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Development of the Diabetes Oral Health Assessment Tool © for Nurses

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Abstract

Although some studies have suggested a bidirectional relationship between diabetes and periodontal disease, there were no appropriate tools for nurses to evaluate oral status and oral health behaviors in patients with diabetes. Therefore, the Diabetes Oral Health Assessment Tool (DiOHAT©) was developed with items contributed by health care professionals (diabetologists, periodontal specialists, a preventive dentist, a Certified Nurse in Diabetes Nursing, a national registered dietitian, registered nurses, a dental hygienist, and nursing researchers) who were involved in the medical care of patients with diabetes. Subsequently, a survey of 700 Diabetes Nurse Specialists (DNS) was conducted to determine their score of recognition and implementation of the DiOHAT©, however, 304 participants (43.4%) responded. Constructive concept validation and the Cronbach's alpha coefficient for all assessment items was 0.932, indicating high reliability: Factor 1, Patient's oral health status (α = 0.874); Factor 2, Implementation of oral health behaviors (α = 0.890); Factor 3, Information transmission regarding dental visits (α = 0.862); and Factor 4, Perceptions and knowledge of oral health behaviors (α = 0.793). Although the mean score of recognition of DiOHAT© was 3.5 ± 0.4 points, the mean value of the implementation score was 1.5 ± 0.5

points (obtained using a 4-grade scale). The implementation scores were significantly lower than the recognition scores for all items ($p < 0.001$). The findings suggested that the DNS were not inclined to implement all items of DiOHAT©, despite recognizing their importance.

Keywords

Diabetes, Oral Health Behavior, Oral Status, Nursing Assessment, Diabetes Nurse Specialist

1. Introduction

It is becoming increasingly important worldwide to take critical measures to manage diabetes. In Japan, there are no signs of a decreasing prevalence of diabetes [1]. The continuing goal of treatment is to prevent or delay complications [2], which can be achieved via patients with diabetes (hereafter referred to as patients) self-care interventions. Patients need not only amend their diet, exercise, and medication but also consider how they can maintain their overall health. Diet therapy is a requirement for all patients. There have been many studies about the relationship between postprandial blood glucose levels and mastication [3]-[5]; eating vegetables before carbohydrate [6]; and higher masticatory performance and slow eating [7]. To implement these behavioral activities, patients need good oral health. The 2011 Survey of Dental Diseases [8] conducted in Japan showed that the percentages of those with the highest community periodontal index codes in permanent teeth were 74.2% (in total) and 86.7% (within the age group of 45 - 49 years old). In particular, patients are often susceptible to periodontal disease [9], which can be easily exacerbated [10] by oral health disease conditions. Periodontal disease is referred to as the sixth complication of diabetes [11] and its exacerbation has a negative influence on diabetes [12] [13]. It is therefore important that patients maintain good oral health behaviors to prevent periodontal disease from developing or if existing, from worsening.

In Japan, some attempts have been made to share patient information among medical staffs (e.g., internists, ophthalmologists, and dentists), who treat patients with diabetes by utilizing a diabetes information sharing notebook [14] [15]. Patients bring these notebooks to the medical staffs to report their physical conditions (e.g., hemoglobin A1c levels, retinopathy stage, periodontal disease stage). These surveys by a cooperative medical and dental team also clarified the association between periodontal disease and glycemic control [16].

In a study by nurses aimed to determine support of patients with difficulty maintaining good oral health, in addition to identifying the oral health behaviors and associated factors of the patients [17], the result indicated that it was important for nurses to understand both the perceptions [18] [19] and behaviors of their patients. To prevent severe diabetic complications, such as ischemic heart disease, the goal of oral health behaviors is to prevent the onset and/or worsening of oral diseases, including periodontal disease and dental caries, and their associated diseases [20]. It is also effective to ensure that patients receive appropriate dental care considering their current diabetic therapies.

Clarification of nurses' assessments of patient oral health behaviors will facilitate the provision of support to patients to conduct appropriate oral health behavioral assessments. Current oral health care assessments by Eilers' Oral Assessment Guide [21] and its revised versions [22]-[24] are often used as references. These are assessment methods for the oral cavity, especially for detecting mucositis in patients undergoing chemotherapy [25]-[27] or radiotherapy [28]. However, for nurses' use, there are no existing guidelines for assessing oral status and oral health behaviors of patients that consider diabetes treatment goals and current oral physical status.

The aims of this study were to develop the Diabetes Oral Health Assessment Tool (DiOHAT©) which enabled nurses to evaluate patients' oral status and oral health behaviors easily and simply, and to clarify how diabetes nurse specialists recognize the contents of DiOHAT© and the frequency of its use in the real world.

2. Methods

2.1. The Process to Develop the Diabetes Oral Health Assessment Tool (DiOHAT©) for Nurses

2.1.1. Identification of Items to Develop the DiOHAT©

From the literature reviews and preliminary survey interviews conducted, sources of items describing the oral

health status and oral health behaviors were identified to initiate the development of the DiOHAT©. Information derived from interviews with internists, dentists, and nurses who were working in medical or dental departments regarding patients' oral health status and oral health behaviors, were analyzed. From these sources, the draft DiOHAT© was developed.

2.1.2. Discussions among Interdisciplinary Team of Professionals

Discussions among members of the interdisciplinary team of professionals focused on determining the validity of the assessment items of the DiOHAT©. In a meeting conducted by health care professionals (including diabetologists, periodontal specialists, a preventive dentist, a Certified Nurse in Diabetes Nursing, a national registered dietitian, registered nurses, a dental hygienist, and nursing researchers), interdisciplinary approaches to support oral health behaviors for patients, and recognition of effective assessment ways were discussed. From this meeting, the assessment items were identified including terms depicting situations that predict periodontal disease and characteristics of diabetes treatments. Consequently, the draft of the assessment items was modified such that it would be possible for any nurses to easily conduct an efficient bedside assessment. There were more than 50 items in the initial assessment tool. However, after careful discussion and focused consideration, the final assessment items of the DiOHAT© were reduced to 21, comprising four assessment areas of concern, namely, "Patient's oral health status", "Patient's implementation of oral health behaviors", "Patient's visit to dental clinic", and "Patient's perceptions and knowledge of oral health behaviors".

2.1.3 Detailed Description of the Assessment Items

The items included in the area of "Patient's oral health status" are related to the main functions of the teeth and the oral cavity. These are basic items intended to assess mastication and swallowing, vocalization and pronunciation, facial appearance, and saliva secretion.

The items pertaining to "Patient's implementation of oral health behaviors" focused on whether patients are able to perform two critical actions for oral health by themselves: cleaning dental plaque (biofilms) from the surface of teeth (oral self-care), undergoing regular dental examinations and cleanings performed by dentists or dental hygienists (professional oral health care) for the prevention of cavities and periodontal disease.

The items pertaining to "Patient's visit to dental clinic" assessed whether or not patients are able to visit dentists and offer information regarding their therapies from the internists to dentists, and to relay that information to their medical staffs. The common complications of diabetes are incomplete healing of wounds [29] due to hyperglycemia associated with the onset and exacerbation of infectious disease and hypoglycemia caused by delayed or missed meals after the dental therapy, for example during interventions involving the use of anesthesia. In addition, when patients are given an anti-platelet agent, it is often difficult for bleeding to stop. It is also crucial that patients inform their dentists before therapy if they have any diabetes-related complications, such as hypertension and heart disease.

The items pertaining to "Patient's perceptions and knowledge of oral health behaviors" assessed how well the patients understand the close link between periodontal disease and diabetes, and the importance of oral health behaviors.

2.2. Diabetes Nurse Specialists' Recognition and Implementation of the Diabetes Oral Health Assessment Tool (DiOHAT©)

2.2.1. Participants of the Study

Three hundred four Certified Nurses in Diabetes Nursing and Certified Nurse Specialists in Chronic Care Nursing were recognized as Diabetes Nurse Specialists (DNS) in Japan. Seven-hundred self-administered questionnaires by anonymous form were mailed to the DNS. They agreed to participate in the survey and returned the questionnaires containing the demographic data sheet and the DiOHAT©. The data were collected from December 2014 to January 2015.

2.2.2. Instruments

In the questionnaire participants were asked to include their personal data such as age, gender, years of experience as a nurse, certifications as DNS, years passed since the acquisition of certifications, and presence or absence of a specialty outpatient department for diabetes in the clinics where they work.

A five-point Likert scale questionnaire was used with responses for each of the items of the DiOHAT©.

These items were focused on the necessity of patients' oral health behaviors. Recognition scores were set as follows: "not necessary at all, one point", "not very necessary, two points", "cannot determine, three points", "a little necessary, four points", and "very necessary, five points". Participants were asked to answer the frequency of implementation of the assessment within the last two weeks, by choosing one of four alternatives. Implementation scores were set as follows: "never, one point", "sometimes, two points", "often, three points", and "always, four points". It was found that the higher the score, the more the participants implemented and recognized the necessity of the assessment.

2.2.3. Methods of Analysis

The Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy for the factor analysis of the 21 items were calculated, and confirmed an appropriate value of 0.923. In addition, Bartlett's test of sphericity was used to confirm the validation of the factor analysis (chi-squared test value of 3702.6, $p < 0.001$). The factor analysis was conducted by adopting the principal factor analysis. Regarding the rotation method, the varimax rotation method supplemented with Kaiser Normalization test was used. The analysis was conducted by setting the four factors with the corresponding factor loadings of greater than 0.30 being adopted.

To compare the scores obtained for the recognition of the necessity of each assessment item (five-point scale) and those for implementation of the item (four-point scale), the modified scores for the recognition of necessity were obtained by multiplying these scores by 0.8. These scores were divided by the number of factors to obtain an average score, which was taken as the score for each factor. In order to compare the recognition and implementation of each assessment item, these were compared using paired t-test. The significance level was set at 5%. The IBM SPSS Statistics 19.0, 23.0 were used for the statistical analyses.

2.3. Ethical Considerations

This research was conducted with the approval of the clinical research ethics review board at Tokushima University Hospital Clinical Trial Center for Developmental Therapeutics (reference number 2042). The approval document states that cooperation with this research is on a voluntary basis, where completing the questionnaire is considered as approval, and cancellation of a response is not permitted because all responses are anonymous. Information for distribution of the questionnaires was obtained from the website of the Japan Nursing Association.

3. Results

3.1. Demographic Data (Table 1)

Out of the 700 questionnaire copies distributed to prospective participants, only 304 were returned and received. The return rate was 43.4%. The mean age of the participants was 41.7 ± 6.6 years. Most of them (74.7%) worked at the clinic/hospital with a specialty outpatient clinic for patients with diabetes. Although there were 277 Certified Nurses in Diabetes Nursing (CNDN), only 262 responded about the years of work after acquiring their certification. There were 29 Certified Nurse Specialists in Chronic Care Nursing (CNSCCN), but only 24 provided information about years or practice after acquisition of certification.

3.2. Factor Analysis of the ©Diabetes Oral Health Assessment Tool (Table 2)

Cronbach's alpha coefficient was 0.932, showing a high degree of reliability. As a result of the factor analysis, the following classifications were confirmed for the assessment items: Factor 1, Patient's oral health status ($\alpha =$ 0.874), seven items; Factor 2, Patient's implementation of oral health behaviors ($\alpha = 0.890$), six items; Factor 3, Patient's information transmission regarding dental visits ($\alpha = 0.862$), five items; and Factor 4, Patient's perceptions and knowledge of oral health behaviors ($\alpha = 0.793$), three items. Additionally, the researchers further considered the following points: whether the assessment items were easy to use and whether the content regarding professional oral health care was adequate.

3.3. Differences between Diabetes Nurse Specialists' Recognition and Implementation to Assess Patients' Oral Health Status and Behaviors (Table 3)

The average score for all items pertaining to recognition was 3.5 ± 0.4 points out of a possible 4. In particular,

Table 1. Characteristics of participants.

		n	(%)
Gender	Male/Female	13 / 290	4.3 / 95.4
	No description	1	0.3
Department (can be plural)	Ward	127	41.8
	Outpatient	132	43.4
	Diabetes nursing outpatient	68	22.4
	Others	39	12.8
Number of beds in the facility	1 - 19 beds	6	2.0
	20 - 199 beds	41	13.5
	200 - 499 beds	127	41.8
	More than 500 beds	123	40.5
	No description	7	2.3
Clinics opened in the hospital	Specialty outpatient clinic for diabetes	227	74.7

		n	M	SD
Age (years old)		295	41.7	6.6
Experience as a nurse (years)		301	18.6	6.5
Experience working as a nurse for diabetes patients (years)		295	11.6	4.6
After the acquisition (years) (can be plural)	Certified Nurses in Diabetes Nursing (N=277)	262	3.3	2.9
	Certified Nurse Specialists in Chronic Care Nursing (N=29)	24	3.5	2.4

N = 304, M: Mean, SD: Standard Deviation.

the items regarding "knowledge of a relationship between periodontal disease and systemic disease including diabetes (3.8 ± 0.4)" and "dental visiting more than once a year (3.7 ± 0.5)" scored very highly. In contrast, "counting the patient's total number of teeth (3.0 ± 0.8)", "checking the one's inside of mouth with a mirror by oneself (3.3 ± 0.6)", "biting firmly on molar or dentures (3.3 ± 0.6)", and "toothbrushing one by one very carefully (3.3 ± 0.6)", showed lower scores compared with the others.

The average total implementation score was 1.5 ± 0.5 points out of a possible 4. Those items with very low scores were as follows: "counting the patient's total number of teeth (1.2 ± 0.5)", "biting firmly on molar or dentures (1.3 ± 0.6)", "toothbrushing around the border between the teeth and marginal gingiva (1.3 ± 0.6)", "checking the one's inside of mouth with a mirror by oneself (1.3 ± 0.6)", and "toothbrushing one by one very carefully (1.3 ± 0.7)". In contrast, those items showing higher scores were as follows: "dentures (2.3 ± 1.1)", "knowledge of a relationship between periodontal disease and systemic disease including diabetes (2.0 ± 1.0)"; "dental visiting more than once a year (1.9 ± 1.0)"; and "showing diabetes information-sharing notebook to the dentist (1.7 ± 1.0)".

In the comparison between recognition scores and implementation scores, the latter were significantly lower for all factors ($p < 0.001$). Furthermore, for all items of the implementation scores were very low ($p < 0.001$).

4. Discussion

For all assessment items, Cronbach's alpha coefficient of reliability was 0.932, with the α-coefficients of the four factors ranked below ranging from 0.793 to 0.890, suggesting a rather high level of reliability of the items. The assessment items were confirmed to be reliable from a statistical point of view. In addition, it was considered clinical validity of the DiOHAT© is likely to be sufficient, because its items were developed based on agree-

Table 2. Result of factor analysis for assessment items for nurses (Row of factors after rotation).

Assessment Items	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: Patient's oral health status ($\alpha = 0.874$)				
Bleeding during toothbrushing	0.706	0.309	0.183	0.184
Abscess on gingiva	0.697	0.315	0.238	0.175
Awareness of halitosis	0.670	0.351	0.183	0.128
Dentures (partial or full)	0.633	0.134	0.081	0.283
Biting firmly on molar or dentures	0.603	0.237	0.239	0.188
Checking the patient's inside of mouth	0.555	0.263	0.073	0.255
Counting the patient's total number of teeth (dentures, bridges and implants are excluded)	0.446	0.136	0.104	0.135
Factor 2: Patient's implementation of oral health behaviors ($\alpha = 0.890$)				
Toothbrushing around the border between the teeth and marginal gingiva	0.302	0.853	0.160	0.230
Toothbrushing one by one very carefully	0.284	0.815	0.173	0.224
Supplementary tools (e.g., interdental brush, dental floss.)	0.346	0.762	0.152	0.095
Checking the one's inside of mouth (teeth, gums, buccal mucosa, and tongues) with a mirror by oneself	0.385	0.583	0.221	0.178
Experience being given dentists' instructions for brushing	0.366	0.400	0.368	0.143
Dental visiting more than once a year	0.169	0.333	0.270	0.243
Factor 3: Patient's information transmission regarding dental visits ($\alpha = 0.862$)				
Showing medicine information-sharing notebook to the dentist	0.090	0.100	0.761	0.089
Showing diabetes information-sharing notebook to the dentist	0.110	0.107	0.745	0.069
Showing self-monitoring blood glucose notebook to the dentist	0.079	0.186	0.728	0.124
Telling dental treatment to the diabetes doctor	0.241	0.154	0.685	0.190
Telling dental treatment to the diabetes nurse	0.354	0.142	0.595	0.240
Factor 4: Patient's perceptions and knowledge of oral health behaviors ($\alpha = 0.793$)				
Perceptions of one's oral health status	0.362	0.245	0.212	0.717
Perceptions of oral care efficacy regardless of timing of care initiation	0.300	0.271	0.239	0.578
Knowledge of a relationship between periodontal disease and systemic disease including diabetes	0.334	0.158	0.195	0.545

		Factor 1	Factor 2	Factor 3	Factor 4
Square sum of loading after rotation	Fixed value	3.847	3.321	3.168	1.769
	Cumulative rate (%)	18.321	34.133	49.217	57.640
Correlation factor between contents: significance probability (one sided test) Spearman	Factor 1	1.000			
	Factor 2	0.692	1.000		
	Factor 3	0.468	0.541	1.000	
	Factor 4	0.626	0.589	0.488	1.000

Method to select factors: Primary factor method. Barimax rotation method supplemented by a normalization of Kaiser rotation method. Cronbach's alpha coefficient (α) 0.932 for all assessment items.

Table 3. Comparison between recognitions and implementation of nursing specialists.

Assessment Items	Recognition		Implementation		t value[1]	p value[2]
	Mean	SD	Mean	SD		
Total score	3.5	0.4	1.5	0.5	54.4	**
Factor 1: Patient's oral health status	3.4	0.5	1.5	0.5	51.4	**
Bleeding during toothbrushing	3.5	0.6	1.5	0.7	42.8	**
Abscess on gingiva	3.4	0.6	1.4	0.7	42.6	**
Awareness of halitosis	3.3	0.7	1.4	0.7	40.8	**
Dentures (partial or full)	3.6	0.5	2.3	1.1	20.6	**
Biting firmly on molar or dentures	3.3	0.6	1.3	0.6	44.8	**
Checking the patient's inside of mouth	3.6	0.6	1.6	0.8	41.1	**
Counting the patient's total number of teeth (dentures, bridges and implants are excluded)	3.0	0.8	1.2	0.5	40.4	**
Factor 2: Patient's implementation of oral health behaviors	3.4	0.5	1.5	0.6	48.0	**
Toothbrushing around the border between the teeth and marginal gingiva	3.4	0.6	1.3	0.6	44.2	**
Toothbrushing one by one very carefully	3.3	0.6	1.3	0.7	43.0	**
Supplementary tools (e.g., interdental brush, dental floss)	3.3	0.7	1.4	0.7	39.0	**
Checking the one's inside of mouth (teeth, gums, buccal mucosa, and tongues) with a mirror by oneself	3.3	0.6	1.3	0.6	45.0	**
Experience being given dentists' instructions for brushing	3.4	0.6	1.5	0.8	37.4	**
Dental visiting more than once a year	3.7	0.5	1.9	1.0	31.1	**
Factor 3: Patient's information transmission regarding dental visits	3.5	0.5	1.6	0.7	42.5	**
Showing medicine information-sharing notebook to the dentist	3.5	0.6	1.6	0.9	36.0	**
Showing diabetes information-sharing notebook to the dentist	3.6	0.6	1.7	1.0	34.9	**
Showing self-monitoring blood glucose notebook to the dentist	3.3	0.7	1.5	0.8	35.8	**
Telling dental treatment to the diabetes doctor	3.6	0.6	1.7	0.9	34.1	**
Telling dental treatment to the diabetes nurse	3.4	0.6	1.4	0.8	38.8	**
Factor 4: Patient's perceptions and knowledge of oral health behaviors	3.7	0.4	1.7	0.7	44.2	**
Perceptions of one's oral health status	3.6	0.5	1.6	0.7	43.5	**
Perceptions of oral care efficacy regardless of timing of care initiation	3.5	0.6	1.5	0.7	42.3	**
Knowledge of a relationship between periodontal disease and systemic disease including diabetes	3.8	0.4	2.0	1.0	32.1	**

[1]Paired t-test. [2]**: $p < 0.001$.

ments among the diabetes health care professionals.

The DNS recognized most of the items to be "necessary". In particular, the following items were also found to be necessary: "knowledge of a relationship between periodontal disease and systemic diseases including diabetes", "dental visiting more than once a year", "perception of one's oral health status", "showing diabetes information-sharing notebook to the dentist", and "telling dental treatment to the diabetes doctor".

It was considered by DNS that communication with dentists is an important, and recognizing the importance of periodontal disease. In addition, for items such as "dentures (full/partial)", "knowledge of a relationship between periodontal disease and systemic disease including diabetes", and "dental visiting more than once a year", almost half of the DNS answered "yes". However, most of DNS didn't assess about patient's dental status and

functions, such as "counting the patient's total number of teeth", "checking the one's inside of mouth with a mirror by oneself", and "biting firmly on molar or dentures". Similarly, the items assessing the actual status of the implementation of oral health behaviors, such as "toothbrushing around the border between the teeth and marginal gingiva" and "toothbrushing one by one very carefully", showed lower scores. This showed that although they understood the basic concept of oral health behaviors, they have not yet confirmed what to do to avoid aggravation of dental status. Therefore oral education for nurses is important and oral assessment items are needed.

Regarding patients' feet, nurses often watch, care, and educate [30] patients to prevent foot ulcers. Similar to the case of foot care, it is easy to obtain information about the oral cavity by direct visual observation with penlight. Nurses' counting the number of teeth [31] is a useful method to assess the health of the oral cavity without any expertise required. It is possible to determine the trajectory of oral illness by the loss of teeth, due to periodontal disease or dental caries, which enables us to acquire important information to evaluate oral functions such as mastication. The loss of teeth reduces mastication ability, alters the senses in the oral cavity, and affects physical appearance. By counting the patients' total number of teeth, nurses can watch the position of the teeth and they can get the data of cleanliness of the oral cavity, too. Then it is possible to estimate the mastication function and implementation of oral health behavior. In addition, it is also reported that "total number of teeth" is linked to dementia [32], mortality [33], and quality of life [34].

Nurses are positively involved in solving problems associated with the oral cavity, as caused by systemic diseases. For example, when patients' suffering from chemotherapy induced oral mucositis [25]-[27], stroke care settings [35], in these patients situation, nurses have to provide oral care for such patients. In the textbooks used in fundamental nursing courses, there are few descriptions on dental mastication, which is a basic oral function, but there are instructions for classic tooth brushing. It is obvious that there is a need to strengthen the basic information on oral health assessment [36], which included occlusion and mastication.

Further discussions from the viewpoint of nursing education are necessary. Nurses need to assess the oral cavity of patients. Self-monitoring [37], (e.g., blood glucose, body weight, diet) is important for the patients. A positive involvement in oral care by nurses might provide good effects through patients' self-care. In addition, oral care by nurses is not appreciated enough in the Japanese medical insurance system; and foot care is rewarded by medical service fees to nurses: this is not the case for oral care. As Costello *et al.* [38] pointed out, while nurses appreciate the need for oral care, in reality they lack knowledge and experience about this area of care.

In the consideration of the oral health behavior of patients, it is essential to evaluate the number of existing teeth. Based on the results obtained, loss of any teeth increased the importance of the remaining teeth. Nurses need to collect comprehensive data to provide patients with appropriate oral care using evidence-based assessment tools. In checking the patients' oral cavity, the nurses evaluate their oral functions.

The findings of the study further showed that although the DNS recognized the usefulness of the assessment items, they were not inclined to perform them. These warrant further investigation.

5. Limitations

In this research study the response rate for returning the questionnaire was 43.4%, this was not satisfactory. In the future, it is necessary to clarify the problems occurring on the clinical sites clearer by utilizing these assessment items of DiOHAT© as a trial for examining the patients' oral health status and behaviors.

6. Conclusion

The DiOHAT© was developed with the four factors: Patient's oral health status, Patient's implementation of oral health behaviors, Patient's information transmission regarding dental visits, and Patient's perceptions and knowledge of oral health behaviors. These four factors were determined reliable and valid by factor analysis, and Cronbach's alpha coefficient of reliability of 0.932. However, DNS did not assess all items of oral health behaviors in the DiOHAT© despite being aware of the importance of the assessment items.

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Competing Interests

The authors declare that they have no competing interests for this article.

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