Objective: To assess the medical costs and the number of quality-adjusted life years lost owing to juvenile-onset recurrent respiratory papillomatosis (JORRP).

Design: We examined hospital and physician charges for JORRP surgical procedures in Maryland in 1994 adjusting for inflation and the cost-charge ratio. Centers for Disease Control and Prevention data on treatment intensity for JORRP were augmented with a review of treatment records for 18 patients with JORRP. Sensitivity analyses were performed. To illustrate the application of our cost estimates, we compare the costs of JORRP to the costs of the surgical procedures that would be necessary to prevent it.

Results: We find that the present value at birth of the cost of a single case of JORRP is $201,724 (range, $61,822-$474,334). The annual cost for a single case of JORRP is $57,996 (range, $32,407-$94,114). The annual cost of JORRP in the United States is between $40 million and $123 million depending on the prevalence. Cesarean section (CS) for women with condyloma has been suggested as a potential strategy to prevent JORRP, but its efficacy remains to be determined. Our results suggest that if only 1% of the CSs actually prevented JORRP, this strategy would be a cost-effective means to prevent JORRP.

Conclusions: Studies to reduce the uncertainty surrounding the efficacy of CS and the effect of both CS and JORRP on families need to precede consideration of a policy of CS for women with clinically evident genital condyloma. Patients should be kept thoroughly informed about the role of CS for the prevention of JORRP and the nature of the remaining uncertainties.
METHODS

The present value of the total benefits derived from a prevented case of JORRP is calculated in dollar costs and quality-adjusted life-years (QALYs). The assumptions behind these estimates of cost and disease burden are varied to assess sensitivity of the results. These estimates are subsequently compared with the additional costs of a policy to perform elective CS for all pregnant women who enter the ninth month of pregnancy having genital condyloma visible on physical examination.

This study adheres to published guidelines for conducting cost-effectiveness studies. We adopt the perspective of the medical sector.

MEDICAL BENEFIT

The medical benefit of preventing JORRP can be expressed in prevented medical costs. Most of the medical costs of JORRP are incurred as children undergo repeated laser surgical procedures to ablate laryngeal lesions. Most children undergo fewer than 15 procedures in a lifetime, but some undergo far more, and a handful of children are unfortunate enough to require tracheostomy. Most children begin their surgical experience after the age of 2 years and continue to have operations for many years.3

NUMBER OF SURGICAL PROCEDURES

The National Registry for Recurrent Respiratory Papillomatosis has enrolled 399 children with JORRP (defined as active cases younger than 18 years) from 20 different tertiary care centers across the United States. Because the national registry provides a cross-sectional view of prevalent cases from infancy to late adolescence, the reported annual mean number of surgical procedures of 4.4 (range, 0.03-18.9) is likely to be weighted downward by the presence of less intense cases from the older age groups.

From a clinical standpoint there is wide variation in the duration of JORRP; an individual case is characterized by alternating periods of exacerbation and latency. The type of long-term prospective data on disease intensity required to adequately model the dynamic nature of this disease do not exist. As an alternative, we assume that, on a population basis, the disease follows a simple process: incident cases flow into a pool of prevalence that after an average dwell time releases a flow of remissions back to a state of health. In equilibrium the incidence rate equals the remission rate. To a first approximation the remission rate equals the number of prevalent cases divided by the dwell time. Applying these approximations to the Centers for Disease Control and Prevention estimates of US prevalence (1400-2226 cases) and incidence (254-763 cases per year) leads to the estimate that average population dwell time in the diseased state is 2.9 to 5.5 years or an average of 4.2 years. The notion of “population dwell time” will have little relation—to the observed duration of disease in any individual patient—particularly because of the prolonged relapsing nature of any individual case. As an approximation, the population perspective is appropriate only for policy analysis—it should not be used for prognosis in clinical practice. We believe that if anything, 4.2 years understates the true duration with which the population of patients with JORRP endures a disease intensity of 4.4 surgical procedures per year.

MEDICAL COSTS PER SURGERY

Treatment costs for patients with JORRP are incurred primarily at each operation, although physicians provide nonsurgical services such as monitoring disease progression and providing medical therapies for the disease. Based on a review of the practice style of a single surgeon and 217 patient encounters for JORRP, we found a ratio of 1 surgical encounter for every 3 nonsurgical visits.

The cost of each nonsurgical visit is estimated as the fee from the Maryland Resource-Based Relative Value Scale (RBRVS) fee schedule for an office visit for an established patient encounter for every 3 nonsurgical visits. The physician cost of each surgical visit is estimated as the fee from the Maryland RBRVS fee schedule for direct operative laryngoscopy with excision of tumor which was $339 in 1997.

Estimates of the hospital cost of each surgical visit are based on the Maryland Health Services Cost Review Commission hospital charges for visits to hospitals by patients younger than 20 years who had as their diagnosis benign neoplasm of the larynx. The Health Services Cost Review Commission collects administrative data for every hospitalization in the state of Maryland. Hospital costs in

multaneously setting all of the parameters at their extreme values. The Figure presents a “tornado diagram” to display the sensitivity of the estimates to perturbations of individual parameters. The diagram indicates that the estimates are the most sensitive to changes in the discount rate and surgical procedures per year. A similar exercise with the parameters used for QALYs suggested that the case-fatality rate was the most crucial parameter making up the estimates of QALYs.

We have estimated that the lifetime disease burden of an average patient with JORRP can be expressed as 2.01 QALYs. The lifetime costs to the medical sector alone are in the range of $201,724. To illustrate how these estimates can be applied to policy analysis one can consider what medical costs of CS could be justified by the medical costs of JORRP. Evidence that JORRP is less common in children born by CS has motivated some to consider a policy of offering CS to women with clinically evident genital condyloma. The efficacy of such a policy remains unknown.

Of the 4 million women giving birth each year in the United States, approximately 3.1 million have vaginal deliveries. Of these, approximately 1% are thought to have clinically evident condyloma. What if a policy calling for CSs in the 31,000 pregnant women with condyloma offered a disease preventing benefit to
Maryland were just 0.16% below the national average per adjusted hospital admission.8

The average charge from 47 randomly selected patients with a diagnosis of JORRP was $4400 in 1994, which when inflated to 1997 dollars and subjected to the Maryland-cost charge ratio leads to the cost estimate of $4374 in 1997 dollars. Thus each surgery is associated with hospital costs of $4374 + physician costs of $339 + 3 outpatient visits at $38 (or $104) for a total cost of $4817 per surgery.

The National Registry for Recurrent Respiratory Papillomatosis reports that 11% of 397 children have ever had a tracheostomy.7 However, Derkay et al found a lifetime prevalence of tracheostomy of 14% of children described in a survey of practicing otolaryngologists. Tracheostomy remains a last resort in the treatment of JORRP. To our knowledge, there are no published studies of the medical costs incurred by patients who underwent tracheostomy for JORRP. Medical costs for patients with conditions requiring tracheostomy for mechanical ventilation assistance suggests that these costs exceed $100 000 per year.9 Patients with JORRP generally do not require mechanical ventilation assistance so their costs could be lower. Uncertainty about tracheostomy maintenance costs incurred by patients with JORRP is modeled by using a range of figures (mean range) from $75000 ± $15000 per year. We assume that these costs are incurred over a 4.2-year time horizon for 14% of the population with JORRP.

QUALITY OF LIFE AND COSTS PER DISEASE EXACERBATION AND SURGERY

Based on Johnson et al10 the Quality of Well-Being (QWB) score of adults for 1 day of severe shortness of breath was 0.68 (reference range, 0-1). Assuming that adult QWB can be scaled similarly to children and that each operation is associated with 14 days of severe shortness of breath leads to the estimate of 0.0012 lost QALYs per surgical procedure.

DEATH

With the provision of regular and timely medical intervention, death is a rare complication of JORRP. The Centers for Disease Control and Prevention’s death certificate database11 lists 64 deaths in patients aged between 0 and 24 years from benign and malignant neoplasms of the larynx (International Classification of Diseases, Ninth Revision codes 937 of the 254 to 763 annual cases of JORRP. Simple calculations suggest that if medical cost minimization were the only concern and it were proven that performing 100 prophylactic CSs could prevent a single case of JORRP, then such a strategy would be cost beneficial. The extra cost of an elective CS over and above vaginal delivery is about $2500.12 Performing 100 CSs would cost the medical sector $250 000 and if by preventing a case of JORRP this strategy produced 2.09 QALYs, that would yield a cost-effectiveness ratio of $120 000 per QALY. The figure of $120 000 is high, but within the range of cost-effectiveness ratios for many accepted interventions currently widespread in medical practice.

But there is still no prospective evidence to support such a strategy. Furthermore, there are many factors other than cost minimization that would properly bear on the method with which an infant is delivered.

Neither the American College of Obstetricians and Gynecologists nor the American Academy of Pediatrics has endorsed a policy of offering elective CS to pregnant women with visible genital condyloma. Seldom do current local standards of obstetric practice lead physicians to even discuss an option of delivery by CS with a woman at risk. There is evidence that a bill for a CS where the indication is condyloma would be denied by third-party payers. These might be considered “patient-elected” CSs by some insurers.18,19 Based on the foregoing estimates, one might consider it hasty for an insurer to deny pay-
ment to a clinician who combines emerging evidence and judgment in an attempt to prevent a high-cost pediatric disease.

**CONCLUSIONS**

The potential for there to be as much as $123 million in annual medical cost savings from preventing JORRP is a strong justification for public investment in research that will help lead to its prevention. A prospective study of the efficacy of preventive interventions would be one of the more costly research tasks in this area, but would be justified by the costs of the disease.

Substantial uncertainty remains to be resolved before policymakers will be in a position to recommend CS as a nationwide policy for all pregnant women with visible genital condyloma. In the interim, parents at risk ought to be given the opportunity to weigh the existing evidence in a context that appropriately conveys the remaining and substantial uncertainty about the potential benefit of CS. A clinician whose best judgment supports the recommendation of

### Variables, Range, and Sources for Juvenile-Onset Recurrent Respiratory Papillomatosis (JORRP) *

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* Md HSCRC indicates Maryland Health Services Cost Review Commission; HCFA, Health Care Financing Administration; and CDC, Centers for Disease Control and Prevention.

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Tornado diagram showing the results of the sensitivity analysis. The solid vertical line represents the cost estimate of $201,724 per case of juvenile-onset recurrent respiratory papillomatosis; horizontal bars, the range of cost estimates obtained by setting each variable at the lower and upper limit of its range and holding all other variables constant at their baseline value; and top bar, the range obtained by simultaneously setting all variables at the limit of their range.
prophylactic CS to prevent JORRP could be practicing cost-conscious medicine.

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Correction

Calculation Error. In the article titled “The Cost of Juvenile-Onset Recurrent Respiratory Papillomatosis,” by Bishai et al, published in the August 2000 issue of the Archives (2000;126[8]:935-939), an error in the spreadsheet used to calculate the costs of juvenile onset respiratory papillomatosis (JORRP) produced an incorrect estimate of cost and discounted quality-adjusted life-years (QALYs) in the “Results” subsection of the “Abstract” and the first 2 paragraphs of the “Results” section on page 935. The corrected paragraphs should read as follows:

“Annual costs incurred by a statistical case of JORRP are estimated to be $29,946. Setting all parameters at their extreme values, the range for this estimate is $19,101 to $43,267. The present value of the lifetime costs are estimated at $104,159 in the baseline estimate with extreme values of $43,267 to $218,067. Based on the estimated prevalence, the annual medical costs of JORRP in the United States are estimated at $42 to $67 million.

We estimate the burden of lost QALYs at 0.31 per year of disease. Setting all parameters at their extreme values, the range for this estimate is 0.10 to 0.96 QALYs lost per year of JORRP. The estimated number of discounted lifetime QALYs lost due to a single case of JORRP is 1.21 with an extreme range of 0.26 to 4.89 QALYs.”

We gratefully acknowledge Harrell Chesson, PhD, in calling these errors to our attention.