The NS score is the sum of 5 subdomains that are all scored between 1 and 4 on a Likert scale. A score of 1 represents a worse state and 4 points the best. Scored domains are physical condition, mental condition, activity, mobility and incontinence. Total score ranges from 5 to 20 points. A NS score lower or equal than 14 points is considered to be a high risk for the development of pressure ulcers<sup>2</sup>. The score can be found in Figure 1.

The data were analyzed as follows; (1) the Norton's total score as a continuous variable (2) two groups according to a NS cut-off point of 14 and (3) domains of the Nortons score.

The primary outcome was mortality at 90 days. Secondary outcomes were ICU mortality, ICU length of stay and hospital length of stay.

### Statistical analysis

Statistical analysis of the data was performed using JMP Pro, version 17 software (SAS Institute, Cary, NC, USA). Categorical data are represented as numbers and proportions, and compared by A Chi-square test. The distribution of continuous data was analyzed, represented as either mean  $\pm$  SD or median and IQR and compared by Student t-test or Mann-Whitney U-test, respectively. Neither multiple data imputation for missing values, nor correction for multiple testing was done.

Correlations were calculated by univariate regression analysis. Multivariable logistic regression analysis for 90-day mortality was performed including the APACHE III score, the Charlson Comorbidity Index and the Norton score. The area under the receiver operating characteristic (ROC) curve (AUROC) and the misclassification rate were reported. The lack of fit-test (Hosmer-Lemeshow) was performed to estimate calibration. Analyses were performed in JMP Pro, version 14.1.0 (SAS Institute Inc, Cary, NC, USA). For each test, a two-sided p-value  $<0.05$  was considered statistically significant.

## Results

### Study population

Of the 2271 patients admitted to the ICU in 2021, 1888 patients had a completed Norton Scale score

Punt	Physical function	Mental/cognitive state	Activity	Mobility	Incontinence
1	Slecht	Onbewust	Bedgebonden	Immobiliteit	Volledig
2	Matig	Verward	Stoelgebonden	Ernstig beperkt	Geregeld
3	Redelijk	Apathisch	Ambulant met hulp	Licht beperkt	Af en toe
4	goed	Goed	Ambulant	Volledig	niet

Fig. 1 — The Norton Scale in Dutch as was taken at the bedside of the patient.

upon admission (83,13%). The mean age of this cohort was 64 +/- 16 years and 1332 (59%) of them were male. The median Charlson Comorbidity (CCI) score was 4 (IQR 2-6) and the mean Apache III score was 60 +/- 24. The median Norton total score was 20 (IQR 15-20) (Table I).

### High- versus low-risk group

Using a Nortons score of 14 as a cut-off point, we identified a “high risk group”, having a NS ≤14, and “low risk group”, having a NS >14. Of the 1888 patients, 183 patients (9,7%) had a Norton score ≤14. This group was generally older, had more comorbidities, as shown by a higher CCI score, and were more severely ill, as shown by a higher APACHE III score (Table I).

The high-risk group had a prolonged ICU and hospital stay with a respective average stay of 6,4 and 25,8 days, as compared to 3,8 and 15,8 days in the low-risk group (p<0.0001). The mortality rate was also threefold higher in the high-risk group as compared to the low-risk group, with a 90-day mortality rate of 32% in the high-risk group (p=0.0001).

Using a logistic regression model accounting for comorbidities and severity of illness, we could identify the Norton score as an independent variable for 90 days survival with an odds ratio of 1,13 (1,08 to 1,18), meaning that every point increase in Norton score was associated with a relative 13% more change in survival. The lack of fit test was not significant (P=1), suggesting good calibration. Furthermore, having a Nortons score ≤14 was associated with an OR of 0,47 (0,32-0,70) for 90 days survival, meaning that belonging to the high-risk group was associated with 53% less chance of survival. The lack of fit test was not significant (P=0.89), suggesting good calibration.

### Domains of the Norton scale

The distribution of the scores in each domain of the NS is presented in Table III. Lower scores were most prevalent in the physical condition, activity and mobility domain with more than 30% patients having less than 4 points. Lower scores were least prevalent in the mental/cognitive state and incontinence domain, with more than 85% of

**Table I.** — Baseline characteristics of the total patient sample and the groups divided in a high risk versus low risk NS score using a NS score of 14 as a cut-off.

Characteristic		Total group N=1889	Norton>14 N=1706	Norton≤14 N=183	
<b>Demographics</b>					
	Age, years (Mean;SD)	64 (15)	63 (15)	67 (13)	0.0005
	Norton total score (Mean;SD)	18,19 (2,90)	18,96(1,5)	11,03(3,03)	<0,0001
	Sex, Male (%)	1125 (59%)	90 (49%)	1035 (60%)	0.003
<b>Co-morbidity</b>					
	CCI score (Mean; SD)	4,45 (3,14)	4,39 (3,11)	5,11 (3,35)	0.006
<b>Type of admission– no. (%)</b>					
	Emergency surgery	300 (15%)	253 (14%)	47 (25%)	
	Planned surgery	940 (50%)	919 (54%)	21 (11%)	
	Medical	641 (34%)	526 (30%)	115 (62%)	
<b>Admission diagnosis system – no. (%)</b>					
	Cardiovascular	651 (34%)	623 (36%)	29 (15%)	
	Gastro-intestinal	193 (10%)	171 (10%)	22 (12%)	
	Genito-utinary	46 (0,2%)	40 (2%)	6 (3%)	
	Hematological	9 (0,4%)	8 (0,4%)	1 (0,5%)	
	Metabolic	26 (0,1%)	21 (1%)	5 (2%)	
	Musculoskeletal/skin	56 (0,2%)	54 (3%)	2 (1%)	
	Neurological	407 (21,6%)	353 (20%)	54 (29%)	
	Respiratory	433 (23%)	380 (22%)	53 (28%)	
	Trauma	55 (0,2%)	44 (2%)	11 (6%)	
Apache III score	Mean (SD)	59 (21)	57 (20)	76 (27)	<0.0001
SAPS III score	Means (SD)	62 (12)	60 (12)	72 (12)	<0.0001
BMI	Mean (SD)	27 (6)	27 (5)	27 (10)	0.47

**Table II.** — Outcome measures of the total patient sample and the groups divided in a high risk versus low-risk NS score using a NS score of 14 as a cut-off.

Outcome		Total group N=1889	Norton>14 N=1706	Norton≤14 N=183	
Length of ICU stay, days	Median (IQR)	4.1 (7.2)	3.8 (6.8)	6.4 (10.3)	0.0001
Length of Hospital stay, days	Median (IQR)	16.8 (23.7)	15.8 (23)	25.8 (28.3)	0.0001
ICU mortality	Number of deceased patients (%)	127 (6%)	101 (5%)	26 (14%)	0.0001
90-day mortality	Number of deceased patients (%)	258 (13%)	198 (11%)	60 (32%)	0.0001

**Table III.** — The distribution of the domain's grades of the total patient sample.

	Physical function	Mental/cognitive state	Activity	Mobility	Incontinence
Score					
1	50 (2,6%)	25 (1,3%)	111 (5,8%)	77 (4%)	73 (3,8%)
2	132 (6,9%)	61 (3,2%)	74 (3,9%)	103 (5,4%)	44 (2,3%)
3	490 (25,9%)	76 (4%)	417 (22%)	432 (22,8%)	154 (8,1%)
4	1217 (64%)	1727 (91%)	1287 (68,1%)	1277 (67,6%)	1618 (85,5%)

**Table IV.** — The relative risk for 90-day mortality by NS domains score. In Dutch as was taken at the bedside of the patient.

		Odds ratio 90 days survival	P value
Physical function			
	Slecht	0.45 (0.18;1.12)	0.08
	Matig	0.23 (0.14;0.39)	<0.0001
	Redelijk	0.53 (0.37;0.75)	0.0005
	goed	1 (ref)	
Mental/cognitive state			
	onbewust	0.20 (0.06;0.60)	0.004
	verward	0.74 (0.36;1.49)	0.4
	apathisch	0.49 (0.26;0.92)	0.02
	goed	1 (ref)	
Incontinence			
	Volledig	2.26 (0.95;5.33)	0.06
	Geregeld	1.55 (0.63;3.82)	0.33
	Af en toe	0.62 (0.39;0.97)	0.04
	Niet	1 (ref)	

the patients receiving 4 points, being the maximum score.

Using a logistic regression model, again accounting for comorbidities and severity of illness, we could only identify three domains of the Norton scale that were independently associated with 90 days survival, being physical function, incontinence and mental/cognitive state. Odds ratios for 90 days survival depending on score in these three domains can be found in Table IV.

Next, we evaluated whether adding these three domains to a logistic regression model for mortality prediction, in which CCI and Apache III were used, would increase the performance of this model. Adding these three domains to the

logistic regression model increased the AUC of the ROC curve from 0,78 to 0,81, indicating a better performance of this model. The misclassification rate was 239 patients out of 1888 (12.6%).

## Discussion

This study was able to show that the Norton Score (NS), being a pressure ulcer risk score, can be used as an independent prognostic marker for mortality in critically ill patients. Every point decrease in the NS, while correcting for baseline characteristics and severity of illness, was associated with a relative 13% decrease in survival. These findings correlate with prior research, correlating the Norton scale to

mortality in other populations. Specifically, this association has been established in general internal medical and cardiology departments, in patients undergoing certain interventional cardiologic procedures and in patients receiving surgery for hip fractures or lower limb amputation<sup>10-17</sup>. Whereas the NS consists out of 5 domains, only 3 domains were independently associated with 90 days survival, being physical function, incontinence and mental/cognitive state. This suggests that these 3 domains reflect the baseline health status of the patient. These 3 domains also improved the prognostic model for mortality in this patient cohort. These findings suggest that the NS can be a valuable tool to improve prognostic stratification in critically ill patients and can be easily implemented, since many ICU determine this risk score already. It should be noted that, although our findings indicate that the NS may serve as a prognostic marker for mortality in ICU patients, its applicability is limited by the scope of the assessed domains. Prior established independent risk factors, such as mechanical ventilation, are not considered in the score. Other validated scoring systems and variables can therefore still provide additional insight and aid in clinical decision-making<sup>20-22</sup>.

Baseline functional status, which can be defined as the physical, physiological and cognitive reserve, is an important baseline characteristic of critically ill patients. A status or syndrome of reduced physical, physiological and cognitive reserve is described with the term frailty<sup>18</sup>. Although frailty has long been recognized in geriatric medicine, it has only been recently identified as a determinant of prognosis in critically ill patients<sup>1</sup>. Whereas routine measurement of frailty could provide clinicians with important prognostic information for survival and recovery, routine measurement of frailty upon ICU admission isn't currently implemented. Interestingly, the NS scores several domains that assess these physical, physiological and cognitive reserves and it has been suggested that the NS could be used to quantify frailty<sup>7,19</sup>. Indeed, in our study patients with a low NS were generally older, had more comorbidities and were more severely ill upon admission, suggesting that these patients were indeed frail. Our findings therefore further support that the NS could potentially be used to identify frail patients. However, in our study, validated frailty scales, such as the Frailty Index or the Clinical Frailty Scale, weren't routinely determined, so a comparison between validated frailty scores and the NS couldn't be performed.

Interestingly, frailty has been associated with increased mortality in critically ill patients and the NS has been associated with survival in several

disease states, however, to our knowledge, the NS as a prognostic tool hasn't been evaluated in the setting of ICU<sup>1,6-9</sup>. Our study was able to show that the NS was indeed associated with survival, with lower NS scores associated with decreased survival. When correcting for baseline comorbidities and severity of disease, the NS remained an independent prognostic marker for mortality in critically ill patients. This suggests that the baseline functional status of patients admitted to the ICU is indeed an important prognostic factor<sup>1</sup>. Out of the 5 domains scored in the NS, especially the physical and cognitive function determined the outcome of critically ill patients.

Our study does have some limitations. This is a retrospective study from a single medical center, hence generalization of our findings could be limited. The NS used in this study weren't measured for research purposes and are real life data and could therefore be less reliable. Furthermore, since the NS were not determined in all the patients admitted to the ICU, only in 1889 of the 2271 admitted patients, there might be a selection bias. However, we do believe that the NS was calculated less frequently in the "less sick patients" and that hence such a bias, if existing, probably is an underestimation of the prognostic value of the NS. Another limitation is the missing data, which is due to the retrospective design of the study. No data imputation was used. As an additional result of the retrospective nature of the study, no data concerning baseline functionality or frailty was assessed, as this was not standard of care at the time of data collection. Whether the Norton scale may be a surrogate or an improvement of the frailty score needs to be assessed in future studies.

The NS is an independent prognostic marker for mortality in critically ill patients. Incorporating the NS in prognostic scores could assist the ICU physicians in better risk stratification and may help patients and their families to make better informed decisions about goals-of-care when they are critically ill. Therefore, since this score is already determined in many ICU's, we believe that the NS should be included in the risk assessment of ICU patients.

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