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Diagnosis and Management of Pharyngitis in a Pediatric Population Based on Cost-Effectiveness and Projected Health Outcomes

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ABSTRACT

BACKGROUND. Pharyngitis is a common childhood complaint. Current management for children and adolescents includes 1 of 6 strategies, ie, (1) observe without testing or treatment, (2) treat all suspected cases with an antibiotic, (3) treat those with positive throat cultures, (4) treat those with positive rapid tests, (5) treat those with positive rapid tests and those with positive throat cultures after negative rapid tests, or (6) use a clinical scoring measure to determine the diagnosis/treatment strategy. The sequelae of untreated group A hemolytic streptococcal (GAS) pharyngitis are rare, whereas antibiotic treatment may result in side effects ranging from rash to death. The cost-utility of these strategies for children has not been reported previously.

METHODS. A decision tree analysis incorporating the total cost and health impact of each management strategy was used to determine cost per quality-adjusted life-year ratios. Sensitivity analyses and Monte Carlo simulations assessed the accuracy of the estimates.

RESULTS. From a societal perspective with current Medicaid reimbursements for testing, performing a throat culture for all patients had the best cost-utility. For private insurance reimbursements, rapid antigen testing had the best cost-utility. Observing without testing or treatment had the lowest morbidity rate and highest cost from a societal perspective but the lowest cost from a payer perspective. The model was most sensitive to the incidence of acute rheumatic fever and peritonsillar abscess after untreated GAS pharyngitis. Monte Carlo simulations demonstrated considerable overlap among all of the options except for treating all patients and observing all patients.

CONCLUSIONS. Observing patients with pharyngitis had the lowest morbidity rate. The costs of this option were primarily from parental time lost from work. Before recommending observation rather than treatment of GAS pharyngitis, accurate estimates of the risk of developing acute rheumatic fever and peritonsillar abscess after GAS pharyngitis are needed.

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Key Words

group A streptococcus, pharyngitis, cost-utility analysis, peritonsillar abscess, acute rheumatic fever

Abbreviations

GAS—group A hemolytic streptococcal
QALY—quality-adjusted life-year
QALD—quality-adjusted life-day
PTA—peritonsillar abscess
ARF—acute rheumatic fever
AAP—American Academy of Pediatrics
IDSA—Infectious Diseases Society of America
CI—confidence interval

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PHARYNGITIS IN THE pediatric age group is a common complaint, but the optimal approach for these patients has been a matter of debate, primarily driven by the desire to identify, treat, and avoid the complications associated with group A hemolytic streptococcal (GAS) pharyngitis, including acute rheumatic fever (ARF), peritonsillar abscess (PTA), rheumatic heart disease, and death. To date, 6 approaches have been identified, each with its strengths and weaknesses. The first approach, treating all patients with pharyngitis without testing, has the advantage that no case of GAS pharyngitis that presents to a physician goes untreated. Unfortunately, this approach involves treating 70% to 90% of patients with pharyngitis who do not have GAS pharyngitis. Treatment with antibiotics can have side effects, including anaphylaxis and death. Also, indiscriminate antibiotic use has been linked to antibiotic resistance.

The second approach, observing all patients without providing testing or treatment, saves the costs of testing and treatment. Because nearly all cases of GAS pharyngitis resolve spontaneously, the health preserved through treatment may be minimal. The risks associated with antibiotic use are avoided. Conversely, early treatment with antibiotics may decrease the symptoms of GAS pharyngitis by 1 or 2 days and may prevent other rare complications of untreated GAS pharyngitis, including PTA, ARF, rheumatic heart disease, and death.

The third approach, testing all patients with pharyngitis with a rapid antigen test and treating those with positive test results with antibiotics, identifies nearly all individuals with GAS pharyngitis and avoids antibiotic use for those with pharyngitis resulting from other causes. A few patients with GAS pharyngitis are missed and face the risk of untreated disease. This approach is recommended by the American Academy of Pediatrics (AAP) and the Infectious Diseases Society of America (IDSA), if physicians validate adequate sensitivity of the test in their practice.^{1,2} The IDSA also recommends this approach for adult patients.²

The fourth approach, testing all patients with pharyngitis with a throat culture and treating those with positive test results with antibiotics, has the advantage of missing few cases of GAS pharyngitis but has the disadvantage of a 2-day delay until treatment is initiated. This increases morbidity and parental lost wages. This is one of the approaches recommended by the AAP,¹ the IDSA,² and the Institute for Clinical Systems Improvement.³

The fifth approach, testing all patients with pharyngitis with a rapid antigen test, treating those with positive test results with antibiotics, and performing a culture for those with negative test results, is a very popular approach. It allows most patients with GAS pharyngitis to initiate therapy immediately and allows nearly all cases of GAS pharyngitis to be identified. It does, however, add the expense of a second test for the 70% to

90% of patients with non-GAS pharyngitis. This is one of the approaches recommended by the AAP and the IDSA.^{1,2}

Finally, a clinical scoring system to triage the diagnostic approach would ignore those with a low score, test and treat those with positive results with an intermediate score, and treat without testing those with a high score. This scenario combines the advantages and disadvantages of the other approaches. This approach is recommended for all patients by the American Academy of Family Practice⁴ and for adult patients by the Centers for Disease Control and Prevention.⁵

Although several studies have explored the cost-effectiveness of different approaches to pharyngitis, the findings of these studies are often presented in dollars saved per rare complication of GAS pharyngitis avoided. For the average practitioner, who is unlikely to have ever seen these complications, this method of reporting the results means little. More valuable to clinicians is a determination of which approach preserves the most health for the money. Cost analyses and cost-effectiveness analyses involving the pediatric population have been performed and reported, but their results have been suspect or difficult to interpret. For example, a 1999 cost analysis favored the third approach, but the study had assumed an inexplicably low cost for throat culture and a low sensitivity for the rapid antigen test, inconsistent with today's clinical practice. The study also failed to provide a sensitivity analysis.⁶ A more recent study's outcome measure was the cost to prevent 1 case of rheumatic fever.⁷

None of the analyses of the diagnostic and therapeutic approaches to pharyngitis among children and adolescents measured health outcomes or included a no-testing/no-treatment scenario. To assess the health care value of the 6 options properly, costs must be estimated accurately and health outcomes included. The most commonly used yardstick for health outcomes is quality-adjusted life-years (QALYs). Although a recent study among adults used this standard for health outcomes,⁸ a cost-utility analysis of the diagnostic and treatment approaches for pharyngitis among children would be substantially different. For example, an analysis involving children would need to include the cost associated with parents missing work to stay home and care for a sick child. The number of QALYs lost because of chronic illness or death would be higher for children. Finally, the incidence of GAS pharyngitis among those presenting to a physician with pharyngitis is higher among children than among adults.⁹

GAS pharyngitis has a self-limited course, with infrequent complications. We hypothesize that forgoing testing for and treating GAS pharyngitis among children and adolescents may be a cost-effective option, compared with 5 established testing and treatment options currently used in clinical practice. To test this hypothesis,

we estimated and compared the cost-utility of these 6 approaches for a patient presenting with pharyngitis, to identify the optimal approach.

METHODS

We constructed a decision tree including the 6 approaches to pediatric pharyngitis that accounted for all patient outcomes. The literature was reviewed to determine the values and confidence intervals (CIs) of the variables (costs, incidences, and morbidity) needed to derive the estimates from the model. The decision tree model estimated the overall costs (in dollars) and utility (in quality-adjusted life-days [QALDs]) for each of the 6 options. The marginal differences in costs and utility were computed for each of the options. In comparing approaches, one approach would be preferred over another if it preserved more health and the cost of this health preservation was less than \$200 000 per QALY, a threshold recommended by Hirth et al¹⁰ in 2000.

The medical literature was searched by using PubMed, with search phrases of “group A streptococcal pharyngitis” alone and with “cost-effectiveness” and “cost-utility.” Additional references were found in the bibliographies of the reviewed articles.

The model used the societal perspective and a discount rate of 3% as part of the reference case standard developed by the Panel on Cost-Effectiveness in Health and Medicine convened by the US Public Health Service in 1993.¹¹ The probability assumptions used in the model are shown in Table 1.

The costs of testing, treatment, expected sequelae, and parental time lost from work and their CIs are

presented in Table 2. All costs were adjusted to 2003 US dollars by using the Consumer Price Index.¹⁹ Utility measures and their CIs were estimated with the General Health Policy Model and the Quality of Well-being Scale, and previously published values are shown in Table 3.^{8,20–22} The model assumptions for time lost from work for the various conditions are shown in Table 4.

The clinical scoring approach used the modified Centor scoring system, as described by McIsaac et al.¹⁵ Those with a score of 0 or 1 received no testing or treatment. Those with a score of 2 or 3 were tested with a rapid test, and those with positive test results were treated. Those with a score of ≥ 4 were treated without testing. Because McIsaac et al¹⁵ excluded scores of 1 and 0 from their study, enough patients with scores of 0 and 1 were added to this model to give an overall incidence of GAS of 26%. Those with a score of 0 or 1 were assumed to have a 5% incidence of GAS. The incidences for the other scores and their ranges, the 95% CIs, were taken from the study by McIsaac et al.¹⁵

Several of the values used for the variables deserve comment. First is the incidence of abscess formation. Treatment of pharyngitis with antibiotics reduces the risk of developing PTA sixfold to ninefold.^{23,24} The incidence in untreated GAS pharyngitis is not well studied, but values between 0.5%⁷ and 3%²⁵ have been put forth. We used an incidence of 1.5% for our baseline estimate, with a range of 0% to 3%.

Second is the incidence of ARF. Treatment of GAS pharyngitis with antibiotics reduces the risk of ARF eightfold.¹² A current accurate estimate of ARF risk is unavailable. In 1961, Seigel et al²⁶ reported 2 cases of

TABLE 1 Probability Variables Used in Determining the Cost-Utility of Diagnosing and Treating Pharyngitis Among Children

Variable	Source	Probability		
		Baseline	Range Low	Range High
PTA	See text	0.015	0	0.03
ARF	See text	0.00000656	0	0.000328
Reaction to antibiotics				
Mild	Neuner et al ⁸	0.02	0.007	0.04
Severe	Tompkins et al ¹²	0.0064	0.0025	0.0075
Death	Neuner et al ⁸ ; deShazo and Kemp ¹³	0.00001	0.000005	0.000015
Effective treatment	Pichichero ¹⁴	0.80	0.70	0.90
Incidence of GAS				
General population	Mayes and Pichichero ⁹	0.26		
Score 0 or 1	McIsaac et al ¹⁵	0.05	0.02	0.10
Score 2	McIsaac et al ¹⁵	0.2045	0.1203	0.2888
Score 3	McIsaac et al ¹⁵	0.2754	0.2227	0.3280
Score 4	McIsaac et al ¹⁵	0.6778	0.5812	0.7743
Incidence of clinical scores				
Score 2	McIsaac et al ¹⁵	0.1477	0.1192	0.1761
Score 3	McIsaac et al ¹⁵	0.4631	0.4231	0.5031
Score 4	McIsaac et al ¹⁵	0.151	0.1223	0.1798
Culture sensitivity	Webb ¹⁶	0.834	0.77	0.93
Culture specificity	Webb ¹⁶	0.99	0.95	0.995
Rapid test sensitivity	Webb ¹⁶	0.891	0.80	0.95
Rapid test specificity	Webb ¹⁶	0.95	0.90	0.99

TABLE 2 Cost Variable Values Used in Determining the Cost-Utility of Diagnosing and Treating Pharyngitis Among Children

Variable	Source	Cost, 2003 US Dollars		
		Baseline	Range Low	Range High
PTA	Webb ¹⁶ ; Neuner et al ⁸	5232.25	2234.80	8937.14
Penicillin	Neuner et al ⁸	10.23	5.14	20.56
Cephalosporin	Red Book ¹⁷	20.29		
ARF	Ehrlich et al ⁷ ; Webb ¹⁶	6000	2000	22 928.35
Throat culture	Ehrlich et al ⁷	30 private; 5 Medicaid	1.45	40
Death	See text	10 000	8000	12 000
Mild reaction to penicillin	Neuner et al ⁸	52.10	26.05	104.32
Rapid antigen test	Neuner et al ⁸	15 private; 7.84 Medicaid	3.93	15.69
Rheumatic heart disease	Webb ¹⁶	20 000	5000	25 000
Severe reaction to penicillin	Webb ¹⁶ ; Neuner et al ⁸ ; Lieu et al ¹⁸	4808.07	1812.94	8546.75
Follow-up telephone call	Webb ¹⁶	5.73	0	10
Parental wages (per h)	US Department of Labor ¹⁹	17.18	13	25

TABLE 3 Utility Variable Values Used in Determining the Cost-Utility of Diagnosing and Treating Pharyngitis Among Children

Variable	Source	Utility, QALDs		
		Baseline	Range Low	Range High
PTA	Neuner et al ⁸	5	1.65	10
ARF	Neuner et al ⁸	76.5	9	744
Death	See text	22 995	14 000	25 000
Mild penicillin reaction	Neuner et al ⁸	0.625	0.15	1.50
Rheumatic heart disease	Neuner et al ⁸	744	56	744
Severe penicillin reaction	Neuner et al ⁸	9	3	18
Untreated GAS	Neuner et al ⁸	0.25	0	0.5
After rapid test	Neuner et al ⁸	0.15	0.1	0.25
After culture	Neuner et al ⁸	0.20	0.15	0.25

TABLE 4 Estimated Time of Parental Lost Work for Various Conditions

Condition	Source	Work Lost, h		
		Baseline	Range Low	Range High
GAS untreated	Neuner et al ⁸	16	8	24
Immediate treatment	Neuner et al ⁸	8	0	16
Delayed treatment	Neuner et al ⁸	8	0	16
Death		80	40	120
ARF		80	40	120
Rheumatic heart disease		80	40	120
Mild penicillin reaction		8	4	12
Severe penicillin reaction		40	20	60

ARF among 608 patients with untreated GAS pharyngitis (0.328%; 95% CI: 0–0.784%). There is evidence suggesting that the incidence of ARF has decreased 50-fold since then.²⁷ Consequently, we estimated the incidence of ARF to be one fiftieth the incidence reported by Seigel et al.²⁶ Ten percent of ARF cases result in complications and 1% in death.^{28,29}

Third is the cost of throat culture. Previous estimates of the cost of throat cultures were based on the culture being performed in the physician's office.^{8,16,30} This is no longer a common practice.⁷ We used \$30 as the private patient cost and \$5 as the Medicaid cost.

Fourth is the cost of death. The cost of lost future

wages cannot be used in the standard reference case.¹¹ This cost is an approximate estimate of the medical costs incurred before death.

Fifth is the utility of treatment of GAS pharyngitis. Treatment of GAS pharyngitis with antibiotics hastens recovery, with quicker resolution of sore throat, headache, abdominal pain, and fever.^{24,31} Symptoms improve 16 hours to 2.5 days sooner.^{24,25,32–35} Utility measures are those used by Neuner et al.⁸

Sixth is cephalosporin versus penicillin. A recent meta-analysis suggested that cephalosporins are more effective in the treatment of GAS pharyngitis.³⁶ We modeled this by assuming that the costs of a first-generation cephalosporin were \$20.29, based on the Red Book costs and the pharmacy fee.¹⁷ We assumed that the efficacy improved from 80% to 86%.

Sensitivity analysis of each variable (costs, incidences, and morbidity) across its CI was performed and tornado diagrams were developed. A tornado diagram shows the impact of the range of each variable on the model's outcome. The variables are ordered with those with the broadest range of impact on the top. Variables with progressively narrower ranges of impact are placed below, giving an appearance similar to that of a tornado. Two- and 3-way sensitivity analyses were performed for the most influential variables. Threshold values for vari-

TABLE 5 Costs and Health Impact for the Approaches to Diagnosing and Treating Pharyngitis Among Children, Relative to Treating Everyone

Approach	Cost, 2003 US Dollars	Utility, QALDs
Treatment with penicillin using Medicaid reimbursement, societal perspective		
Treat all	65.1285	0.3103
Treat none	79.1269	0.0512
Rapid testing	43.8112	0.0953
Culture all	40.7639	0.0930
Rapid testing then culture	41.5743	0.0998
Clinical scoring	43.9217	0.1257
Treatment with penicillin using private reimbursement, societal perspective		
Treat all	65.1285	0.3103
Treat none	79.1269	0.0512
Rapid testing	50.9712	0.0953
Culture all	61.5417	0.0930
Rapid testing then culture	66.3079	0.0998
Clinical scoring	48.2950	0.1257
Treatment with cephalosporin using Medicaid reimbursement, societal perspective		
Treat all	70.4419	0.3072
Treat none	79.1269	0.0512
Rapid testing	42.2838	0.0926
Culture all	37.0156	0.0911
Rapid testing then culture	39.5343	0.0970
Clinical scoring	42.6473	0.1241
Treatment with cephalosporin using private reimbursement, societal perspective		
Treat all	70.4419	0.3072
Treat none	79.1269	0.0512
Rapid testing	49.4438	0.0926
Culture all	57.4766	0.0911
Rapid testing then culture	64.2147	0.0970
Clinical scoring	47.0206	0.1241
Treatment with penicillin using Medicaid reimbursement, payer perspective		
Treat all	43.5274	0.3103
Treat none	6.9189	0.0512
Rapid testing	21.1494	0.0953
Culture all	14.4978	0.0930
Rapid testing then culture	24.9238	0.0998
Clinical scoring	20.0975	0.1257
Treatment with penicillin using private reimbursement, payer perspective		
Treat all	43.5274	0.3103
Treat none	6.9189	0.0512
Rapid testing	28.3094	0.0953
Culture all	35.2756	0.0930
Rapid testing then culture	49.6574	0.0998
Clinical scoring	24.4708	0.1257
Treatment with cephalosporin using Medicaid reimbursement, payer perspective		
Treat all	53.1723	0.3072
Treat none	6.9189	0.0512
Rapid testing	23.4822	0.0926
Culture all	14.3155	0.0911
Rapid testing then culture	27.2101	0.0970
Clinical scoring	22.8705	0.1241
Treatment with cephalosporin using private reimbursement, payer perspective		
Treat all	53.1723	0.3072
Treat none	6.9189	0.0512
Rapid testing	30.6422	0.0926
Culture all	34.7766	0.0911
Rapid testing then culture	51.8905	0.0970
Clinical scoring	27.2439	0.1241

ables for the most influential variables were determined. For comparison, analyses were performed by using a payer perspective, in addition to the societal perspective. A CI for the estimated costs and utility for each of 6 options was estimated with Monte Carlo simulation with

10 000 repetitions. Monte Carlo simulations use random sampling techniques to assign values from within a specified range and distribution for each of the variables in the model. The cost-utility model is run once with the value of each variable assigned. With repeated simula-

tions, a distribution of results for the model is generated, from which mean values and CIs can be estimated. The analyses were performed with DATA 3.5 for Healthcare for Windows (TreeAge Software, Williamstown, MA).

RESULTS

The costs and utility measures for each of the scenarios are given in Table 5. These values are shown graphically in Figs 1 and 2 as health policy space. The points in the health policy space that are below (less morbidity) and to the left (less expensive) than other points dominate.

When a societal perspective is used and testing is reimbursed at Medicaid rates, treating all cases of pharyngitis is dominated by the clinical scoring, rapid test, culture, and rapid test then culture options. Similarly, the scoring option is dominated by the rapid test, culture, and rapid test then culture options. The rapid test option and the rapid test then culture option are both dominated by the culture option. The expense of moving from the culture option to the test none option, which had lower morbidity rates, would be \$288 117.18 per QALY. Consequently, in this reimbursement setting, performing a throat culture for all patients with pharyngitis has the best cost-utility.

When a societal perspective is used and testing is reimbursed at private insurance rates, treating all cases of pharyngitis is dominated by the clinical scoring, rapid test, and culture options. The rapid test then culture option is dominated by both the rapid test and culture options. To move from the scoring option to the rapid test option, which has lower morbidity rates, would cost \$32 132.01 per QALY, which by our criteria is worth the expense. To move from the rapid test option to the

culture all option would cost \$1 677 492.39 per QALY, and moving to the test none option would cost \$233 034.71 per QALY. Consequently, in this reimbursement setting, performing a rapid test for all patients with pharyngitis has the best cost-utility. From the payer perspective, the test none option dominated all other options by having the lowest morbidity rate and the lowest cost.

Tornado diagrams are depicted in Figs 3 and 4 for impact on costs and utility, respectively. Not surprisingly, the incidences of PTA and ARF after untreated GAS pharyngitis have the largest impact on the model. For example, 4 of the 5 factors most influential with respect to morbidity reflect the incidence and health impact of PTA and ARF.

In 1-way sensitivity analysis using a privately insured patient as the baseline, only 1 variable changed the preferred option over its range of values. If the cost of a throat culture was below \$17.13, then the throat culture only option had the best cost-utility. Two-way sensitivity was performed on the cost of a throat culture and the cost of a rapid test. The results are shown in Fig 5. When the costs of both tests were low, the option of a rapid test followed by a culture for those with negative results was preferred. As the cost of a rapid test increased, the throat culture only option was preferred; as the cost of a throat culture increased, the rapid test only option was preferred.

From the societal perspective, prescribing cephalosporins decreased overall costs and morbidity rates for the clinical scoring, rapid test, culture all, and rapid test then culture options. The treat all option had an increase in cost but a decrease in morbidity rate. This improvement

FIGURE 1

Health policy space for the 6 strategies for management of pediatric pharyngitis from a societal perspective. Values represented by squares reflect Medicaid reimbursement for testing, whereas values represented by circles reflect reimbursement from private insurance.

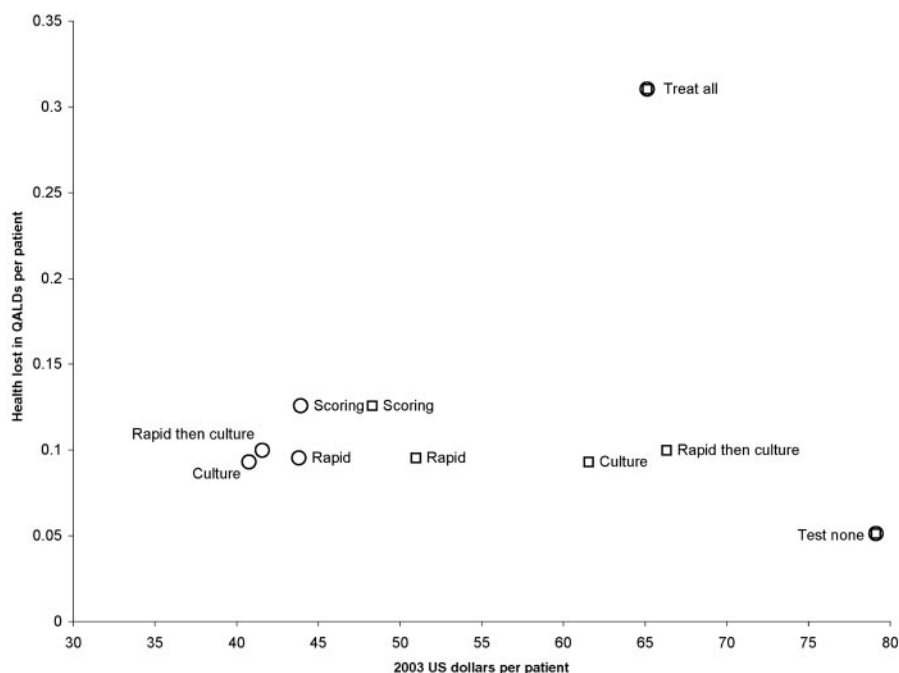


FIGURE 2

Health policy space for the 6 strategies for management of pediatric pharyngitis from a payer perspective. Values represented by squares reflect Medicaid reimbursement for testing, whereas values represented by circles reflect reimbursement from private insurance.

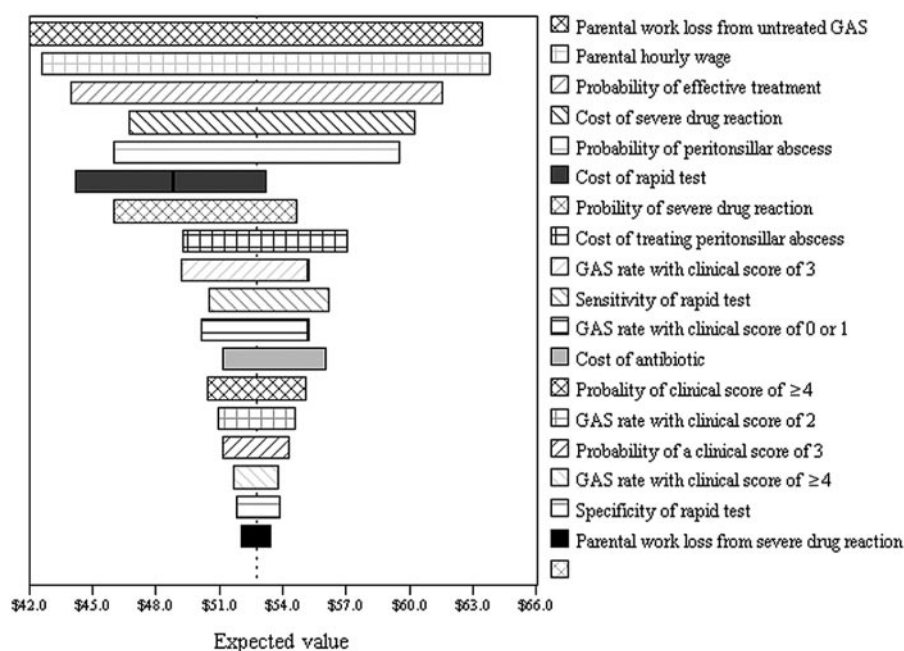
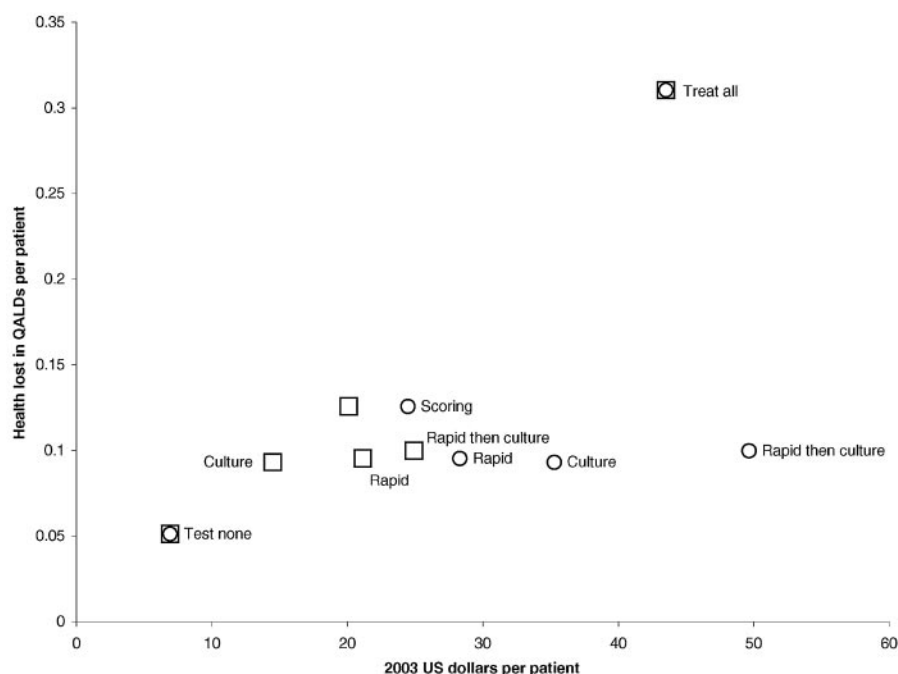


FIGURE 3

Tornado diagram indicating the variables with most influence on costs.

in health would cost \$625 492.00 per QALY. The test none option, as expected, remained unchanged. From the payer perspective, all options except test none had decreases in morbidity rates, but only the culture all option had decreased costs. The treat all option would cost \$1 135 609 per QALY saved. The clinical scoring option would cost \$632 000 per QALY, the rapid test option would cost \$315 000 per QALY, and the rapid test then culture option would cost \$291 000 per QALY. None of these trade-offs are considered acceptable. From

a payer perspective, the test none option had the lowest cost and lowest morbidity rate.

The results of the Monte Carlo analysis are shown in Table 6 and as health policy space in Fig 6. In the comparisons of the options, the treat none option was significantly more costly ($P > .05$) than the scoring, rapid test, culture all, and rapid test then culture options. Conversely, the treat all option has significantly more ($P > .05$) morbidity than all other options. The treat none option had significantly less morbidity

FIGURE 4
Tornado diagram indicating the variables with the most influence on utility.

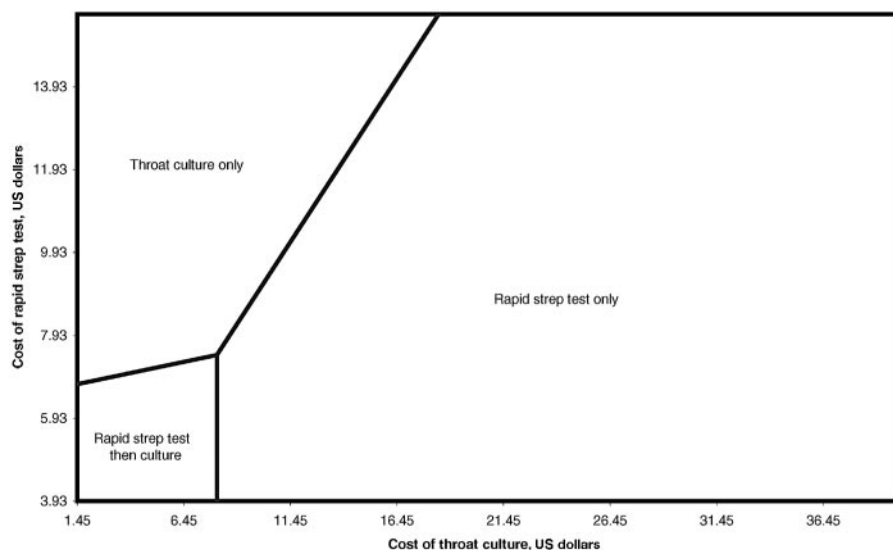
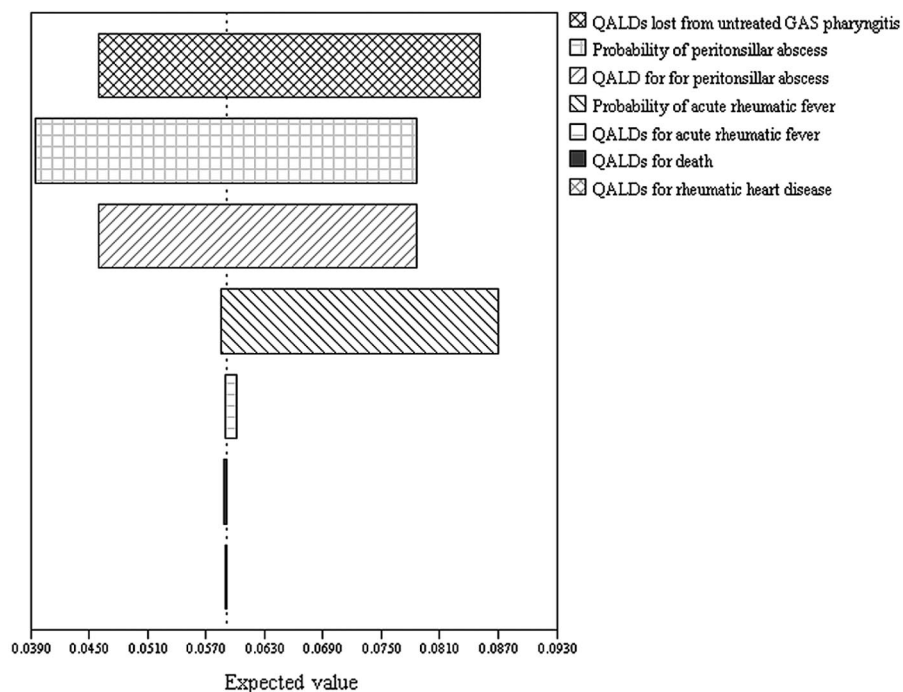


FIGURE 5
Two-way sensitivity analysis with the cost of rapid antigen testing on the y-axis and the cost of throat culture on the x-axis. Strept indicates streptococcus.

than all other options. The error in the model, as evidenced by the 95% CI bands, makes it difficult to recommend definitively one of the testing options over the others.

DISCUSSION

When the cost of a culture is low, in comparison with a rapid test, culturing samples for all children with pharyngitis may be the best option. As the cost of a throat culture increases, relative to the price of a rapid test, the rapid test becomes a better option. In neither setting did the rapid test followed by culture option add much value. The amount of morbidity avoided for the large

expenditure was not within the currently acceptable range. No intervention had the lowest overall morbidity rate and, from the payer perspective, it was also the least expensive option.

The justification for testing for and treating GAS pharyngitis among children is to prevent the sequelae of infection. With the risk of ARF being one fiftieth of that reported previously, this model reflects the minimal impact of this complication. Not surprisingly, the incidence of the serious complications from GAS pharyngitis had the most impact on the model. Unfortunately, the studies in which the incidences of ARF and PTA after untreated GAS pharyngitis were estimated are few in num-

TABLE 6 Estimates and 95% CIs for the Cost per Patient and the Health Lost per Patient for the Approaches to Diagnosing and Treating Pharyngitis Among Children

Approach	Cost, 2003 US Dollars (95% CI)	Health Lost, QALDs (95% CI)
Treat all	68.76 (44.20–93.33)	0.2943 (0.1886–0.4001)
Treat none	101.15 (57.33–144.97)	0.0793 (0.0436–0.1150)
Rapid testing	52.74 (34.72–70.76)	0.0981 (0.0664–0.1298)
Culture all	60.60 (35.38–85.81)	0.1002 (0.0710–0.1294)
Rapid testing then culture	58.98 (37.27–80.69)	0.0994 (0.0659–0.1329)
Clinical scoring	52.59 (33.95–71.23)	0.1310 (0.0896–0.1725)

ber and markedly outdated. We think our estimate of PTA overstates the risk of this complication, because it is rarely seen in a primary care practice. If for every patient seeking health care with a sore throat there are 4 to 6 who do not,^{37,38} one would expect to treat more cases of PTA, considering that many, if not most, cases of GAS pharyngitis never present to a physician for care. Conversely, the overprescription of antibiotics may have a role in the decreased incidence of ARF. If treatment of GAS pharyngitis is to be recommended, then the rates of ARF and PTA among untreated patients need to be measured accurately, to justify this recommendation.

Several analyses have suggested that cephalosporins are more effective in eradicating GAS from the throat of affected individuals. Some have suggested that these differences merely reflect the ability of cephalosporins to eradicate GAS in the throat of those normally colonized with the organism. We attempted to measure the impact of using a more expensive antibiotic with slightly improved efficacy, and we found that using low-priced first-generation cephalosporins could decrease costs and morbidity rates. The science behind the increased effec-

tiveness of the cephalosporins has, however, been called into question.³⁹

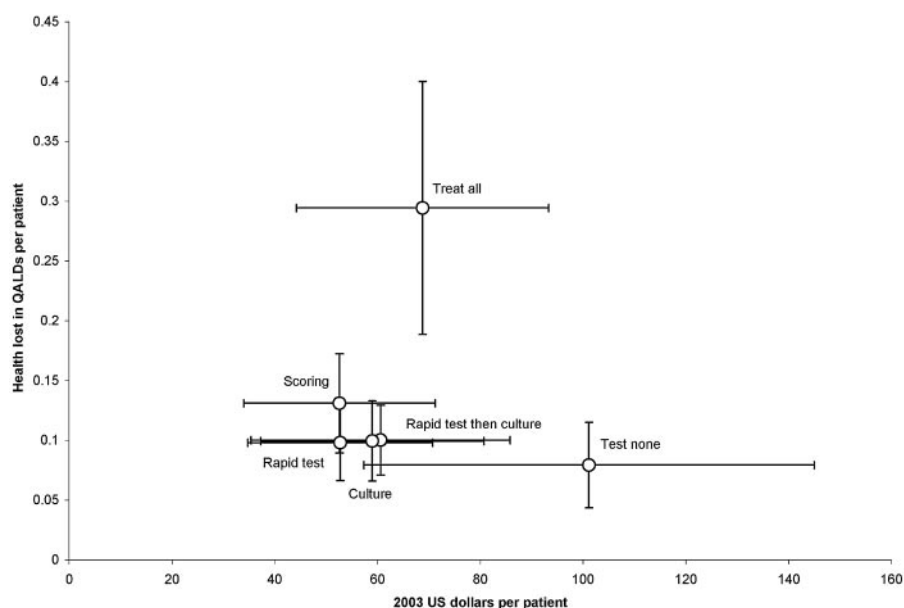
The financial costs estimated with these models, much like other cost-utility analyses involving children,⁴⁰ are driven by parental time lost from work. Inclusion of this element in the societal perspective continues to be controversial. One issue driving the controversy is parental time lost from work for contagious infectious illnesses with little morbidity. Small changes in length of illness translate into large changes in overall costs, because the costs from parental time lost from work are disproportionate to the medical costs associated with the illness.

To convey the influence of this factor, most analyses report results from both the payer perspective and the societal perspective. This analysis is no different. The recommended option is markedly different, depending on the model's perspective.

To measure the certainty with which recommendations can be made, the CIs of the model estimates need to be calculated. One method is to calculate the most extreme situations and to expect that the 95% CIs of the estimates lie within that range. The preferred alternative is to use Monte Carlo simulations. By running the model 10 000 times, with values for the variables selected from their expected ranges and distributions, a probability distribution for the model estimates is produced. This gives a clearer idea of the model's variability and reliability. In this case, 4 of the options demonstrated considerable overlap. The variability and overlap seen in our Monte Carlo simulations help explain the varying recommendations from previous studies. These simulations also provided the range within which this model can be trusted. Most of the variance in the model is from im-

FIGURE 6

Health policy space for the 6 strategies for management of pediatric pharyngitis from a societal perspective, showing estimates of the means and 95% CIs with 10 000 Monte Carlo simulations.



precision and lack of confidence in the accuracy of model assumptions, which reflect the quality of studies on which the values of the assumptions were based.

As with any model, the results are driven by the model's assumptions. For example, Lieu et al¹⁸ assumed that the rapid test had a sensitivity of 55% and that a culture cost \$5. Not surprisingly, their model recommended throat cultures over the rapid test. Several studies have recommended the rapid test, primarily because of delays in treatment associated with using throat cultures.^{16,29,32}

One study found that patients with non-GAS pharyngitis treated with antibiotics had symptoms for 0.9 days less than patients with non-GAS pharyngitis not treated with antibiotics.²⁵ Other studies failed to document the same results.^{31,34} If antibiotics shorten the duration of non-GAS pharyngitis, then the treating all patients with pharyngitis may become a reasonable option. Clearly, this is an area deserving additional study.

Before recommending observation rather than treatment of GAS pharyngitis, accurate estimates of the risk of developing ARF and PTA after untreated GAS pharyngitis, both regionally and nationally, are needed. If these risks are found to be low enough to support observation instead of testing and treatment, then the next major barrier would be to make observation acceptable to parents.

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DOCTORS WILL PUSH TO VACCINATE KIDS FOR SEXUAL DISEASE

“With sexually transmitted diseases on the rise among teens, a majority of pediatricians in a survey say they intend to recommend a new vaccine for children as young as nine to protect against a virus linked to cervical cancer. But the doctors admit their biggest concern is getting parents to face up to the threat of STDs, and convincing them of the benefits of protecting children, especially before they reach puberty. Vaccines to prevent cervical cancer and genital warts, which are caused by the human papilloma virus, are expected to be available in the U.S. sometime next year. . . . Nearly 75% of pediatricians in a survey led by researchers at Cincinnati Children’s Hospital said they would recommend a vaccine, if approved, to boys and girls between the ages of 9 and 17. But in the survey of 513 pediatricians around the country, published in the *Journal of Adolescent Health*, more than 40% said they expect parents to be reluctant to discuss sexuality and sexually transmitted diseases with their children, and half the pediatricians expect parents to resist vaccinating their child against any sexually transmitted infection. About 42% expect parents to fret that immunization may lead to riskier sexual behaviors, and fully 70% said they expect safety concerns about the HPV vaccine to weigh on parents’ decisions to immunize children. . . . ‘There is a huge need to educate parents about the importance of the vaccine in protecting their children from harm,’ says Jessica Kahn, a Cincinnati pediatrician who conducted the survey. HPV infection is common among sexually experienced youth, Dr. Kahn says; almost half of the 15- to 19-year-old young women who participated in a recent study were HPV-positive within three years of sexual initiation. Dr. Kahn says it is possible that vaccination will be recommended for boys as well as girls, and if so, it will be important to educate doctors and parents about the importance of administering it to both.”

Landro L. *Wall Street Journal*. December 30, 2005

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Diagnosis and Management of Pharyngitis in a Pediatric Population Based on Cost-Effectiveness and Projected Health Outcomes

Robert S. Van Howe and Louis P. Kusnier, II

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