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Assessment of risk factors and test performance on malnutrition prevalence at admission using four different screening tools

Josefina Olivares[1], Luis Ayala[1], Jordi Salas-Salvadó[2], M.ª José Muñiz[1], Antoni Gamundí[3], Lorea Martínez-Indart[4] and Lluis Masmiquel L.[1]

[1]Servicio de Endocrinología y Nutrición. Hospital Son Llàtzer. Palma de Mallorca. [2]Unidad de Nutrición Humana. Hospital Universitari de Sant Joan de Reus. Facultad de Medicina y Ciencias de la Salud. Universitat Rovira i Virgili. CIBER Obesidad y Nutrición. Instituto Carlos III. [3]Laboratorio de Neurociencias. IUNICS-Universitat de les Illes Balears. Palma de Mallorca. [4]Unidad de Epidemiología Clínica. Hospital Universitario de Cruces. Servicio Vasco de Salud. Barakaldo. Bizkaia. Spain.

Abstract

Background & aims: **Malnutrition is very common in patients when admitted to the hospital. The aim of the present study was: a) to determine the prevalence of malnutrition at admission in a tertiary care hospital and identify risk factors for malnutrition, and b) to test the sensitivity and specificity of different screening tests for malnutrition compared to subjective global assessment (SGA).**

Methods: **We conducted a prospective study at 24h of admission in order to assess malnutrition in 537 adult subjects (56.4% males, mean age of 61.3±17.7 years) using 4 different screening tools: mininutritional assessment short form (MNA-SF), nutritional risk screening 2002 (NRS2002), malnutrition universal screening tool (MUST), and SGA. Anthropometrics and co-morbidities were registered.**

Results: **The overall rate of undernutrition was 47.3%. Specific rates were 54.2% in patients > 65y *vs.* 40.7% < 65y (p = 0.002) and 63.4% in medical *vs.* 34.0% surgical department (p < 0.001). Identified risk factors of malnutrition at admission were: the presence of heart disease (OR 1.74 CI 95% 1.16-2.60 p = 0.007) for MNA-SF (AUC 0.62); liver disease (OR 4.45 CI 95% 1.9410.22 p < 0.001), > 65y (OR 2.10 CI 95% 1.19-3.93 p = 0.011), medicine department (OR 3.58 CI 95% 1.93-6.62 p < 0.001) for SGA (AUC 0.96); lung disease (OR 3.34 CI 95% 1.45-7.73 p = 0.005), medicine department (OR 2.55 CI 95%1.09-5.98 p = 0.032) for NRS 2002 (AUC 0.97). Recent unintentional weight loss was a common factor.**

Conclusions: **Undernourishment at hospital admission is frequent. Comorbidities may contribute to the presence of undernutrition at admission. Nonetheless, SGA, NRS2002, MNA-SF or MUST can be used in our setting.**

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Correspondence: Josefina Olivares.
Servicio de Endocrinología y Nutrición.
Hospital Son Llàtzer.
Ctra. Manacor, km. 4.
07198 Palma de Mallorca. Spain.
E-mail: josefinaolivares@gmail.com

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VALORACIÓN DE LOS FACTORES DE RIESGO Y VALIDEZ DE CUATRO TESTS DE CRIBAJE SOBRE LA PREVALENCIA DE DESNUTRICIÓN AL INGRESO HOSPITALARIO

Resumen

Antecedentes y objetivos: **La desnutrición es muy frecuente en los pacientes que ingresan en el hospital. El objetivo de nuestro estudio es a) determinar la prevalencia de desnutrición al ingreso en un hospital de tercer nivel e identificar los factores de riesgo para desnutrición. b) Estudiar la sensibilidad y especifidad de diferentes test de cribado de desnutrición comparados con las valoración global subjetiva (VGS).**

Material y métodos: **Realizamos un estudio prospectivo a las 24 h del ingreso hospitalario a individuos (56.4% hombres con una edad media de 61,3 ± 17 años) utilizando 4 test de cribado diferentes: mininutritional assessment short form (MNA-SF), nutritional risk screening 2002 (NRS2002), malnutrition universal screening tool (MUST) y VGS. Además, se recogieron medidas antropométricas y comorbilidades.**

Resultados: **La prevalencia global de desnutrición fue de 47.3%. Las tasas específicas fueron 54,2% para > 65 años, 40,7% en < 65 años (p = 0,002), 63,4% en las áreas médicas, 34,0% áreas quirúrgicas (p < 0,001). Los factores que influían en la presencia de desnutrición al ingreso fueron: cardiopatía (OR 1,74 IC 95% 1,16-2,60 p = 0,007) en el MNA-SF (AUC 0,62); hepatopatía (OR 4,45 IC 95% 1.9410,22 p < 0,001), > 65años (OR 2,10 IC 95% 1,19-3,93 p = 0,011), áreas médicas (OR 3,58 IC 95% 1,93-6,62 p < 0,001) en la VGS (AUC 0,96); neumopatía (OR 3,34 IC 95% 1,45-7,73 p = 0,005), áreas médicas (OR 2,55 IC 95% 1,09-5,98 p = 0,032) en el NRS 2002 (AUC 0,97). La pérdida de peso involuntaria fue común a todos los test.**

Conclusiones: **La desnutrición es frecuente al ingreso hospitalario. La presencia de comorbilidades puede influir en la presencia de desnutrición al ingreso, sin embargo, podemos utilizar cualquiera de los tests propuestos para su detección en nuestro hospital.**

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Palabras clave: *Desnutrición. Prevalencia. Enfermedad crónica. Morbilidad.*

Abbreviations

MNA: Mini nutritional Assessment.
MNA-SF: Mini nutritional Assessment short form.
MUST: Malnutrition Universal Screening Tool.
NRS 2002: Nutritional risk Screening 2002.
SGA Suggestive Global Assessment.
BAPEN: British Association of parenteral and enteral nutrition.
ESPEN: European society for clinical nutrition and metabolism.
Yo: Years old.
BMI: Body mass index.
ROC: Receive operative curves.
AUC: Area under the curve.
CI: Confidence interval.
SPSS: Statistical Package for the Social Sciences.

Introduction

About 10-85% patients are undernourished when admitted to the hospital. Some data exist in relation to the prevalence of malnutrition in Spanish hospitals.[1-4] However, as well as surveys conducted in other countries,[5-6] a wide range of malnutrition prevalence has been reported, as a result of type of population or institution studied, expertise in screening or assessing nutritional status and tool used, but also on the different diagnostic criteria used to define nutritional status.[7]

Malnutrition is associated with many adverse outcomes including depression of the immune system, impaired wound healing, muscle wasting, longer lengths of hospital stay, higher treatment costs and increased mortality.[8-10] Referral rates for dietetic assessment and treatment of malnourished patients have proven to be suboptimal, thereby increasing the likelihood of developing such aforementioned complications. Nutrition risk screening using a validated tool is a simple technique to rapidly identify patients at risk of malnutrition, and provides a basis for prompt dietetic or specialized nutritional support referrals.[11,12]

Screening tools need to be low cost and time consuming, reliable, simple and adapted to the clinical setting where it will be used. Therefore, within last decades, several screening tools have been developed to detect malnutrition in worldwide hospitals, home care institutions and community patients. The most used tools in clinical practice are the Mininutritional Assessment (MNA) Test, the Malnutrition Universal Screening Tool (MUST), the Nutritional Screening Risk (NRS2002) and the Suggestive Global Assessment (SGA) tests. Each one of these screening tools have been developed to fit in a certain scenario and validated for this.

The MNA was developed to screen and assess frail elderly individuals living in community or hospitalized as a result of a decrease in caloric intake even before changes in weight or albumin occur.[13] The MUST was validated for home-dwelling population,[14] although it is now being also used for patients at hospital admission, and institutionalized individuals. The NRS-2002 was developed for inpatients and, the SGA screening tool, initially designed to screen surgical patients, it is now recognized as an accurate nutritional screening tool used as a gold standard test in many conditions.[15]

The primary objective of the present study was to estimate the prevalence of malnutrition at hospital admission in a randomized sample of patients from our hospital. We also aim to compare the predictive capability of different screening tools to evaluate malnutrition and identify the factors most likely to influence the nutritional state of our screened patients.

Individuals and methods

Patients

We conducted prospective study evaluating individuals at 24h of hospital admission in medical and surgical departments during the period March-June 2010. All adult individuals entering to Son Llatzer Hospital during this period were considered potential participants. Refusing to participate or to sign the informed consent has been considered exclusion criteria for the study. Patients admitted for major ambulatory surgery, eye surgery, or those admitted to the rheumatology, gynecology, obstetrics, psyquiatry departments or the intensive care unit were also excluded for the study.

The Son Llatzer Hospital Research Committee approved the study protocol and written informed consent was obtained in all subjects.

Anthropometric measurements and screening malnutrition tools used

Ad hospital admission, trained dietitians conducted the anthropometric measurements and assessed the risk of malnutrition using 4 different tools: MNA-SF, SGA, NRS2002, and MUST. Comorbidities were obtained by medical history and confirmed by medical records. Body height was measured to the nearest 0.5 cm with a stadiometer in patients who could stand, and recumbent height or alternatively, demispan calculated formula was used to estimate height in patients who were unable to stand up. Body weight was measured to the nearest 0.1 kg with a scale or hoist with attached weighing device for patients who were bed-ridden while subjects wore hospital gowns. The body mass index (BMI) was calculated as weight (kg) divided by height (m^2) (kg/m^2). If unable to measure height or weight, we used recently documented or self-reported measurements if they were realistic or reliable.

Percentage of weight loss was derived by the following equation: [(usual weight-current weight)/ current weight]* 100.

SGA questionnaire. The SGA test was performed as previously described,[11] classifying individuals as A = well nourished, B = suspected malnourished or moderately malnourished, and C = severely malnourished. This test was used as the gold standard for statistical analysis.[10]

Mininutritional Assessment short form questionnaire. The MNA test[8] was originally developed to detect the risk of malnutrition. However, we used the short-form that has also been validated[12,13] as a screening tool and shown as high sensitivity (97%) and specificity compared to the MNA full test.[14] With this questionnaire, patients were scored and classified as: 0-7, undernourished; 7-11, at risk of undernourishment; and 12-14, well nourished.

Nutritional Risk Screening 2002. The NRS-2002 was performed as described by ESPEN guidelines.[15] Thus, patients are classified as: without risk, 0; at low risk, 1-2; at medium risk, 3-5, and at high risk, > 5 of malnutrition.

Malnutrition Universal Screening Test. The MUST test was conducted accordingly to BAPEN guidelines.[16] The overall risk of undernutrition using this tool was classified as: 0, low risk; 1, medium risk; and > 2, high risk of malnutrition.

Risk factors for malnutrition assessment

The following factors have been considered *a priori* risk factors for malnutrition: age (> 65 years), sex, weight loss > 5% in previous 6 months, food intake below 75% of energy requirements one week prior to admission, type of diet (solid, liquid or puree), hospitalization or surgery 6 months prior to admission, and the intake of nutritional supplements before the hospital admission. The presence of the following disease comorbidities were also considered to potentially increase the risk of malnutrition: hypertension, diabetes mellitus, dyslipidemia and other reported chronic conditions such as: a) chronic heart disease (coronary heart disease, hypertensive myocardiopathy, moderate or severe valvulopathy), b) chronic pulmonary disease (obstructive or asthma), c) chronic liver disease of any etiology, and d) chronic kidney disease (eGFR < 60 ml/min/1.73m^2).

Statistical analysis

The sample size was calculated based on the 20-50% prevalence of hospital malnutrition in local studies carried out in different hospitals and regions in Spain with similar characteristics to ours. Based on estimated prevalence assuming of 20%, an accuracy of 3% and a significance level of 5%, an estimated 15% dropout, the final sample calculated was 599 patients to be included. 67 patients were not included in data analysis due to exclusion criteria (refusing to participate or not being able to answer questionnaires).

We classified patients into 2 groups based on malnutrition risk: undernourished (including those at risk of undernutrition, SGA = B + C, MNA-SF < 11 MUST < 1, NRS-2002 < 3) and well- nourished (when no risk of undernourishment was present). They were also reclassified as medicine and surgical patients according the hospital ward admitted. The qualitative variables were described in percentages and quantitative by means, standard deviation, and range values. The χ^2 test was used to compare two categorical variables, and the t-test to compare two continuous variables. Univariate and multivariate logistic regression analysis were used to assess the associations between malnutrition and potential risk variables. ROC curves were used to assess reliability of each test. Sensitivity, specificity and predictive values were calculated to evaluate the different nutritional scores. SGA was considered the gold standard test for statistical analysis. The *k* statistic was calculated to measure agreement between tools (STAT 509), and the Shrout classification was used to interpret the *k* values as follows: 0-0.1, virtually none; 0.11-0.40, slight; 0.41-0.60, fair; 0.61-0.80, moderate; and 0.81-1, substantial. Data were analyzed using the SPSS statistical package version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). The level of significance was set at 0.05.

Results

A total of 537 adult subjects (56.4% males, n = 303) with a mean age of 61.3 ± 17.7 years were assessed in medical (45%, n = 243) and surgical (55%, n = 294) wards. General physical characteristics of the population by gender are shown in table I.

No differences in general physical characteristics (sex, weight, height, BMI and body weight loss) between individuals of surgical and medical wards were shown except for age. Individuals admitted to medical wards were older (medical *vs.* surgical patients 68.1 ± 16.3 *vs.* 55.6 ± 16.8 years; P < 0.001). The most frequent comorbidities observed in our population were hypertension (38.7%), chronic heart diseases (29.7%), chronic lung diseases (29.5%), dyslipidemia (28.1%), and diabetes (20.9%). Table II shows the prevalence of comorbidities for medical and surgery patients. Type 2 diabetes mellitus, chronic heart and lung disease, and hospital admission in the last 6 month were significant more frequently observed in individuals admitted to the medical wards compared to those admitted to the surgical wards.

Table III shows the prevalence of malnutrition determined using different screening tools. The prevalence of malnutrition determined by the presence of at least one of malnutrition screening tool was 47.3%; 54.2% in patients older than 65 years *vs.* 40.7% in patients < 65 years old (P = 0.002). The prevalence of malnutrition determined by the presence of at least one of malnutrition screening tools was significantly different

Table I
General physical characteristics of participants

	Men (n = 303)		*Women (n = 234)*	
	Mean	*SD*	*Mean*	*SD*
Age (years)	61.5	17.65	60.98	17.56
Current weight (kg)	69.37	16.17	77.39	14.63
Usual weight (kg)	69.63	16.01	78.33	14.11
Height (cm)	157.65	7.75	169.75	8.04
Body mass index (kg/m^2)	27.9	6.12	26.82	4.55
Weight loss (%)	0.139	6.97	1.14	6.74

Weight loss was measured as: [(Usual weight-current weight)/current weight* 100).

Table II
Comorbidities present in the total population studied

	Medical wars (n = 243)			*Surgery wards (n = 294)*	
	Number	*%*		*Number*	*%*
Diabetes mellitus	73	30.0	39	13.3	< 0.000
Hypertension	102	42.0	106	36.1	0.161
Dyslipemia	74	30.5	77	26.2	0.274
Heart disease	115	47.3	44	15.0	< 0.000
Lung disease	127	52.3	31	10.6	< 0.000
Liver disease	22	9.1	26	8.8	0.932
Kidney disease	24	9.9	27	9.2	0.785
Surgical procedures < 6 months	28	11.5	44	15.0	0.244
Hospital admission < 6 months	92	37.9	78	26.5	0.005

Weight loss was measured as: [(Usual weight-current weight)/current weight* 100).

between medical and surgical patients, being higher in surgical patients (63.4% *vs.* 34.0%, P = < 0.001). The prevalence of malnutrition in those individuals older than 65 years was 31.8, 29.9, 28.4 and 23.9% by MNA-SF, SGA, NRS2002 and MUST, respectively. Accuracy values for different tests classified by age and type of wards are shown in table IV.

Specificity for NRS2002, MUST and MNA-SF were relatively high in overall the sample (> 90%), age category (> 90%) and type of wards groups (> 80%), although sensitivity was lower (between 59.7 and 84.9%). All the tests showed fair agreement with the subjective global assessment (considered the gold standard tool) except for MUST in case of < 65 year old (k = 0.464). Negative predictive values were also high in all the screening tests for different settings (between 91.5%- and 98.5%) except for medical wards (82.7% to 85.1%) and elderly individuals (82.3% to 89.6%). Positive predictive values were lower for NRS-2002 and MUST than MNA-SF in all settings. Comparison of AUC showed no differences among tests compared to SGA. In the multivariate analysis, factors associated to the presence of malnutrition at admission were the presence of heart disease (OR 1.74; 95% CI 1.16-2.60, P = 0.007) for the MNA-SF test (AUC = 0.62); liver disease (OR 4.45; 95% CI 1.94-10.22 P < 0.001), age > 65 years (OR 2.10; 95% CI 1.19-3.93 P = 0.011), medical wards (OR 3.58; 95% CI 1.93-6.62 P < 0.001) for SGA (AUC=0.97); lung disease (OR 3.34; 95% CI 1.45-7.73 P = 0.005), medical ward (OR 2.55 95% CI 1.09-5.98 P = 0.032) for NRS-2002 (AUC = 0.97). Recent unintentional weight loss was a common factor among SGA, NRS 2002 and MUST. Neither the rest of comorbidities nor the type of diet or previous nutritional support influenced the presence of malnutrition at admission.

Table III
Prevalence of manultrition using different screening tools

	MNA-SF	*SGA*	*NRS 2002*	*MUST*	*Any tool*[#]
Overall population					
Malnourished	17.7 (97)[+]	19.5 (107)	21.3 (115)	18.8 (102)	47.3 (254)
Wellnourished	82.3 (442)	80.4 (430)	78.7 (422)	81.2 (435)	52.7 (283)
Medical wards					
Malnourished	35.4 (86)	32.9 (80)	33.7 (82)	26.3 (64)	63.5 (154)*
Wellnourished	64.6 (157)	32.9 (163)	66.3 (161)	73.7 (179)	36.6 (89)
Surgical wards					
Malnourished	25.3 (74)	8.6 (25)	10.9 (32)	12.6 (37)	34.0 (100)
Wellnourished	74.7 (219)	91.4 (267)	89.1 (261)	87.4 (256)	66.0 (194)

MNA: Mini-nutritional assessment test; SGA: Subjective assessment questionnaire; NRS: Nutritional risk screening; MUST: Malnutrition universal screening test.
[#]Presence of malnutrition by using any tools.
[+]Expressed as percentage and (number).
χ^2 test (*P < 0.05 Medical *vs.* Surgical wards).

Table IV
Accuracy values for screening test compared to the Subjective Global Assessment test

	NRS 2002	*MUST*	*MNA-SF*
Overall			
Sensitivity	68.9% (59.4 %-77.1 %)	64.1% (54.5%-72.7%)	69.9% (60.5%-77.9%)
Specificity	90.1% (86.9%-92.6%)	91.9% (89.0%-94.1%)	94.7% (92.2%-96.4%)
NPV	92.4% (89.5%-94.6%)	91.5% (88.5%-93.8%)	93.0% (90.2%-95.0%)
PPV	62.3% (53.1%-70.6%)	65.3% (55.7%-73.9%)	75.8% (66.3%-83.3%)
k value	0.567	0.564	0.666
< 65 years (n = 265)			
Sensitivity	56.7% (39.2%-72.6%)	60.0% (42.3%-75.4%)	70.0% (52.1%-83.3%)
Specificity	97.9% (95.3%-99.1%)	91.8% (87.6%-94.6%)	95.1% (91.6%-97.2%)
NPV	94.8% (91.3%-96.9%)	94.4% (91.3%-97.1%)	96.3% (93.0%-98.0%)
PPV	77.3% (56.6%-89.9%)	47.4% (32.5%-62.7%)	63.6% (46.6%-77.8%)
k value	0.618	0.464	0.623
> 65 years (n = 272)			
Sensitivity	72.6% (61.4%-81.5%)	65.8% (54.3%-75.6%)	69.9% (58.6%-79.2%)
Specificity	90.1% (85%-93.5)	92.1% (87.4%-95.2%)	94.2% (90.0%-96.8%)
NPV	89.6% (84.5%-93.2%)	87.6% (82.3%-91.4%)	82.3% (71.0%-89.8%)
PPV	73.6% (62.4%-82.4%)	76.2% (64.4%-85.0%)	89.1% (84.1%-92.7%)
k value	0.629	0.605	0.672
Medicine wards (n = 243)			
Sensitivity	68.8% (57.8%-78.1%)	59.7% (48.6%-70%)	64.9% (53.8%-74.7%)
Specificity	82.5% (76.0%-87.6%)	89.7% (83.5%-93.0%)	92.2% (87.1%-95.4%)
NPV	85.1% (78.8%-89.8%)	82.7% (76.5%-87.5%)	85.0% (79.1%-89.5%)
PPV	64.6% (53.8%-74.1%)	71.9% (59.9%-81.4%)	79.4% (67.8%-87.5%)
k value	0.505	0.512	0.6
Surgery wards (n = 294)			
Sensitivity	69.2% (50%-83.5%)	76.9% (57.9%-89.0%)	84.6% (83.3%-98.0%)
Specificity	94.8% (91.4%-96.9%)	93.7% (90.1%-96.0%)	96.3% (93.3%-98.0%)
NPV	96.9% (94.1%-98.4%)	97.7% (95.0%-98.9%)	98.5% (96.1%-99.4%)
PPV	56.3% (39.3%-71.8%)	54.1% (38.4%-69.0%)	68.8% (51.4%-82.0%)
k value	0.508	0.593	0.733

NRS: Nutritional risk screening; MUST: Malnutrition universal screening test; MNA: Mini-nutritional assessment test; NPV: Negative predictive value; PPV: Positive predictive value.
[#]Expressed as percentage and 95% interval confidence.

Discussion

The present study is the first conducted in Spain assessing test performance and risk factors for malnutrition using four different screening tools. Our data confirm that NRS2002, MNA-SF, and SGA have high reliability as screening tools for patients admitted at a hospital and invalidate the MUST for that setting after adjusting for risk factors. Despite that, the MUST test sensibility, sensitivity, precision and validity have shown to be similar to previously described.[22,23] This is probably because, weight loss and BMI < 20 kg/m^2 (the 2 items of MUST test) are not frequent in our population as shown in our data.

Overall malnutrition rates are similar whatever different screening tools used in our study. Those rates are also similar to previously published in Spanish[1,4,21,24] and other developed countries using NRS2002[7,25,26] for similar level of healthcare. Likewise, a higher prevalence of malnutrition in medical ward was observed in our study compared to the surgery wards.[27,28] Recent unintentional total weight loss and chronic lung, heart and liver diseases have been delimitated as the most frequent risk factors influencing the prevalence of malnutrition at admission in our study. These risk factors for malnutrition also have been identified in some studies conducted in other hospitalized populations.[29-32]

Differences in the prevalence malnutrition identified by the SGA, MNA-SF and MUST screening tests could be explained by severity of underlying disease, population setting (homecare, free-living) and age of the population studied.[3] Therefore, those with end-stage disease, homecare and elderly being the most like to be undernourished when admitted at hospital.[33] The advanced stage of a chronic medical condition is characterized by an inflammatory status that enhances energy expenditure and decreases functional capacity which leads to an utterly loss of weight and cachexia.[34] Also, elderly patients, particularly those in a homecare setting, are commonly admitted in medicine wards.[35]

Our study has some limitations. It was conducted in a second level hospital from Spain; therefore, our results could not be extrapolated to other type hospitals from other countries. In addition, because our hospital is not the hospital of reference in our province, in our study we do not have assessed other high risk of malnutrition patients like transplants or surgery of the upper gastrointestinal track. Nevertheless, it is remarkable that we have screened 100% of the patients admitted in our hospital and thus, the sample it is representative of our population and permit to analyze the possible determinants of malnutrition in our hospital. Finally, our results are also consistent with Predyces, the only multicentric study performed in Spain.[24]

In conclusion, undernourishment at hospital admission is frequent. The results of our study suggest that for screening hospital malnutrition at admission, it can be used any of the listed screening test. Nonetheless, it's worth to mention that it is recommended to choose the easiest and less time consuming test. Therefore, we would recommend NRS2002 as the screening tool in our hospital accordingly to ESPEN guidelines.

Statement of authorship

All authors have made substantial contributions to all of the following: the conception and design of the study, acquisition of data, or analysis and interpretation of data; b) drafting the article or revising it critically for important intellectual content, and c) final approval of the version to be submitted.

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