

Malpractice Risk Among US Pediatricians



WHAT'S KNOWN ON THIS SUBJECT: Despite evidence on how malpractice risk varies according to physician specialty, there is growing but still limited evidence about malpractice among US pediatricians. The frequency of malpractice claims against pediatricians is low among specialties, but payments are among the highest.



WHAT THIS STUDY ADDS: This study describes malpractice risk among US pediatricians using data from a nationwide liability insurer covering 1630 pediatricians from 1991 to 2005. It compares pediatric malpractice experience with other specialties and studies patient factors associated with pediatric malpractice claims.

abstract



OBJECTIVE: To characterize malpractice risk among US pediatricians.

METHODS: We analyzed malpractice claims of all pediatricians and other physicians covered by a nationwide liability insurer from 1991 to 2005 ($n = 1630$ pediatricians; 40 916 total physicians). We characterized annual malpractice risk among pediatricians compared with other physicians. We characterized claims according to patient age, injury type, months required to resolve the claim, and whether an indemnity payment was made. We estimated how patient age and injury type were associated with whether a claim resulted in payment to a patient (and if so, payment size) and the time required to resolve the claim.

RESULTS: The annual percentage of pediatricians facing a malpractice claim was 3.1% (7.4% among other physicians, $P < .001$). Among 404 claims, 83 (20.5%) resulted in an indemnity payment and 15 (3.7%) resulted in a payment exceeding \$1 million. Annual rates of indemnity were lower among pediatricians (0.5%) than other physicians (1.6%, $P < .001$), whereas rates of payments exceeding \$1 million were similar (0.13% among pediatricians and 0.11% among other physicians, $P = .57$). The mean indemnity payment was \$562 180 (SD \$667 962). Cases with permanent injury ($n = 172$) had larger mean payments (\$703 373) compared with fatalities (\$559 102; $n = 131$) or temporary or psychological injuries (\$127 663; $n = 101$), $P < .05$. The mean time to resolution was 23.4 months (SD 21.8 months).

CONCLUSIONS: Indemnity payments among pediatricians are infrequent but large, particularly in cases with permanent patient injury rather than death or temporary injury. The time required to resolve claims may be considered to be long. *Pediatrics* 2013;131:1148–1154

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KEY WORDS

malpractice, litigation

ABBREVIATION

NPDB—National Practitioner Data Bank

Drs Jena and Seabury carried out the initial analysis and drafted the initial manuscript; all authors conceptualized and designed the study, reviewed and revised the manuscript, and approved the final manuscript as submitted.

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Despite evidence on how malpractice risk varies according to physician specialty,^{1–6} there is growing but less evidence about malpractice risk among US pediatricians.^{7–9} Pediatric and obstetric malpractice is clearly unique among physician specialties in that the victims of malpractice are predominantly children. And while there has been public concern expressed about high malpractice costs for obstetricians,¹⁰ pediatric malpractice has received less attention.^{11–14} This is important given that although the frequency of malpractice claims against US pediatricians is among the lowest of all specialties, the mean malpractice indemnity payments paid by pediatricians are among the highest.^{1,3} For example, in a recent study of malpractice claims of a nationwide liability insurer, pediatricians ranked 24 of 25 specialties in the proportion of physicians facing a malpractice claim annually (2.8% annual rate). The mean indemnity payment, however, was the largest among all specialties (\$520 904 among pediatricians compared with \$274 887 among all physicians).³ Pediatric malpractice differs from other specialties in other important dimensions as well; for instance, previous work studying outcomes of malpractice cases litigated against physicians found that pediatrics was among the lowest specialties in rates of case dismissal by a judge and highest in rates of claims that are eventually litigated.⁴

Previous studies of pediatric malpractice have primarily relied on data from 2 sources, each with their own strengths and limitations. One study used national data from the National Practitioner Data Bank (NPDB),⁷ which includes most cases in the United States in which a plaintiff was paid on behalf of a licensed health care provider.¹⁵ However, the NPDB has known limitations in terms of its ability to accurately identify pediatric malpractice cases and to

analyze claims that do not result in payment to a patient.^{16–18} As shown elsewhere, these unpaid claims against physicians are substantially more prevalent than paid claims³ and contribute to the overall cost of the malpractice system through defense costs.¹⁹ A related study of malpractice claims from the Physician Insurers Association of America, a large trade association of malpractice companies, allowed for analyses of both paid claims and claims against pediatricians that did not result in payment; however, it was aggregate in nature and did not estimate the overall risk and predictors of malpractice among pediatricians.⁹

We analyzed unique malpractice data on all pediatricians covered by a large, nationwide liability insurer. Data from this insurer have been used to study outcomes of malpractice claims that undergo litigation, malpractice risk according to physician specialty, and defense costs of malpractice.^{3,4,19} At the pediatrician level, we characterized the annual malpractice risk among pediatricians compared with all physicians covered by the insurer. At the malpractice claim level, we characterized claims according to age of the patient, type of injury, time required to resolve the claim, and whether an indemnity payment was made to a patient. Among all malpractice claims, we estimated how patient age and type of injury were associated with whether a claim resulted in payment to a patient and the time required to resolve the claim. Among claims resulting in indemnity payments, we also estimated how these factors were associated with payment size.

METHODS

Malpractice Data

We obtained all malpractice claims closed between 1991 and 2005 against all physicians covered by a large

physician-owned professional liability insurer with coverage in every US state and the District of Columbia ($n = 40\,916$). The safeguarding procedures of these data were approved by the institutional review board at RAND. Claims were defined as an allegation of malpractice against a physician and a request for compensation by either an injured patient or the patient's attorney. Once a claim is filed, the physician, insurer, and the patient's attorney negotiate to resolve the case, with a settlement possible at any stage before or after trial.

Across all physicians, there were 233 738 physician-years of coverage, reflecting a mean length of coverage of 5.7 years per physician. There were 30 751 claims closed during the study period that involved some defense cost. Claims that involved no defense costs were excluded, as these involved claims that were preemptively reported by physicians to the insurer in anticipation of an actual patient claim, but no claim was ultimately filed by a patient.^{3,4} Claims that were not closed by 2005 were unavailable. The insurer covered 1630 (4%) pediatricians with 7581 physician-years of coverage (mean length of coverage 4.6 years). Among pediatricians, there were 404 malpractice claims closed during the study period.

Our data included information for each physician on whether a malpractice claim was closed against that physician in a given year. We were able to distinguish between malpractice claims that resulted in an indemnity payment to a patient and those that did not. This is important because previous work has demonstrated that although a minority of malpractice claims result in indemnity payment, claims without payments are frequent and may be important drivers of physician perceptions of malpractice risk.³

In addition to the physician-level data, each malpractice claim included the severity of patient injury, the age of the injured, the time required to resolve the claim (defined as the time elapsed between when a claim was filed and resolved), and whether a plaintiff was paid and if so the size of the indemnity payment. We coded injury severity into 3 categories: death of the patient, permanent injury, or temporary or psychological injury. Age of the injured was divided into 3 categories as well: younger than 1 month, between 1 and 12 months, and older than 1 year. Indemnity payments that were associated with a claim were normalized to 2008 dollars by using the Consumer Price Index. These payments arose from either settlement with the claimant or trial verdict.

Physician-Level Analysis of Malpractice

We began by describing malpractice risk among pediatricians at the physician level. We calculated the annual percentage of pediatricians who faced a malpractice claim, the annual percentage who made an indemnity payment to a patient, and the annual percentage who made an indemnity payment exceeding \$1 million (often termed a blockbuster payment or jackpot award).³ We compared malpractice risk among pediatricians with all other physicians in our sample, as well as physicians practicing in high- and low-risk specialties. After previous work with these data, high- and low-risk specialties were defined according to the annual percentage of physicians facing a malpractice claim.³ High-risk specialties included neurosurgery, cardiothoracic surgery, general surgery, orthopedic surgery, and plastic surgery; low-risk specialties included dermatology, family general practice, pediatrics, psychiatry, and other specialties.³ In this study, pediatrics was excluded from the low-risk category to

allow for comparison with other low-risk specialties.

Claims-Level Analysis of Malpractice

We examined several characteristics of pediatric malpractice claims, including the mean percentage of claims resulting in an indemnity payment, the mean percentage resulting in an indemnity payment exceeding \$1 million, the mean indemnity payment among claims in which a payment was made, the mean length of time required to resolve a malpractice claim from the time it was filed, and the distribution of claims according to patient age and injury severity.

To understand how patient characteristics, such as age and injury type, affected the outcomes of malpractice claims, we also explored whether patient age and injury type were independently associated with 3 outcomes: the probability that a malpractice claim resulted in payment, the time required to resolve claims, and the size of indemnity payments. For each of the outcomes, we reported both unadjusted and adjusted means according to patient age category and injury type (temporary or psychological injury, permanent disability, and death). Adjusted means were estimated from multivariate regressions of each outcome variable against patient age and injury type. Physician age and state and year fixed effects were also included. We used joint significance tests (*F*-tests) to assess the statistical significance of the differences across patient age and injury type categories. As noted in past work, these data oversample physicians in California.³ To adjust for the lack of geographic representativeness, sampling weights were based on county-level statistics on the number of physicians from the Area Resource File.³ Stata version 11 (Stata Corp, College Station, TX) was used for statistical analyses.

RESULTS

Annual Malpractice Risk Among Pediatricians

Pediatricians faced substantially lower annual rates of malpractice claims and indemnity payments compared with other physicians (Table 1). For instance, the percentage of pediatricians facing a claim in a given year was 3.1% compared with 7.4% among all other physicians ($P < .001$) and 14.5% among physicians in high-risk specialties ($P < .001$). Annual rates of indemnity payments were also lower among pediatricians (0.5%) compared with other physicians (1.6%, $P < .001$) and high-risk specialists (3.3%, $P < .001$). Despite substantially lower rates of both malpractice claims and overall indemnity payments, rates of indemnity payments exceeding \$1 million (blockbuster awards) were statistically indistinguishable between pediatricians (0.13%) and all other physicians (0.11%, $P = .57$). Similarly, rates of indemnity payments exceeding \$750 000 were similar between pediatricians (0.16%) and other physicians (0.13%, $P = .59$).

Characteristics of Malpractice Claims Among Pediatricians

Among 404 malpractice claims closed during the study period, 83 (20.5%) resulted in an indemnity payment, 18 resulted in a payment exceeding \$750 000 (4.5%), and 15 resulted in a payment exceeding \$1 million (3.7%) (Table 2). The mean time to resolution across all claims was 23.4 months and the mean payment among claims with an indemnity payment was \$562 180. The median indemnity payment was \$187 546, reflecting the skewed nature of the indemnity payments. Mean time to resolution increased substantially over the study period; for example, mean time to resolution was 11 months from 1991 to 1995, 23 months from 1998 to 2000, and 30 months from 2004 to 2005. Most

TABLE 1 Annual Percentage of Pediatricians With a Malpractice Claim Compared With Other Physician Specialties

	Pediatricians	All Other Physicians	High-Risk Specialties	Low-Risk Specialties
Number of physicians	1630	39 918	6115	11 928
Number of physician-years	7581	235 567	37 129	73 696
Any claim in year, % (<i>P</i> value)	3.1	7.6 (<.001)	14.1 (<.001)	4.5 (<.001)
Claim with indemnity payment in year, % (<i>P</i> value)	0.5	1.6 (<.001)	3.3 (<.001)	1.0 (.002)
Claim with payment \geq \$750 000 in year, % (<i>P</i> value)	0.16	0.17 (.86)	0.22 (.33)	0.13 (.59)
Claim with payment \geq \$1 million in year, % (<i>P</i> value)	0.13	0.11 (.57)	0.14 (.94)	0.08 (.27)

High- and low-risk specialties were defined according to the proportion of physicians with a malpractice claim in a year. High-risk specialties included neurosurgery, cardiothoracic surgery, general surgery, orthopedic surgery, and plastic surgery. Low-risk specialties included dermatology, family general practice, psychiatry, and other specialties. *P* values reflect a 2-tailed comparison of malpractice claim rates between pediatricians and all other physicians, high-risk specialties, or low-risk specialties.

claims involved children older than 1 year (198; 49%), with the remainder divided approximately evenly between children <1 month old and children between 1 and 12 months. Claims with permanent injury were most common (172; 42.6%), followed by fatality (131;

32.4%) and temporary or psychological injury (101; 25.0%). Physicians older than 50 accounted for most malpractice claims (204; 50.5%).

Association of Patient Age and Type of Injury With Outcomes of Malpractice Claims

Malpractice claims involving children between 1 and 12 months were more likely to result in indemnity payment compared with claims involving children <1 month and children >1 year in unadjusted analyses (Table 3). For instance, among claims involving children between 1 and 12 months, 21.5% resulted in indemnity payment, compared with 18.1% among children >1 year and 15.3% among children <1 month, although these differences were not statistically significant (*P* = .42). Claims involving a permanent injury were also more likely to result in indemnity payment (19.7%) compared with claims involving a fatality (16.8%) or temporary or psychological injury (13.3%) in unadjusted analyses (*P* = .41). In adjusted analyses, claims involving children between 1 and 12 months were most likely to result in indemnity payment (21.2%), followed by children <1 month old (18.7%), and children older than 1 year (10.8%). In adjusted analyses, the difference in probability

of indemnity payment between claims involving permanent injury and other injury types widened. For instance, 23.9% of claims involving permanent injury were estimated to result in indemnity payment compared with 12.1% of claims involving fatality and 10.8% of claims involving temporary or psychological injury (*P* = .09).

Pediatric malpractice claims took nearly 2 years to resolve on average, with unadjusted time to resolution highest for cases involving children <1 month (26.0 months) and adjusted time to resolution highest for cases involving children between 1 and 12 months (27.2 months). In both unadjusted and adjusted analyses, mean time to resolution was substantially greater for cases involving permanent injury compared with other injury types. For instance, adjusted mean time to resolution of cases involving permanent injury was 28.0 months compared with 18.4 months for fatality and 20.4 months for temporary or psychological injury. The differences in time to resolution across injury types were statistically significant at *P* < .05 in both the unadjusted and adjusted analysis, because of the large effect associated with permanent injuries.

Among 83 malpractice claims resulting in indemnity payment, mean indemnity payments were greatest for cases involving children of <1 month (\$925 380) compared with children >1 year (\$518 887) and children between 1 and 12 months (\$313 514) in unadjusted analyses (Table 4). These differences were statistically significant (*P* = .02). In adjusted analyses, however, differences in mean indemnity payments across patient age groups narrowed considerably (range \$522 230 for children 1 to 12 months, \$657 852 for children <1 month). Moreover, the differences in adjusted indemnity payments across patient age were not jointly statistically significant (*P* = .71).

TABLE 2 Characteristics of Malpractice Claims Against Pediatricians

Total no. of claims	404
Claim outcomes	
Claims with payment, <i>n</i> (%)	83 (20.5)
With payment \geq \$750 000, <i>n</i> (%)	18 (4.5)
With payment \geq \$1 million, <i>n</i> (%)	15 (3.7)
Mean time to resolution, mo (SD)	23.4 (21.8)
Mean indemnity payment, \$ (SD)	562 180 (719 492)
Median indemnity payment, \$ (interquartile range)	187 546 (1 092 334)
Patient age at time of incident, <i>n</i> (%)	
<1 mo	198 (49.0)
1–12 mo	100 (24.8)
>1 y	106 (26.2)
Type of injury, <i>n</i> (%)	
Fatality	131 (32.4)
Permanent injury	172 (42.6)
Temporary or psychological	101 (25.0)
Physician age, <i>y</i> , <i>n</i> (%)	
30–39	57 (14.1)
40–49	143 (35.4)
\geq 50	204 (50.5)

Malpractice claims are from all pediatricians covered by a nationwide liability insurer (*n* = 1630 pediatricians, 7581 physician-years of coverage). Patient age at time of incident was divided into 3 categories: <1 mo old, between 1 and 12 mo, and >1 y.

TABLE 3 Association of Patient Age and Injury Type With Probability of an Indemnity Payment and Time to Resolution Among Pediatric Malpractice Claims

	Claims Resulting in an Indemnity Payment, Mean %		Time to Resolution of Claims, Mean mo	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Patient age at time of incident				
<1 mo	15.3	18.7	23.7	21.6
1–12 mo	21.5	21.2	19.9	27.2
>1 y	18.1	10.8	26.0	23.9
<i>P</i> value for difference across all age categories	.42	.36	.15	.05
Type of injury				
Fatality	16.8	12.1	18.9	18.4
Permanent injury	19.7	23.9	30.5	28.0
Temporary or psychological	13.3	10.8	14.4	20.4
<i>P</i> value for difference across all injury categories	.41	.09	<.001	.02

Adjusted means were estimated from multivariate linear regressions that adjusted for patient age, injury type, physician age, and state and year fixed effects. The *P* values are based on joint significance tests of the differences in means across categories.

Cases with permanent injury had substantially larger unadjusted mean payments (\$703 373) compared with fatalities (\$559 102) or temporary or psychological injuries (\$127 663). In the adjusted analysis, the difference between fatalities (\$366 052) and temporary injuries (\$389 547) fell, whereas the average payments for permanent injuries remained highest (\$724 430).

TABLE 4 Association of Patient Age and Injury Type With Size of Indemnity Payment Among 83 Malpractice Claims With Indemnity

	Indemnity Payment Mean \$	
	Unadjusted	Adjusted
Patient age at time of incident		
<1 mo	518 887	535 899
1–12 mo	315 514	522 230
>1 y	925 380	657 852
<i>P</i> value for difference across all age categories	.02	.71
Type of injury		
Fatality	559 102	366 052
Permanent injury	703 373	724 430
Temporary or psychological	127 663	389 547
<i>P</i> value for difference across all injury categories	.03	.01

Reported dollar payments were converted to 2008 dollars by using the Consumer Price Index. The *P* values are based on joint significance tests of the differences in means across categories.

The differences in mean indemnity payments across injury categories were statistically significant at $P < .05$ in both the unadjusted and adjusted analyses, driven largely by the impact of permanent injuries.

DISCUSSION

By using data from a nationwide liability insurer, we described the annual malpractice risk of US pediatricians compared with other physicians and studied how outcomes of malpractice claims were affected by patient age and type of injury. Despite facing lower annual rates of malpractice claims and indemnity payments than other physicians, pediatricians were equally likely to make large indemnity payments exceeding \$1 million. At the claim level, most malpractice claims against pediatricians did not result in an indemnity payment; the probability that a pediatric malpractice case resulted in an indemnity payment was ~20%, similar to estimates from other specialties.³ Among all malpractice claims, those involving children between 1 and 12 months (compared with children <1 month old and children >1 year) and those involving permanent injury (compared with fatality or temporary or psychological injury) were associated

with a higher probability of indemnity (through either settlement with the plaintiff or trial verdict).

The mean size of indemnity payments faced by pediatricians was large, ~\$560 000. This is consistent with past work showing high indemnity payments in pediatrics cases involving conditions such as meningitis, infant neurologic injury, premature birth, and pneumonia.⁸ Although mean indemnity payments in our study were largest for cases involving children <1 month old, this relationship was considerably attenuated when adjusting for type of patient injury. This appears to be driven by the fact that cases involving children <1 month old result in permanent disabilities associated with high payments, in part because they involve estimating earnings losses and medical expenses that will accumulate over the course of the injured child's life. Others have also suggested that these high indemnity payments may occur because children with catastrophic injuries provoke sympathy among attorneys, insurers, and juries, further increasing indemnity payments.²⁰ Attorneys, insurers, and courts may also fail to objectively use clinical guidelines to determine the presence of malpractice and size of indemnity payments when children are involved.²¹ Courts may also use the malpractice system as a form of social insurance to provide for the care of an injured patient, regardless of whether that injury resulted from malpractice.

The time required to resolve malpractice cases may be considered to be long: nearly 2 years on average across all claims and highest for claims involving children between 1 and 12 months and children with permanent injury in adjusted analyses. We also observed that mean time to resolution for pediatrics cases increased significantly over our sample period, consistent with past findings.^{4,22} Lengthy time to resolution

is an additional cost of medical malpractice that is often not estimated but may be substantial when there is lost practice time and nonmonetary costs to physicians, such as reputational damage and anxiety.³ Pediatric patients and their families are also adversely affected by delays in compensation and personal closure that are caused by lengthy time to resolution. It is important to note that whereas the observed time required to resolve pediatric malpractice cases may appear long, a lengthy investigative and litigation process may be needed to elucidate whether negligence truly occurred in complex medical cases in which causality is often difficult to establish.

Our study offers several strengths and limitations compared with previous work on pediatric malpractice. A study of malpractice claims from the NPDB was among the first national studies of pediatric malpractice, but could not accurately identify pediatric malpractice cases and could not study the large number of claims that do not result in indemnity payment.³ An analysis of aggregate claims from the Physician Insurers Association of America was able to account for nearly 25% of malpractice cases in the United States, but was unable to estimate the overall risk of malpractice among pediatricians and patient factors associated with malpractice outcomes.⁹

Despite our ability to characterize annual rates of malpractice at the physician level (both unpaid claims and those resulting in indemnity) and to study patient factors associated with

malpractice outcomes, our study had several limitations. As with other work,²³ our study used data from a single larger insurer. The insurer is among the largest in the United States and has insured physicians in each state but may not be nationally representative. In our previous work with this database, however, malpractice characteristics of physicians (such as median size of indemnity payments across all covered physicians and annual probability of an indemnity payment) were demonstrated to be similar to estimates of all physicians in the NPDB.³

The sample size of claims was also limited compared with studies of aggregated pediatric malpractice data collected by the Physician Insurers Association of America.⁹ However, a comparison of high-risk specialties in terms of size of indemnity payments was similar in our database and data collected by the Physician Insurers Association of America.^{3,9} Our analysis of malpractice claims was also restricted to claims closed before 2005. Given the long statute of limitations for pediatric malpractice cases, as well as the length of time typically elapsing between incident date and filing of a claim, our data underrepresent more recent years in which the frequency and size of indemnity payments may be different from the years covered in our sample. Our study also lacked clinical information on the causes of pediatric malpractice, which precluded an analysis of how specific clinical conditions, such as meningitis and pneu-

monia, affect the likelihood and size of indemnity payments.⁸ The particular clinical scenarios that drive pediatric malpractice are important to understand, given the greater size of indemnity payments in pediatrics compared with other specialties. Finally, we did not have detailed information on pediatricians themselves (eg, practice type and subspecialization).

CONCLUSIONS

Medical malpractice continues to be an important issue for physicians, patients, policymakers, and liability insurers. With the exception of obstetrics, pediatrics is unique among specialties in that the patients affected are children. Perhaps as a consequence, malpractice payments in pediatrics are among the highest. The long statute of limitations and lifetime over which patient earnings may be lost and medical costs incurred likely explain this finding. It may be reassuring to pediatricians, however, that the frequency of malpractice payment is among the lowest compared with other specialties.

To help patients and physicians resolve future potential conflicts, more and better data are needed to understand the particular clinical scenarios that are important to pediatric malpractice. As the time required to resolve malpractice claims against pediatricians may also be considered to be long, malpractice reforms designed to reduce this time could be of great benefit to patients, their families, and the physicians involved in malpractice.

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NEW TRICKS FOR AN OLD DOG: *Leprosy, also known as Hansen's disease, has been a scourge of humans for millennia. Chronic and disfiguring, leprosy has long been associated with severe social stigma. In the Middle Ages, some settlements banned individuals infected with leprosy, known as lepers, while other towns and cities required lepers to warn of their arrival by ringing bells. For centuries, people with leprosy have been quarantined together in leper colonies. Probably the most famous leper colony in the United States is in Kalaupapa, Hawaii. Over the course of a century, more than 8,000 people were banished to the colony, often separated forever from family. India, even today, has an estimated 1,000 leper colonies. The social stigma of leprosy is so severe that a few years ago, Brazilians, when asked whether they would rather have leprosy or HIV, chose HIV (despite the fact that leprosy is now easy to treat). While few cases of leprosy are diagnosed in the United States, worldwide more than 250,000 people are diagnosed each year. India, Brazil, the Philippines, and Indonesia report the highest rates. Diagnosis is often difficult and is too often made after permanent nerve damage has occurred. Signs and symptoms may include patches of discolored skin, areas of skin numbness, loss of eyebrows, or changes in the ear lobes. To date, the diagnosis has been confirmed by microscopic examination of a skin snip or biopsy. Fortunately, as recently reported in The New York Times (Health: February 2, 2013), the diagnosis of leprosy may become much easier. A company has developed a new rapid test that requires only a drop of blood. Similar to a pregnancy test, results are known in a few minutes and require no special training to interpret. Importantly, the test will cost less than a dollar. This has the ability to radically transform the approach to the disease and even, potentially, lead to the elimination of leprosy as a disease of humans. Let us hope that the test is successful and helps leper colonies around the world obsolete.*

Noted by WVR, MD