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EXPERIENCE AND REASON—Briefly Recorded

"In Medicine one must pay attention not to plausible theorizing but to experience and reason together. . . . I agree that theorizing is to be approved, provided that it is based on facts, and systematically makes its deductions from what is observed. . . . But conclusions drawn from unaided reason can hardly be serviceable; only those drawn from observed fact." Hippocrates: *Precepts*. (Short communications of factual material are published here. Comments and criticisms appear as letters to the Editor.)

Transcutaneous Bilirubinometry Decreases the Need for Serum Bilirubin Measurements and Saves Money

Except for routine screening for inborn errors of metabolism, the most frequent laboratory test performed in the well infant nursery is a serum bilirubin measurement. The Minolta/Airshields jaundice meter provides an objective measurement of the degree of newborn jaundice and is useful for identifying which infants require a serum bilirubin measurement.^{1,2} This instrument has been studied extensively and performs well as a screening device.^{1,2}

We hypothesized that the routine use of the jaundice meter in our nursery would reduce both the need for serum bilirubin measurements and costs. We deliver more than 5000 infants annually, 80% of whom are cared for by private pediatricians.

METHODS

We first established the relationship between serum bilirubin levels and the transcutaneous bilirubinometry (TcB) index in 356 white newborn infants born at 36 weeks' gestation or later. All serum bilirubin determinations were performed in the clinical laboratories by direct spectrophotometry (Bilirubinometer; Advanced Instruments, Needham Heights, MA; or Paramax, Irvine, CA). Physicians ordered serum bilirubin levels on clinical indication, and directly after blood was drawn, a TcB measurement was obtained by nursery nurses from the lower end of the sternum. During this phase of the study, the TcB measurement was not provided to physicians.

Ten TcB determinations on each of three infants yielded coefficients of variation of 0%, 3.6%, and 5.2%. The instrument's calibration was checked daily against the glass standards provided by the manufacturer. Once introduced for clinical use, TcB measurements were compared every 3 months with 10 bilirubin determinations to ensure consistency with the data previously obtained.

The jaundice meter was introduced for routine clinical use on November 1, 1990. For the guidance of pediatricians, tables were posted in the nursery showing the relationship between the TcB index and serum bilirubin levels as well as the 95% prediction intervals for the estimates of individual serum bilirubin levels from the TcB index. We reviewed all admissions to our newborn nursery between July 1990 and December 1992 and obtained the number of serum bilirubin levels measured from the laboratory data.

We estimated total direct costs for performing serum bilirubin measurements in the clinical laboratory and the TcB index

in the nursery. These included laboratory labor and supplies and phlebotomists' time and materials. For labor costs we used the midrange of salaries (1995) for laboratory technicians, phlebotomists, and nurses who performed TcB measurements in our well infant nurseries. We measured the average time needed to obtain a heel stick blood sample and a TcB index and for the laboratory technician to perform a serum bilirubin measurement by direct observation of 10 determinations using a stopwatch. We did not calculate depreciation, because it was difficult to estimate the total number of tests performed by the laboratory spectrophotometers (which included serum bilirubins from the neonatal intensive care unit and other areas of the hospital) and the jaundice meter (some infants in the nursery had multiple TcB measurements). The cost of the instruments is similar, however, about \$3000.

RESULTS

The close relationship between the TcB index and serum bilirubin levels is shown in the Figure.

Because the jaundice meter was introduced for clinical use in November 1990, and because it took some time for its acceptance by pediatricians, the period of July through December 1990 was taken as the "pre-jaundice meter" period. The total number of serum bilirubin levels obtained decreased during the five study periods from 1990 to 1992. As a percentage of the admissions, this represents a decrease of about 36% ($P < .0001$). There was a 40% reduction in the number of infants having at least one serum bilirubin level measured and a 56% reduction in those having at least two serum bilirubin determinations ($P < .0001$). If used regularly as a screening test, TcB measurements should also reduce the number of low (and, presumably, unnecessary) serum bilirubin measurements obtained. As shown in the Table, the number of bilirubin levels of less than 10 mg/dL decreased from 46% to 27% of the total serum bilirubin levels obtained ($P < .0001$). These changes cannot be attributed to a decrease in length of stay, which actually increased slightly from 2.3 to 2.5 days.

On average, it required 5.7 (range, 4.6 to 6.5) minutes of a phlebotomist's time to obtain a capillary blood sample for a serum bilirubin determination, whereas a TcB measurement required 27 (range, 10 to 40) seconds. The direct cost of performing a serum bilirubin determination was \$2.20 per test, compared with \$0.15 per test for a TcB measurement, a savings of \$2.05 per test. We calculated the savings we could expect from a delivery population of about 5000 infants per year. If the total number of serum bilirubin measurements obtained annually is equivalent to 75% of all admissions to the nursery (see Table), then 3750 serum bilirubin measurements will be done annually in a population of 5000 babies at a cost of

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Figure. Relationship between serum bilirubin concentration and TcB index in 356 white newborn infants born at more than 36 weeks' gestation. The regression line $y = 6.953 + 0.785x$ was calculated using least squares regression (True Epistat; Epistat Services, Richardson, TX); $r = .87$; $P < .00001$.

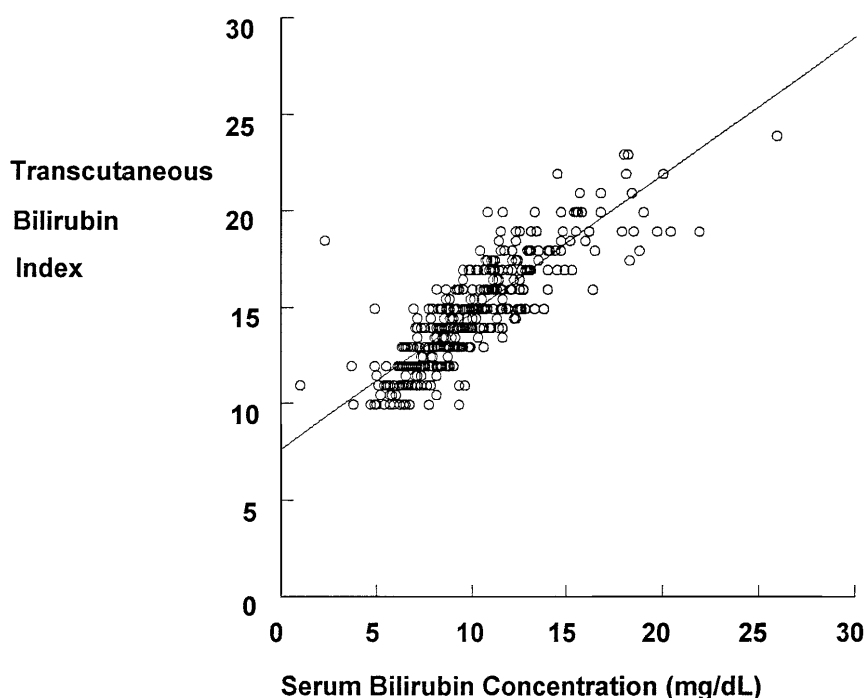


TABLE. Serum Bilirubin Measurements Obtained During 6-Month Periods in the Nursery From July 1990 Through December 1992*

Study Period	Admissions	Total SB† Obtained	SB Levels <10 mg/dL (%)‡	Total SB as % of Admissions‡	Infants who had SB, %		Average Length of Stay, d
					At Least 1 SB‡	At Least 2 SB‡	
Jul-Dec 1990	2605	1992	925 (46)	76.4	27.6	17.1	2.3
Jan-Jun 1991	2484	1559	638 (41)	62.7	24.6	13.5	2.2
Jul-Dec 1991	2486	1143	481 (42)	45.9	19.8	9.0	2.2
Jan-Jun 1992	2483	1291	437 (34)	51.9	21.8	9.9	2.4
Jul-Dec 1992	2567	1248	332 (27)	48.6	16.5	7.5	2.5

* The jaundice meter was introduced for routine clinical use on November 1, 1990. The trend was analyzed using the Cochran-Armitage test (StatXact 3 for Windows; CYTEL Software Corp, Cambridge, MA).

† SB indicates serum bilirubin measurements.

‡ Negative linear trend; $P < .0001$.

$3750 \times \$2.20 = \8250 . Using the jaundice meter will reduce the annual number of serum bilirubin levels obtained to about 2500 at a cost of \$5500 ($2500 \times \2.20). But each serum bilirubin would be preceded by a TcB measurement, costing $2500 \times \$0.15 = \375 . Therefore, the total cost of doing serum bilirubins and TcB measurements is \$5875, a savings of approximately \$2375 per year. However, additional jaundiced infants will have TcB measurements but no serum bilirubin measurements. If we assume that an additional 5000 TcB measurements are obtained annually (which require no further laboratory measurement) an additional cost of \$750 will be incurred. The overall net savings is therefore \$1625 per year ($\$2375 - \750).

DISCUSSION

This was not a controlled trial, so these data must be interpreted with caution. Nevertheless, they do suggest that the introduction of the jaundice meter had a significant impact on the total number of serum bilirubin levels obtained in our nursery and reduced the number of unnecessary serum bilirubin measurements (levels <10 mg/dL). The most signif-

icant effect occurred in 1991, the first year after the introduction of the jaundice meter.

Although measurements obtained by the jaundice meter are highly reproducible and directly related to serum bilirubin concentrations, these measurements are affected by the infant's race, gestational age, and birth weight, which limits the use of the jaundice meter in a heterogeneous population. Nevertheless, it is not difficult to establish a relationship between serum bilirubin levels and TcB measurements in different nurseries and different populations, and the effort seems worthwhile. Jaundice meters have been used routinely in our nurseries for the last 5 years and are well accepted (in fact, welcomed) by our attending pediatricians. In a survey of 43 private attending pediatricians on our staff, conducted in August 1995, 31 (67.4%) routinely and 9 (20.9%) sometimes used the TcB information obtained by the nurses. Only 3 pediatricians did not use this information.

Quality control is necessary. Calibration of the jaundice meter against glass standards provided by the manufacturer should be performed daily and recorded in a nursery log. In addition, every 3

months, TcB measurements should be compared with 5 to 10 bilirubin determinations to confirm that readings are consistent with the calibration curve previously obtained. During the last 5 years, our instruments have had to be returned to the manufacturer on two occasions for recalibration, not because of readings that fell outside the expected range, but because the instruments had been dropped.

The jaundice meter is very useful in an outpatient population and is used regularly by the nurses in our home follow-up program and by our residents in the outpatient clinic. In the current era of short nursery stays, it would be ideal if each pediatrician's office had one of these instruments, but they are expensive, and there is no reimbursement for this type of testing. Thus, individual practitioners, or even groups of practitioners, have not adopted its use.

TcB is a useful screening technique for the well infant population. TcB measurements provide instantaneous information, reduce the need for serum bilirubin measurements, spare infants the trauma of heel sticks, and save money. The jaundice meter is well accepted by pediatricians, and although it costs about \$3000, in a hospital delivering 5000 infants annually, use of the meter generates savings of about \$1600 per year. Thus, the jaundice meter should be a worthwhile investment for many hospital nurseries.

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Cutaneous Myiasis Acquired in New York State

Cutaneous myiasis is attributable to infestation of tissue by the developing larva (maggots) of a variety of fly species. Although not uncommon in tropical and semitropical climates, cutaneous myiasis acquired in North America is rare and generally attributable to *Cuterebra* species.¹ Only about 57 cases of cuterebrid myiasis have been reported in North America.¹⁻⁵ We describe a case acquired in New York State and briefly review the natural history of and treatment options for the disease.

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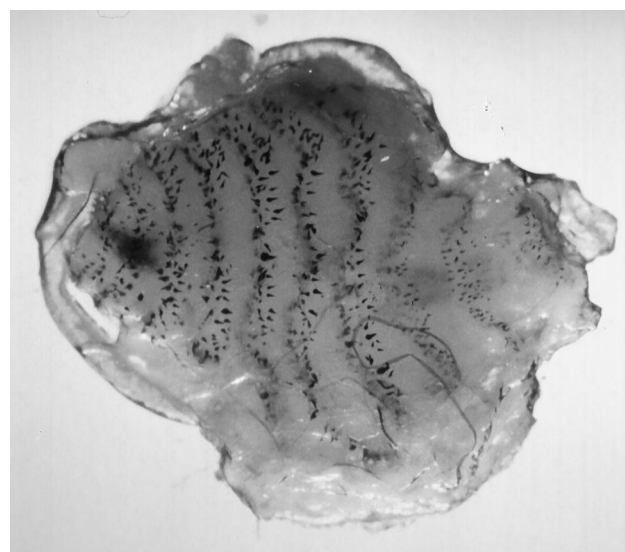


Figure. Second-stage larva of *Cuterebra* species is characterized by the circumferential parallel rows of dark black bristles extending the entire length of the organism. The larva, distorted by surgical extraction, measured $0.4 \times 0.4 \times 0.3$ cm.

CASE REPORT

A 7-month-old white male infant was seen at our medical center on August 7, 1994 for a boil-like lesion superior to the right nipple that did not respond to 7 days of treatment with amoxicillin/clavulanic acid. Physical examination was unremarkable except for an erythematous, firm 3×3 -cm lump on the anterior chest wall. A central pore drained copious serosanguineous fluid. A pale-tan foreign body was seen under the skin and was surgically removed under local anesthesia. The foreign body was identified as the second-stage larva of *Cuterebra* species (Figure).

Additional history revealed that the child lived in a rural area of upstate New York and had never traveled out of the state. On warm summer days he was placed on the grass to crawl and play. He has been in good health since removal of the larva.

DISCUSSION

Skin infestation by fly larva is acquired most commonly in tropical or semitropical climates, but rarely occurs in more temperate zones. Although dozens of species of bot flies cause myiasis, most cases acquired in North America are attributable to *Cuterebra* species. Most infestations have been in children living in the northeastern United States or in the Pacific Northwest.¹ Of these, only a single unpublished case originating in New York State (1975) is mentioned.^{1,5} In this report we firmly document a case of cuterebrid myiasis acquired by a child in New York State. Adult *Cuterebra* are large bumblebee-like flies that lay their eggs on vegetation near the orifice of burrows of rodents (mice, rats, rabbits), which are their natural hosts. The rodent acquires ova on its fur, where the first-stage (instar) larva hatches, penetrates either intact or broken skin, migrates through the host's tissues, and usually locates just beneath the skin. The first instar larva matures and then evolves through two additional instars of development before falling off the host's skin to pupate in soil over the winter, after which it hatches as a mature fly. Because of the natural history of the fly, most human cases manifest in late summer or early fall.¹

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