Archives of Rehabilitation Research and Clinical Translation (2020) 2, 100062

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Rehabilitation Research and Clinical Translation

Archives of Rehabilitation Research and Clinical Translation 2020;2:100062

Available online at www.sciencedirect.com

Original Research

A Feasibility Study Involving Recruitment and Screening for Aphasia in Acute Stroke: Emerging Viability of the English Adaptation of the Language Screening Test (LASTen)

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List of abbreviations: C-SLP, coordinating speech-language pathologist; LAST, Language Screening Test; LASTen, Language Screening Test, English; NVU, Neurovascular Unit; SLP, speech-language pathologist; TAMS, Transient Ischemic Attack and Minor Stroke.

H.L. Flowers received funding from the University of Ottawa, Faculty of Health Sciences, Ottawa, Ontario, Canada.
Disclosures: H.L. Flowers does not perceive a conflict of interest directly with the work for this study. However, after completing the data collection, she provided consultation services to Transperfect (June 2018) as a paid expert, providing suggestions to change items from an existing language tool for application to Canadian English. None of her proposed modifications reflected the content of LASTen. The other authors have nothing to disclose.
Presented to the Clinical Outreach Seminar, School of Communication Sciences and Disorders, February 26, 2018, McGill University, Montreal, Québec, Canada; the Canadian Partnership for Stroke Recovery, Stroke Program in Neurorecovery, June 14, 2018, University of Ottawa, Ottawa, Ontario, Canada; the Summer School, Rehabilitation Department, Laval University, June 27, 2018, Québec, Québec, Canada; and the Ottawa Stroke Summit, Champlain Stroke Network, November 2, 2018, Ottawa, Ontario, Canada.
Cite this article as: Arch Rehabil Res Clin Transl. 2020;2:100062.

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https://doi.org/10.1016/j.arrct.2020.100062

KEYWORDS
Aphasia;
Rehabilitation;
Stroke

Abstract *Objectives:* We describe recruitment feasibility for language screening in acute stroke using the English adaptation the Language Screening Test (LASTen), originally developed in French. We also elucidate preliminary measurement properties of LASTen in patients with and without aphasia.
Design: Prospective eligibility tracking, recruitment, and screening for aphasia using the 2 parallel forms, LASTen-A and LASTen-B.
Setting: The Neurovascular Unit and the Transient Ischemic Attack and Minor Stroke Unit of a tertiary care hospital.
Participants: Stroke patients (N = 12) with hyperacute to subacute stroke.
Interventions: Not applicable
Main Outcome Measures: Numbers of eligible patients and recruitment viability, individual performance indicators for both LASTen versions (15 points each) in 12 patients grouped by aphasia status, and reliability of the 2 parallel forms.
Results: There were 25 eligible stroke patients over 1 month. All 12 recruited patients consented to testing. The patients ranged in age from 29 to 85 years, and 5 were women. Three patients had intracerebral hemorrhage, and 6 had aphasia (mild to severe). The median LASTen scores in patients with and without aphasia were 10 (interquartile range, 8) and 15 (interquartile range, 0), respectively. Five patients had discrepant scores across versions involving a 1-point difference. One patient with aphasia had a 5-point difference, demonstrating improvement on the second version. The Pearson correlation coefficient was 0.95 for parallel form reliability.
Conclusions: Our study confirmed that LASTen appears to function as designed. There was score heterogeneity for patients with aphasia and desired ceiling effects for those without aphasia, alongside excellent parallel form reliability. The findings provide the impetus for a large-scale diagnostic accuracy trial in acute stroke patients.

Aphasia occurs in one-third of stroke patients,[1] often incurring a longer hospital stay[1] and an increased need for rehabilitation services.[1-3] Accurate screening has the potential to enhance early aphasia detection and management,[4] especially in complex patients with multiple co-occurring impairments. In fact, nearly one-third of patients with acute aphasia have concomitant dysarthria or dysphagia,[3] and 1 in 10 stroke patients has all 3 impairments.[3] Without routine referral processes, patients with aphasia requiring management by speech-language pathologists may remain unidentified by front-line health care professionals,[3,5] especially in the context of confounding co-occurring impairments.[5] Accordingly, stroke guidelines recommend aphasia screening and assessment in the acute stage and at transition points in care.[4] Screening is important for rapid identification of potential disease sequelae. Routine implementation of screening protocols may foster improved management involving timely assessment by specialists and comprehensive attention to multiple facets of patient care by the entire health care team.

A recently validated tool, the Language Screening Test (LAST),[6] initially developed in French, addresses the current need for a rapid accurate bedside aphasia screening tool.[6] The LAST has 2 parallel versions, permitting repeated testing in the acute stage and beyond.[6] More specifically, the LAST has excellent psychometric properties,[6,7] proven construct validity,[6] and is practical for routine use.[6] The constructs of the LAST include mental processing specific to language (therefore minimizing demands on memory or executive functions) in oral language modalities (ie, excluding reading or writing tasks).[6]

There are 5 subtests in the LAST within expressive (production) and receptive oral language (comprehension) indices.[6] The expressive index includes 3 subtests: picture naming (5 items), word and sentence repetition (2 items), and automatic speech (1 item).[6] The receptive index includes 2 subtests: picture identification (4 items) and verbal commands (3 items of increasing complexity).[6] Each correct item is accorded 1 point, for a total of 15 points per version (8 from the expressive and 7 from the receptive index).[6] However, there are 29 different items across the 2 versions, because the automatic speech item (expressive index) is identical in each.[6] Consequently, a maximum of 29 points are possible if the 2 versions are administered in rapid sequence (whereby only the first production of the automatic speech item is counted).

The LAST is practical, rapid, and easy to administer, requiring approximately 2 minutes per version.[6] The test is administered from a single sheet of paper with the expressive index on 1 side and the receptive index on the other.[6] The instructions and scoring are on the bottom third of each side of the paper, which is folded for examiner viewing only.[6] Other than a single sheet of paper, the examiner uses a pen and cup (LAST-A) and another piece of paper and a key (LAST-B) for the verbal commands subtest.[6] The LAST is limited to oral language and is, therefore,

appropriate for patients with visual impairments and for those with poor literacy. Overall, the LAST meets recent guidelines for developing routing screenings[8] and aphasia tests in any language.[9]

We recently adapted and harmonized the LAST for multiple English dialects (LASTen)[10] by conducting normative testing in 109 healthy adults in 4 countries: Australia, Canada, England, and the United States.[10] Testing demonstrated equivalent performance across dialects and comparable results on the LASTen-A and LASTen-B.[10] Nevertheless, participants with high school education (or less) made more errors than those who had completed community college or university programs.[10]

The LASTen still requires validation in acute stroke survivors to establish its psychometric properties and to determine appropriate cutoff scores according to education level. The purpose of the current study was to lay the groundwork for a future diagnostic accuracy trial by: (1) determining recruitment potential in acute stroke patients, (2) associating individual profiles with test performance according to aphasia status (presence vs absence), and (3) investigating parallel form reliability. Therefore, our overarching objectives were to ensure recruitment viability and to elucidate psychometric features of the LASTen that would support a future diagnostic accuracy trial in acute stroke patients.

Methods

We prospectively tracked eligibility and recruited patients admitted to the acute stroke units of a tertiary care hospital. The hospital's research ethics board approved the study protocol for the enrollment of 12 patients. We included patients who were at least 18 years of age, had a clinically or radiologically confirmed stroke, spoke English as a first and primary language, and who were alert for 30 minutes at a time or longer. We excluded patients with subarachnoid hemorrhage, history of neurologic disease other than stroke, premorbid dementia, medical instability, severe psychiatric disorders, or severe vision or hearing disturbance. We sampled factors of interest, including varied age, sex, and stroke types. That is, we sought equal sex representation, a mean age of 65 years, varied stroke etiologies (involving an approximate 25% to 75% split for intracerebral hemorrhage and ischemic stroke, respectively), and a range of education levels (from incomplete high school education to university graduation). We also desired comparable characteristics within groups dichotomized for the presence (ranging in severity) or absence of aphasia.

We conducted our study in the Neurovascular Unit (NVU) and the Transient Ischemic Attack and Minor Stroke (TAMS) Unit. The NVU provides tertiary level acute care to stroke patients requiring specialized care such as endovascular therapy. The TAMS Unit provides specialized care in an ambulatory day area where patients with transient ischemic attack or minor stroke receive comprehensive evaluations by a nurse practitioner. Early diagnosis and treatment are paramount for patients admitted to the TAMS Unit. The nurse practitioner conducts a detailed assessment including urgent brain imaging, reviews cases with a stroke neurologist, and makes referrals to the interprofessional health team. Ensuing investigations may include same-day swallowing and communication evaluations by a speech-language pathologist.

We dedicated a full month to eligibility tracking within a year-long recruitment period (June 2017-May 2018) in the NVU and TAMS Unit. Eligibility tracking was important to determine potential numbers of patients for a future diagnostic accuracy trial. It involved significant time resources and close daily communication within the research team and members of the circle of care. In particular, confirming the criterion that patients speak English as a first and primary language often necessitated an informal bedside visit and interview by a speech-language pathologist (SLP). The 1-month period for eligibility tracking also permitted interprofessional discussion and promotion of study awareness among front-line hospital staff. When feasible, we attempted recruitment during the eligibility tracking period. However, we still required a full year for recruitment to permit careful consideration of predetermined characteristics of interest that would ensure the most representative sample of patients with and without aphasia.

Recruitment practices required the study team and attending care personnel to identify new English-speaking stroke patients admitted to the NVU or TAMS Unit, while providing the coordinating SLP (C-SLP [H.L.F.]) with minimal clinical information. That is, the team indicated suspected aphasia status and severity, if necessary, to achieve the desired sample based on factors of interest. The C-SLP remained blind to results of previous or ongoing testing and neuroimaging results. After a member of the circle of care determined patient willingness to discuss the study, the C-SLP presented the study purpose and obtained written consent from the patients. She used supported communication strategies with patients who had difficulty communicating to enable them to sign on their own behalf. The C-SLP also requested consent to video recording from select patients to facilitate development of future training materials. She only initiated video recording sessions when patient care constraints were minimal and when there was adequate time for equipment set up and secure storage procedures.

Before test administration, the C-SLP recorded patient reports of hearing and vision status and noted deviations to their usual use of aids (eg, patient not wearing hearing aids, because they were not at the hospital). She then administered both versions of the LASTen in sequence, reversing the presentation order across patients to ensure counterbalancing. Subsequently, she asked patients about their level of education in the following categories: final grade obtained (if no high school diploma), high school diploma, and college or university degree.

After the LASTen testing, we conducted a chart review to record patient demographics, in-hospital stroke interventions, neuroimaging results, evaluation of aphasia by an SLP, and evaluation of other poststroke impairments by the health care team. Lesion localization was determined from the neuroimaging reports by stroke radiologists and through consultation with the staff stroke neurologist as needed. Medical records identifying the presence of aphasia and other co-occurring impairments included

Table 1 Patient characteristics by aphasia status (N = 12)

Sample Characteristics	No Aphasia (n = 6)	Aphasia (n = 6)
Demographics		
Age, median (IQR)	66 (30)	57 (33)
Women, n	2	3
Right handedness, n	6	5
Completion of college/university, n	2	4
Stroke presentation		
Stroke onset to admission in hours, median (IQR)	17 (53)	20 (117)
NIHSS on admission, median (IQR)	1 (5)	4 (21)
Ischemic stroke, n	5	4
First-ever stroke, n	5*	5†
Stroke subtype		
Ischemic		
Cardioembolic	3	1
Large artery	1	1
Lacunar	0	1
Dissection	1‡	1§
Hemorrhagic		
Primary hypertensive bleed	1‖	1¶
Venous sinus thrombosis	0	1
Lesion localization		
Left side,# n	3	6
Supratentorial, n	4	6
Infratentorial, n	2	0
Stroke interventions		
Reperfusion therapy (eg, t-PA, EVT), n	1	4
Neurosurgery (eg, craniotomy, EVD), n	1	1
LASTen testing		
Stroke onset to LASTen in hours, median (IQR)	61 (58)	319 (357)
LASTen scores, median (IQR)	15 (0)	10 (8)
Other poststroke impairments		
Dysphagia, n	1	3
Cognitive impairment, n	1	3
Length of stay in hours, median (IQR)	66 (35)	307 (259)

Abbreviations: EVD, external ventricular drain; EVT, endovascular treatments; IQR, interquartile range; t-PA, tissue plasminogen activator.

* Previous subarachnoid hemorrhage.
† Previous intracranial hemorrhage.
‡ Vertebral artery.
§ Internal carotid artery.
‖ Lobar.
¶ Deep.
# Five patients had punctate infarct foci in opposite hemisphere (without [n = 2] and with [n = 3] aphasia).

information from usual practice. The presence of aphasia was established based on bedside evaluation by an SLP. Such assessments often involved partial or complete administration of test batteries, such as the Western Aphasia Battery.[11]

The co-occurring impairments of interest were dysphagia, communication impairments other than aphasia, and cognitive deficits. The attending SLP conducted dysphagia assessments based on physician referral. However, the SLP could initiate evaluation of any communication impairments, including dysarthria, apraxia of speech, and cognitive communication dysfunction. Additionally, the attending occupational therapist conducted more comprehensive evaluations of cognition, using standardized tests such as the Montreal Cognitive Assessment.[12]

Data analysis involved summarizing patient characteristics, hospital course, and stroke-related interventions. We described individual profiles according to aphasia status, along with other co-occurring impairments from usual care reports. The LASTen scores were tabulated and depicted to describe patient performance according to aphasia status and brain lesion localization. To evaluate the LASTen-A and LASTen-B total score reliability, we computed a Pearson correlation coefficient.

Results

Our study demonstrated feasible recruitment practices in the acute stroke setting. We established an eligibility rate

of 25 patients per month. In addition, all 12 patients recruited provided written consent, even those requiring additional communication support owing to cognitive impairments or aphasia. Two of 3 patients solicited for video recording provided consent, 1 without aphasia and 1 with moderate aphasia. The sample included 7 men and 5 women aged 29 to 85 years (Table 1). Three had intracerebral hemorrhage, and 10 had sustained a first stroke. The education level ranged from grade 10 to university degree completion.

Timing from stroke onset to the LASTen testing covered the hyperacute to early subacute stages.[13] Median scores in patients with and without aphasia were 10 and 15, respectively (fig 1). Patients without aphasia performed comparably to the healthy participants in a previous normalization study,[10] making occasional isolated errors (table 2). The most likely explanations for errors included lower education level, poor hearing with background noise despite corrective aids, or fatigue on the second version. All but 1 patient with aphasia achieved a maximum of 12 points on both versions, demonstrating complete score dissociation between those with and without aphasia. The patient with aphasia who achieved higher scores had a unique and potentially explanatory profile, being left-handed and having incurred a mild middle cerebral artery borderzone infarction.

There was a strong positive correlation across the LASTen versions, confirming parallel functioning ($r=0.95$). Discrepant scores on the 2 LASTen versions involved a 1-point difference in all but 1 case. One patient had a 5-point difference between the 2 versions. The patient in question had fluent aphasia, spontaneously producing semantically-loaded circumlocutions relating to the LASTen items. This presumed practice effect facilitated naming, automatic speech, and picture identification on the second version, conceivably linked to therapeutic stimulability from inadvertent self-cueing.

Discussion

Our study demonstrated that it is feasible to recruit patients with various characteristics and stroke time course for aphasia screening in the acute setting. Our results have provided evidence for routine screening in stroke patients with aphasia who may have other common co-occurring impairments and an early debilitating recovery course. Implementing the LASTen will be possible once it is validated against a criterion standard. Currently, few rapid and accurate screening tools exist for aphasia early after stroke. Nevertheless, a previous review[14] and systematic review[7] identified 10 aphasia screening tools with psychometric evaluation in the acute stage.[7,14] They include the Sheffield Screening Test,[15] the Frenchay Aphasia Screening Test,[16,17] the Mississippi Screening Test,[18] the Acute Aphasia Screening Protocol,[19] the Aphasia Screening Test,[20] the Screeling,[21] the Ulleval Aphasia Screening,[22] the Mobile Aphasia Screening Test,[23] the Semantic Verbal Fluency Test,[24] and the Language Screening Test.[6] Moreover, we have identified an additional tool, also developed and validated for the acute setting, the Aphasia Rapid Test.[25] The recent systematic review identified the LAST[6] and the Screeling[21] as the most accurate screening tools for acute stroke.[7]

Our review of the 11 tools supports the determination that the LAST is the most accurate and practical tool for the acute setting. Six of the 11 tools lacked validation against standardized test batteries,[15-18,23,25] 2 involved a lengthy administration,[20,21] and 7 included items that require use of executive functions (mental organization and planning) for

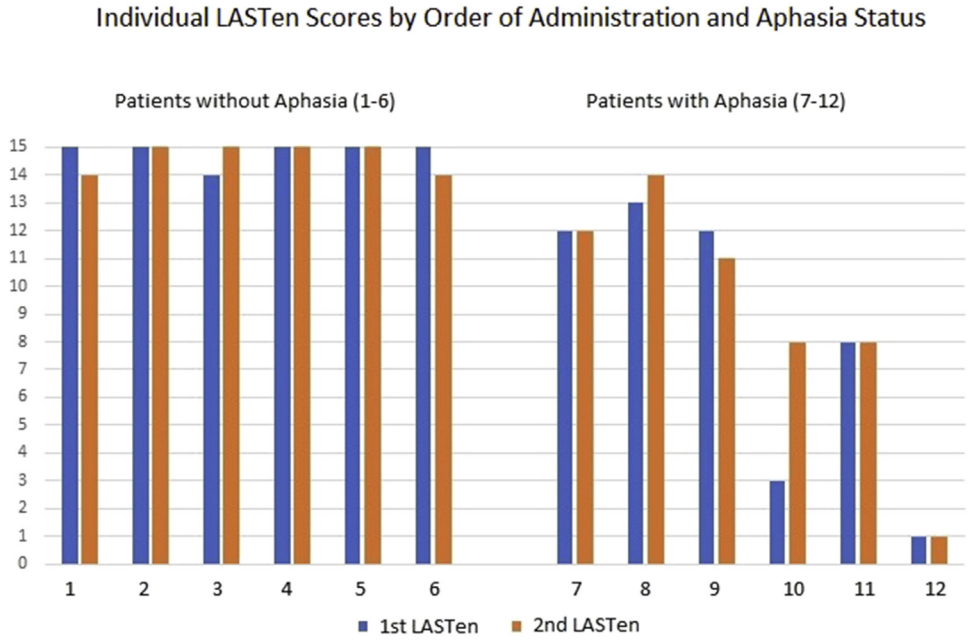

Fig 1 Histogram showing individual patient performance on the 2 LASTen versions according to order of administration by aphasia status. A ceiling score of 15 indicates perfect performance.

Table 2 LASTen performance according to individual profiles

Patients	LASTen Testing				Related Deficits	Lesion Side	Stroke Factors
	Stroke Onset to Testing	First-Second Scores (maximum, 15)	Expressive-Receptive Indices (maximum, 29)	Subtest Errors			Lesion Localization
No Aphasia							
1[*,†]	<5 days	15-14	15-13 (28)	PI	Cognitive	Right	Temporoparietal region Posterior insula
2[*]	<3 weeks	15-15	15-14 (29)	—	—	Right	Cerebellum
3[‡]	<48 hours	14-15	14-14 (28)	NM	—	Right	Posterior putamen Pars triangularis Inferior frontal lobe Middle, inferior temporal gyri
4	<48 hours	15-15	15-14 (29)	—	—	Right	Presumed cerebellar vermis
5[*]	<24 hours	15-15	15-14 (29)	—	—	Left	Posterior frontal region Frontal white matter
6[§,‖]	<4 days	15-14	15-13 (28)	VC	—	Left	Medial occipital lobe High frontal, parietal foci
Aphasia							
7	<5 days	12-12	9-14 (23)	NM, RP, AS	AOS	Left	Parietal cortex Frontal cortex Subjacent white matter
8[*,¶]	<11 days	13-14	13-13 (26)	RP, PI	AOS Dysarthria	Left	MCA border zone Deep white matter Basal ganglia Internal capsule
9[‖,¶]	<24 days	12-11	10-12 (22)	NM, RP, PI, VC	Cognitive[#]	Left	Caudate
10[‡]	<4 days	3-8	2-8 (11)	All	Cognitive Dysarthria	Left	Anterior, superior, posterior temporal lobe High frontoparietal region Frontal operculum
11[‖]	<16 days	8-8	4-12 (16)	NM, RP, VC	Cognitive	Left	Lateral temporal lobe
12[*]	<23 days	1-1	0-2 (2)	All	AOS[#]	Left	Basal ganglia Superior perisylvian temporal lobe Corona radiata Posterior lateral frontal cortex

Abbreviations: AOS, apraxia of speech; AS, automatic speech; NM, naming; PI, picture identification; RP, repetition; VC, verbal commands.

[*] Wearing glasses (otherwise not required).
[†] Wearing hearing aids.
[‡] Lower than high school diploma.
[§] Tested supine (postprocedural restrictions).
[‖] Intracerebral hemorrhage.
[¶] Hearing aids required but not available.
[#] Moderate impairment (otherwise mild).

their language tasks.[16-21,24,25] Like the LAST,[6] 5 other tools were developed in languages other than English, including French,[25] Norwegian,[22] Dutch,[21] and Korean.[23,24] The French-language development and validation of the LAST addressed the current need for a rapid accurate bedside aphasia screening tool.[6] It has the unique advantage of having 2 parallel versions with excellent reliability in the original version demonstrated by an intraclass correlation coefficient of 0.95.[6] To our knowledge, there are 2 recent translations and validations of the LAST, 1 in German[26] and the other in Chinese.[27] Like our study, both demonstrated parallel version equivalence with intraclass correlation coefficients of 0.91[26] and 0.99[27] for the German and Chinese tests, respectively. Even our small sample size demonstrated a very strong correlation across the 2 LASTen versions, confirming the robustness of their parallel functioning.

Study limitations

One limitation of this study was that testing was performed by the C-SLP, who was aware of the study objectives. However, we sought to understand whether the psychometric properties of the LASTen were confirmatory for future validation or problematic, requiring potential modifications. Also, testing was not in keeping with anticipated routine administration by front-line care providers. However, having an SLP conduct testing permitted the consideration of potentially confounding linguistic and communication factors. A future validation will require not only comparison of LASTen scores with a criterion standard, but also measures of inter-rater reliability. Our request to video record patients in the current study served to determine its usefulness for inter-rater reliability procedures and to provide training materials for future routine implementation of the LASTen. We can now consider the possibility that video recordings could supplement online bedside scoring of test administration by multiple raters. That is, video recording could circumvent demands on multiple health care professionals to attend test administration sessions at the bedside. It could provide an alternate or exclusive means to document inter-rater reliability, ensuring independent and blinded scoring.

Another unanticipated limitation was that there were longer latencies between time of stroke onset to LASTen testing for patients with aphasia compared with those without. Our careful documentation of patient characteristics has provided a window into possible reasons. Patients with aphasia had more stroke-related interventions (eg, reperfusion treatments) and more co-occurring deficits than those without. Some patients who had already been admitted to their local hospital required rerouting to the study hospital for specialized treatment, such as endovascular therapy or neurosurgical intervention. Such care transitions inevitably lengthened the timeframe between stroke onset and arrival at our facility for LASTen testing. Also, we awaited patients' capability to attend to a 30-minute assessment session and their capacity to consent, likely delaying testing for some patients with aphasia and co-occurring deficits.

Our study involved a small sample size, but it was sufficient for our purposes. That is, we demonstrated good potential for recruiting stroke patients even in the hyperacute stage. Our focus on individual patient profiles was helpful to show divergence in scores for patients with and without aphasia despite comparable education levels, age, and stroke type. Our sample confirmed desirable functioning of the LASTen, particularly its parallel version reliability. Given that the LASTen is feasible to administer in the acute stage of stroke and that it shows emerging psychometric viability, we will commence a large-scale validation in acute stroke patients.

Conclusions

Currently, a rapid and repeatable screening tool for stroke patients at risk of aphasia is sorely lacking in the English-speaking world. The current study demonstrated feasible recruitment of acute stroke patients and desirable psychometric properties of the LASTen. There were ceiling effects for patients without aphasia and heterogeneity of scores in those with aphasia, along with excellent parallel form reliability. The rigorous development of the LASTen justifies the fully funded multisite validation that we are now commencing in consecutive acute stroke patients. We will finally establish the diagnostic accuracy of the LASTen, permitting dissemination and implementation worldwide, to enable precocious identification of aphasia and sustained care for stroke survivors.

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