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We conducted this study because evidence to date has demonstrated that point-of-care testing for strep throat improves accessibility of care and decreases the number of antibiotic prescriptions written for sore throat, but the economic implications of offering this service in community pharmacies have not been explored.

Nous menons cette étude parce que les preuves ont démontré jusqu'à présent que les analyses hors laboratoire pour l'angine streptococcique permettent d'améliorer l'accessibilité des soins et de diminuer le nombre d'ordonnances d'antibiotiques rédigées pour la pharyngite, mais les implications économiques de l'offre de ce service dans les pharmacies communautaires n'ont pas été examinées.

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Cost-minimization analysis of community pharmacy-based point-of-care testing for strep throat in 5 Canadian provinces

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ABSTRACT

Background: Strep throat point-of-care (POC) testing in community pharmacies will enable pharmacist-based care for this condition. Our objective was to conduct an economic evaluation of treating severe sore throat when this service was offered in pharmacies in 5 Canadian provinces.

Methods: We conducted 5 separate cost-minimization analyses for the provinces of Alberta, British Columbia, Nova Scotia, Ontario and Saskatchewan, from the public payer perspective, to estimate mean cost per patient of treating severe sore throat in 2 scenarios: 1) physician-based usual care in a family physician's office, a walk-in clinic or an emergency room (ER) and 2) a new scenario where patients received care described above or in a pharmacy offering strep throat POC

testing. One-way sensitivity analyses were conducted to account for model uncertainty.

Results: Mean cost per patient for each pathway in the base-case analyses for the 5 provinces ranged from 1) \$37.55 to \$61.57 for family physician, 2) \$37.55 to \$61.57 for walk-in clinic, 3) \$38.88 to \$57.56 for ER and 4) \$19.12 to \$21.83 for pharmacy, representing savings ranging from \$12.47 to \$24.36 per patient for the new scenario. Approximate total cost savings range from \$1.3 million to \$2.6 million per year across the 5 provinces. All sensitivity analyses yielded cost savings for the new scenario.

Discussion: Across 5 provinces, strep throat POC testing in pharmacies was cost saving compared to physician-based care. Sensitivity analyses demonstrated the robustness of these results.

Conclusions: Funding strep throat POC testing in community pharmacies in these 5 provinces would lead to public health system cost savings and potentially improve patients' access to care for severe sore throat. *Can Pharm J (Ott)* 2018;151:322-331.

Introduction

Sore throat is one of the most common reasons for family doctor visits, accounting for 2% to 4% of all visits.^{1,2} While most cases of sore throat are caused by viruses rather than bacteria, the most common bacterial cause is group A beta-hemolytic streptococci (GABHS); *strep throat*

is the common term used to describe this condition. Strep throat most commonly occurs in children between 5 and 15 years old, accounting for 15% to 30% of cases of sore throat; by contrast, it accounts for 5% to 15% of sore throat in adults.¹⁻⁶ Patients diagnosed with strep throat require treatment with antibiotics.

Diagnosis of strep throat involves patient history, clinical examination and laboratory confirmation of GABHS, since clinical findings cannot reliably differentiate between sore throat of viral etiology and that caused by GABHS.^{2,7} The gold standard for detecting GABHS is a throat-swab culture, but it requires at least 24 hours before results are available.¹ An alternative method for detecting the presence of GABHS in suspected cases of strep throat is a rapid antigen detection test (RADT). This test can be done at the point of care (POC), such as in a physician's office or a community pharmacy, and results are available within a few minutes. The sensitivity of this test can be as high as 97%,² and as such, current guidelines do not recommend that adults who test negative have confirmatory testing with a throat-swab culture. It is, however, recommended that children who have a negative result with RADT be considered for confirmatory testing with a throat-swab culture.^{7,8} The specificity of all RADTs is greater than 95%, and as such, confirmatory testing for positive cases is not recommended.⁷

The objective of this analysis was to conduct an economic evaluation of treating severe sore throat when a program for evaluating this condition was offered in community pharmacies in 5 Canadian provinces: Alberta (AB), British Columbia (BC), Nova Scotia (NS), Ontario (ON) and Saskatchewan (SK). Such a program would involve evaluating patients with sore throat using a standardized clinical algorithm⁸ and offering POC testing for strep throat using RADT technology when required.

Methods

We conducted 5 cost-minimization analyses to estimate the mean cost per patient of assessing and treating severe sore throat in the provinces of AB, BC, NS, ON and SK. These analyses evaluated 2 scenarios: 1) the usual-care scenario where patients could receive care from a physician in either a family physician's office, a walk-in clinic or an emergency room (ER) and 2) a new scenario where patients could receive care by a physician in the 3 settings described in point 1 or also from a pharmacist in a community pharmacy offering POC testing using a RADT. They were conducted from the public payer perspective and looked at all costs that would be paid by the provincial ministries of health in these 5 provinces. Results of each provincial analysis

KNOWLEDGE INTO PRACTICE

- Sore throat is one of the most common reasons for patients to seek care from a physician, although 57% of Canadians report difficulty in obtaining a same- or next-day appointment with their physician or nurse.
- Pharmacists are accessible health care professionals, ideally positioned to assess sore throat patients and identify those with strep throat using point-of-care testing technologies.
- Publicly funded community pharmacy-based point-of-care testing for strep throat is cost saving.
- Pharmacist-based care for sore throat could potentially result in quicker identification of strep throat cases, more appropriate antibiotic use and improved outcomes for patients.

were then combined with epidemiologic estimates of the number of children and adults with strep throat in each province, which were generated by combining provincial population data from Statistics Canada with estimates of the incidence of strep throat found in the published literature, to estimate a range of total cost savings for each provincial government should community pharmacy-based strep throat POC testing be funded.

Model structure and underlying assumptions

Care pathways were constructed for each of the 4 settings in which patients could receive care for severe sore throat. Figure 1 contains flow diagrams for each of the pathways. In the new scenario (Figure 1B), a proportion of patients who used each of the 3 pathways in the usual-care scenario (Figure 1A) instead used the community pharmacy pathway.

Patients who sought care in a community pharmacy had their sore throat symptoms evaluated by a pharmacist using a standardized clinical algorithm⁸ to determine whether they should undergo testing for strep throat using RADT. Family physicians, pediatricians and infectious disease specialists reviewed this algorithm (Appendix 1, available at www.cpjournal.ca). For the AB and SK models, we assumed that patients who tested positive for strep throat with RADT in this pathway obtained a prescription for antibiotics either through a pharmacist with prescribing authority or a referral to a physician, as pharmacists with Additional Prescribing Authorization in AB are currently authorized to prescribe medications and SK is in the process

FIGURE 1 (A) Physician-based care pathways (B) Community pharmacy-based care pathways

of regulatory changes to add pharyngitis as a designated condition within the minor ailments framework that enables pharmacists to prescribe. For the ON and NS models, we assumed that patients obtained an antibiotic prescription either through a referral to a physician or through a pharmacist obtaining a telephone or fax prescription from a physician. For the BC model, we assumed that patients obtained an antibiotic prescription either through a referral to a physician or through a pharmacist initiating

a telephone consultation with a physician using the physician-allied health telephone consult mechanism that exists in this province.

A proportion of all patients who underwent RADT in any of the pathways and who tested negative for strep throat sought follow-up care for their symptoms from a physician for 1 of 2 reasons: 1) their results were in fact false negatives (i.e., they had strep throat but were identified incorrectly by the test as not having the disease), or 2) their results were true negatives,

but their symptoms worsened or persisted for a longer duration than expected. These patients sought care from either their family physician or at a walk-in clinic.

For the purpose of this analysis, regardless of the pathway pursued by a patient, all patients who required treatment for strep throat were treated with oral penicillin VK or amoxicillin, the 2 most commonly prescribed antibiotics for this condition.^{1,7}

Parameter inputs

Point estimates for probabilities used in the model were based on published literature and data gathered from surveys of physicians and patients who participated in the Shoppers Drug Mart Strep Throat Testing Pilot Project, where possible. This pilot project was conducted in the provinces of AB, BC and NS between November 2015 and May 2016. Patients who participated in this pilot project presented to a pharmacy where their symptoms of severe sore throat were evaluated by a pharmacist, using a standard clinical algorithm,⁸ to identify likely cases of strep throat. Patients suspected of having strep throat underwent RADT in the pharmacy. Those who tested positive in BC and NS were referred to a physician to obtain an antibiotic prescription; most of those in AB who tested positive (92%) were prescribed antibiotics by the pharmacist, while the remainder were referred to a physician. A total of 7050 patients participated in this pilot project across the 3 provinces; 1004 of them completed a poststudy survey.⁹

For several parameters, no empirical evidence was available to inform estimates, so they were assumed based on best available data and the authors' expert opinions. Table 1 outlines the probabilities used in the base-case analysis and their sources. All probabilities in Table 1 were reviewed by a practising family physician in each of the provinces to ensure face validity.

Costs used in the model are 2017 values. Cost figures were obtained from publicly available information for each province.¹¹⁻²⁶ The cost inputs used in the base-case analysis and their sources are available online at www.cpjournal.ca in Appendices 2 to 6.

Sensitivity analyses

Seven one-way sensitivity analyses (SAs) were done on each of the 5 provincial analyses to quantify uncertainty in the models. Changes in

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- La pharyngite est l'une des principales raisons pour lesquelles les patients consultent un médecin, bien que 57 % des Canadiens signalent qu'ils ont des difficultés à obtenir un rendez-vous le jour même ou le jour suivant avec leur médecin ou infirmière.
- Les pharmaciens sont des professionnels de la santé accessibles, bien placés pour évaluer les patients atteints de pharyngite et ceux atteints d'une angine streptococcique à l'aide des technologies d'analyses hors laboratoire.
- Les analyses hors laboratoire de l'angine streptococcique des pharmacies communautaires subventionnées par l'État sont économiques.
- Les soins d'un pharmacien pour une pharyngite pourraient potentiellement mener à déterminer les cas d'angines streptococciques plus rapidement, à utiliser les antibiotiques de manière plus appropriée et à améliorer les résultats pour le patient.

results were observed over the range of values tested. Two of these SAs were done to account for the fact that point estimates for some parameters would vary between the family physician and walk-in clinic pathways: 1) proportion of patients suspected of having strep throat after initial assessment by family physician and 2) proportion of patients prescribed antibiotics based on clinical assessment only in walk-in clinic pathway. Sensitivity analyses were also conducted on the following parameters: 1) proportion of patients using community pharmacy pathway in new scenario, 2) proportion of patients suspected of having strep throat after initial assessment by community pharmacist, 3) proportion of patients not suspected of having strep throat after initial assessment by pharmacist who are referred to physician, 4) proportion of patients using community pharmacy pathway who test negative after RADT and seek physician follow-up, and 5) for the provinces of AB and SK, where pharmacists have prescribing authority, the proportion of patients who test positive for strep throat with RADT testing in community pharmacy pathway who are prescribed antibiotics by prescribing pharmacist or 6) for the provinces of BC, NS and ON, a hypothetical scenario was assumed where pharmacists in these provinces have prescribing authority and the proportion of patients who test positive for strep throat with RADT testing in the community pharmacy pathway who were prescribed antibiotics by a pharmacist was evaluated.

TABLE 1 Probabilities used in base-case analysis

Parameter	Point estimate					Source
Proportion of patients seeking care for severe sore throat using each usual care pathway	Province					POC Strep Throat Research—Final Report ⁹
	AB	BC	NS	ON	SK	
• Family physician	39%	36%	27%	36%	36%	
• Walk-in clinic	50%	51%	52%	51%	51%	
• Emergency room	11%	13%	21%	13%	13%	
Proportion of patients seeking care for severe sore throat using each new scenario pathway						
• Family physician	10%	10%	10%	10%	10%	Assumption
• Walk-in clinic	25%	25%	25%	25%	25%	
• Emergency room	5%	5%	5%	5%	5%	
• Community pharmacy	60%	60%	60%	60%	60%	
Proportion of patients suspected of having strep throat by family physician who undergo further evaluation or receive antibiotic treatment in each of the following categories						Shoppers Drug Mart GP Omnibus ¹⁰
• Antibiotics prescribed based on clinical assessment only	16%	16%	16%	16%	21%	
• Swab taken and sent for culture but antibiotics prescribed before results available	36%	36%	36%	40%	41%	
• Swab taken and sent for culture but antibiotics not prescribed until results available	23%	23%	23%	10%	28%	
• RADT performed to test for strep throat before antibiotics prescribed	25%	25%	25%	34%	10%	
Proportion of patients suspected of having strep throat by walk-in clinic physician who undergo further evaluation or receive antibiotic treatment in each of the following categories	Province					Assumption
	AB	BC	NS	ON	SK	
• Antibiotics prescribed based on clinical assessment only	16%	16%	16%	16%	21%	
• Swab taken and sent for culture but antibiotics prescribed before results available	36%	36%	36%	40%	41%	
• Swab taken and sent for culture but antibiotics not prescribed until results available	23%	23%	23%	10%	28%	
• RADT performed to test for strep throat before antibiotics prescribed	25%	25%	25%	34%	10%	
Proportion of patients suspected of having strep throat by emergency room physician who undergo further evaluation or receive antibiotic treatment in each of the following categories						Assumption
Antibiotics prescribed based on clinical assessment only	80%	80%	80%	80%	80%	
Swab taken and sent for culture but antibiotics prescribed before results available	15%	15%	15%	15%	15%	
Swab taken and sent for culture but antibiotics not prescribed until results available	0%	0%	0%	0%	0%	
RADT performed to test for strep throat before antibiotics prescribed	5%	5%	5%	5%	5%	

(continued)

TABLE 1 (continued)

Parameter	Point estimate					Source
Proportion of patients who undergo RADT testing in community pharmacy pathway and test positive	26%	22%	22%	22%	22%	POC Strep Throat Research—Final Report ⁹
Proportion of patients who test positive with RADT in community pharmacy and obtain prescription for antibiotics via referral to physician	8%	50%	50%	50%	25%	Assumption
Proportion of patients who test positive with RADT in community pharmacy and obtain prescription for antibiotics from physician via telephone or fax	NA	NA	50%	50%	NA	Assumption
Proportion of patients who test positive with RADT in community pharmacy and obtain prescription for antibiotics via pharmacist with prescribing authority	92%	NA	NA	NA	75%	For AB: POC Strep Throat Research—Final Report ⁹ For SK: Assumption
Proportion of patients who test positive with RADT in community pharmacy and obtain prescription for antibiotics from physician via physician-allied health telephone consultation	NA	50%	NA	NA	NA	Assumption
Point estimates for the parameters below were not province specific; the values presented were used in all 5 analyses						
Proportion of patients suspected of having strep throat after initial assessment by physician				50%	Assumption	
Proportion of patients suspected of having strep throat after initial assessment by pharmacist				63%	POC Strep Throat Research—Final Report ⁹	
Proportion of patients not suspected of having strep throat after initial assessment by pharmacist who go on to seek physician care				20%	Assumption	
Proportion of patients visiting emergency room on various days and at various times of day	Saturday, Sunday or statutory holiday: 30%				Assumption	
	Daytime: 10%					
	Evening: 40%					
	Night: 20%					
Proportion of patients who undergo swab and culture test for strep throat, receive antibiotic prescription prior to results and fill prescription immediately				44%	Shoppers Drug Mart GP Omnibus ¹⁰	
Proportion of patients who undergo swab and culture and test positive				40%	Worrall et al. ¹	
Proportion of patients who undergo RADT testing who test positive when test recommended by physician				31%	POC Strep Throat Research—Final Report ⁹	
Proportion of patients who test negative with RADT when administered by a physician who go on to seek follow-up care				7%	Assumption	
Proportion of patients who test negative with RADT when administered by a pharmacist who go on to seek physician follow-up				10%	Assumption	
Proportion of patients prescribed penicillin VK and amoxicillin	Penicillin VK: 50%				Assumption	
	Amoxicillin: 50%					

AB, Alberta; BC, British Columbia; NA, not applicable; NS, Nova Scotia; ON, Ontario; POC, point of care; RADT, rapid antigen detection test; SK, Saskatchewan.

TABLE 2 Mean cost per patient of treating severe sore throat by care pathway and scenario

Care pathway	Mean cost (savings) per patient				
	Province				
	AB	BC	NS	ON	SK
Family physician	\$53.88	\$41.75	\$37.55	\$40.35	\$61.57
Walk-in clinic	\$53.88	\$41.75	\$37.55	\$40.35	\$61.57
Emergency room	\$44.35	\$58.32	\$50.08	\$38.88	\$53.11
Community pharmacy	\$21.83	\$19.18	\$19.60	\$19.38	\$19.84
Scenario					
Usual care	\$52.83	\$43.90	\$40.18	\$40.16	\$60.47
New scenario	\$34.17	\$29.04	\$27.40	\$27.69	\$36.11
Difference between usual care and new scenario	(\$18.66)	(\$14.86)	(\$12.78)	(\$12.47)	(\$24.36)

AB, Alberta; BC, British Columbia; NS, Nova Scotia; ON, Ontario; SK, Saskatchewan.

TABLE 3 Estimated number of persons with strep throat in each province and potential provincial cost savings with funding of community pharmacy-based strep throat point-of-care testing programs

Province	Estimated number of children (≤ 14 years of age) strep throat per year ^{1,28}	Estimated number of adults (≥ 15 years of age) with strep throat per year ^{3,28}	Estimated provincial cost savings per year*
Alberta	4721-9442	10,398-20,796	\$282,120-\$564,240
British Columbia	4189-8378	12,357-24,713	\$245,870-\$491,730
Nova Scotia	802-1603	2448-4895	\$41,535-\$83,044
Ontario	13,318-26,635	35,380-70,760	\$607,260-\$1,214,500
Saskatchewan	1328-2656	2788-5576	\$100,270-\$200,530

*Calculated by multiplying the sum of lower and upper estimates of adults and children with strep throat by mean cost savings per patient with new scenario presented in Table 2.

Indirect costs and benefits of strep throat POC testing in community pharmacies

Although this analysis did not quantify the indirect costs and benefits of offering a community pharmacy-based program for strep throat POC testing, we conducted a literature search to evaluate these aspects of the program. The findings are detailed in the Discussion section.

Results

Base-case analysis

The mean cost per patient for treating severe sore throat in the 4 care pathways, the 2 scenarios and the savings associated with the new scenario compared to usual care are detailed in Table 2.

Sensitivity analyses

All 7 one-way sensitivity analyses for each of the provincial models yielded cost savings for

the new scenario compared to the usual-care scenario. Details of the sensitivity analyses and their results are available at www.cpjjournal in Appendices 7 to 11.

Province-specific cost savings

Table 3 contains province-specific estimates of the number of adults and children with strep throat and the range of potential cost savings that could be realized to each provincial ministry of health should a community pharmacy-based strep throat POC testing program be funded.

Discussion

This analysis estimates that in a scenario where 60% of patients with severe sore throat seek care in a community pharmacy, compared to a scenario where all patients with severe sore throat seek care through a family physician, walk-in

clinic or emergency room, the health care system in the provinces of AB, BC, NS, ON and SK saves a mean of \$12.47 to \$24.36 per patient. The results of this analysis are robust, as demonstrated by the 7 sensitivity analyses that all yielded cost savings with the new scenario, whereby patients could seek care through a community pharmacy in each of these 5 provinces. The results for all provinces were most sensitive to the proportion of patients using the community pharmacy pathway in the new scenario.

There were 2 main drivers of cost savings associated with the new scenario: 1) the majority of severe sore throat cases that were assessed by a pharmacist and not suspected of being strep throat resulted in the pharmacist making a recommendation for self-care, for which the health care system does not incur any incremental costs, and 2) the cost of RADT in patients suspected of having strep throat was considerably less than the cost of a physician assessment. By contrast, in the usual-care scenario, the health care system incurs the cost of a physician assessment for all patients who seek care for severe sore throat.

Based on Statistics Canada population figures, in combination with estimates that 2% to 4% of family physician visits are related to acute sore throat and that about 30% of sore throat cases in children and up to 15% in adults are caused by strep throat, it is estimated that between 87,729 and 175,454 cases of strep throat occur yearly in these 5 provinces.^{1,3,27} Based on the results of this analysis, the total cost savings to these 5 provincial ministries of health could be approximately between \$1,277,000 and \$2,554,000 per year by funding programs for community pharmacy-based testing for this condition. It should be noted that these costs only represent direct cost savings associated with patients being able to seek care for severe sore throat in community pharmacies and do not account for indirect cost savings that may result from factors such as increasing timely access to care or reducing unnecessary antibiotic prescribing.

A recently published US study evaluated costs associated with POC testing for strep throat using a RADT in a single community pharmacy. The authors found pharmacy-based care was cost saving compared to a physician visit.²⁸ While considerable differences in costs, fee structures and health care delivery exist between Canada and the United States, the results of this study do corroborate the findings of our analysis.

Although our analysis did not quantify any costs or benefits of community pharmacy-based strep throat POC testing other than those directly attributable to provincial public payers, a literature search detailed some of these other implications. Strep throat has been associated with days lost from school and work. A 2008 study, conducted at 2 pediatric practices in Boston, found that children missed a mean of 1.9 school/daycare days (range, 0-7 days), while parents missed a mean of 1.8 workdays in 42% of cases. A second parent or caregiver missed 1.5 days in 14% of families.²⁹ Using the province of ON as an example, this would translate into a cost of \$408.53 and \$340.44 for the primary and secondary parent or caregiver, respectively, per case of strep throat, using the 2016 ON average hourly wage for full-time employees of \$28.37 per hour.³⁰ This example demonstrates the potential monetary impact on families and productivity in the workplace associated with a single pediatric case of strep throat.

Indirect benefits of this program include improved timeliness of assessment and treatment of strep throat, improved antibiotic use and improved accessibility to care for severe sore throat. Early confirmation of strep throat cases will lead to faster treatment, which could in turn lead to improved outcomes and decreased treatment costs.^{31,32} Delayed time to strep throat assessment could lead to delays in appropriate treatment or prompt prescribing of empiric antibiotics at the time of initial assessment or even lead to indiscriminate prescribing of antibiotics.³³

Recent studies from the United States and United Kingdom both found that antibiotics were prescribed in the majority of sore throat cases, even though most cases are of viral etiology. In the United States, from 1997 to 2010, there were approximately 92 million visits by adults to emergency departments and physicians' offices for pharyngitis. Antibiotics were prescribed 60% of the time, even though strep throat accounts for only 5% to 15% of sore throat cases in adults.³ Similarly, in the United Kingdom, 60% of patients with a sore throat in primary care practices were prescribed antibiotics.³¹ Strep throat POC testing has been shown to improve antibiotic prescribing for sore throat, with decreased prescribing rates compared to scenarios where POC testing was not used.^{1,34}

Introducing community pharmacy-based strep throat POC testing will improve access to

care for patients with sore throat. This advantage is particularly important for the almost 15% of Canadians who in 2014 reported that they did not have access to a regular medical doctor.³⁵ Increased accessibility is also beneficial for the 57% of Canadians who have difficulty obtaining a same- or next-day appointment with their doctor or regular health care provider.³⁶

There were 3 main limitations to our analysis. First, a number of the point estimates used for parameter inputs were based on assumptions, since no empirical evidence was available on which to base the estimates. Although these inputs were assumed, sensitivity analyses confirmed that model results are robust, with all values tested yielding cost savings for the new scenario. Second, some costs used in this analysis may have under- or overrepresented the true costs to the public health care system in these 5 provinces, as physician costs were assumed to be based on a fee-for-service model, which does not account for alternative

funding agreements that are used in many cases to reimburse physician services. Third, this analysis only considered costs from the public payer perspective and did not quantify out-of-pocket costs to patients, broader societal costs such as lost productivity or caregiver burden or benefits related to increased accessibility to care for sore throat that would be afforded with this intervention.

Conclusion

This analysis demonstrates that funding of a program to enable POC testing for strep throat in community pharmacies will lead to cost savings within the public health care system in the provinces of AB, BC, NS, ON and SK. Further savings may be realized in a scenario where a greater proportion of patients with severe sore throat are able seek care from community pharmacists who are able to administer POC testing for strep throat and prescribe antibiotics for this condition when required. ■

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Author Contributions: NL designed this study, developed the model, interpreted the results and was primarily responsible for drafting and revising this manuscript. KS, KT, MB, PM and DS reviewed the final draft of this manuscript. KA initiated and supervised this project, provided guidance on developing the model and interpreting the results and contributed to drafting and revising this manuscript.

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