THE SHARN REPORT
VOLUME 2 NUMBER 2

# Liquid Crystal Indicator Outperforms Electronic Devices In CITECH Study.

At the Center for Information on Technology for Health Care (CITECH)[1], four devices that measure skin temperature were tested for accuracy and for response time to rapid temperature changes. Three electronic devices were used—two thermisters and one thermocouple-based product[2], and the fourth was a liquid crystal temperature indicator (Sharn Crystaline™ ST). One of each electronic sensor and 10 of the Crystaline ST were used.

Crystaline™ ST, Model 6102

Each of the electronic devices require a battery-powered monitor and disposable self-adhesive sensors with leads connecting to the monitor. The liquid crystal indicator requires no batteries, electronic monitor or patient lead connectors.

## Methodology Simulated Clinical Usage

Two separate tests were conducted, one to measure the accuracy of the devices at static temperature and the other to measure response time to temperature change.

A method was developed to simulate the way these devices would be used clinically, with the front surface exposed to room air and the back surface exposed to the temperature being monitored. The temperature sensors were affixed to the inside of a closed-end aluminum cylinder. This allowed the sensor to remain dry and exposed to room air while the outside of the cylinder was immersed in a temperature-controlled water bath. In a clinical setting, the sensor would typically be applied to the patient's skin during surgery to measure temperature trends.

TABLE A
STATIC TEMPERATURE TEST RESULTS
All Readings Shown in °C

| | | | | |
|---|---|---|---|---|
| BATH TEMPERATURE (Control) | | 35.0 | 36.0 | 37.0 |
| Sheridan Sonatemp | | 33.0 | 34.2 | 35.0 |
| RSP Bi-Temp | | 34.2 | 35.1 | 36.0 |
| Mon-a-therm | | 34.3 | 36.0 | 36.0 |
| Cystaline ST | Sample #1 | 35.25 | 36.0 | 37.0 |
| | #2 | 35.0 | 36.0 | 37.0 |
| | #3 | 35.0 | 36.0 | 37.0 |
| | #4 | 35.0 | 36.0 | 37.0 |
| | #5 | 35.0 | 36.0 | 37.0 |
| | #6 | 35.0 | 36.0 | 37.0 |
| | #7 | 35.0 | 36.0 | 37.0 |
| | #8 | 35.0 | 36.0 | 37.0 |
| | #9 | 35.0 | 36.0 | 37.0 |
| | #10 | 35.0 | 36.0 | 37.0 |

## Significant Variations Found In Accuracy And Response Time

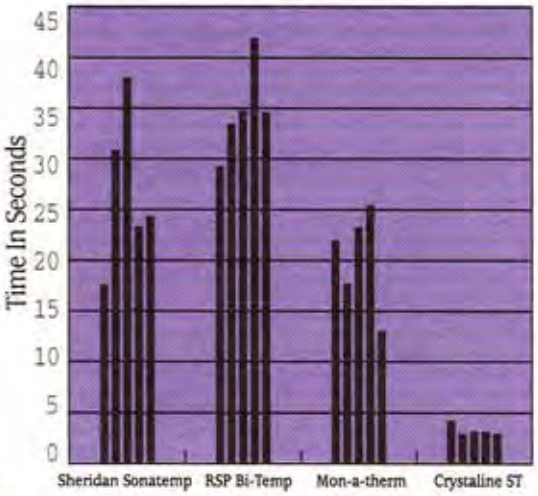
Each device was tested at three different temperatures within the range of skin temperature by immersing the cylinder into the water bath. A certified precision thermometer was used as the control.

Then, static temperature readings at 35.0°C, 36.0°C and 37.0°C were taken at equilibrium using each device. **One device was found to be significantly more accurate.** At every temperature gradient and in each of the ten samples tested, the Crystaline ST identically matched the control temperature. In only one reading did an electronic sensor match the control temperature. (See Table A)

To assess the speed of each device in responding to a sudden rise in temperature equal to 4°F, two water baths measuring 34.8°C and 37.0°C were prepared.

The cylinders, with sensors intact, were first immersed in the warmer bath and equilibrium readings were taken. The cylinders were next placed in the cooler bath where readings were taken at equilibrium, and then moved back to the warmer bath within three seconds. The elapsed time between the final immersion and readings 0.3°C lower than the initial equilibrium reading was recorded and defined as response time. Five readings were obtained for each device. (See Chart B)

CHART B
RESPONSE TIME FOR A 2.2°C (4.0°F) STEP CHANGE




**In each round of testing, the liquid crystal device was significantly faster than any of the electronic products.** The response times for the Crystaline ST ranged from 2.9 to 4.3 seconds, compared to from 13.0 to 41.9 seconds for the electronic devices.

Furthermore, in each of the five testing rounds, the liquid crystal indicator identically matched the reference temperature of each bath at equilibrium; none of the electronic devices did.

The testing agency drew no conclusions regarding the clinical significance of the results.

1. CITECH, A Nonprofit Agency, 5200 Butler Pike, Plymouth Meeting, PA 19462. March 1993. Full study available upon request from Sharn, Inc.

2. The electronic thermometers tested were the Mon-a-therm Model 6500; the Respiratory Support Products (RSP) Bi-Temp, Model 200D, and the Sheridan Sonatemp 400/700.

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# Sharn Temperature Indicators Outperform Thermocouple And Thermistor Sensors in Lab Study.

## Tests Show Significant Differences In Accuracy And Response Time.

Skin surface temperature measurement is a clinically useful method of monitoring peripheral temperature changes.

Recently, a study was conducted to compare the accuracy and response time to temperature change of a liquid crystal device (Sharn's Crystaline™ ST) to thermistor and thermocouple-based temperature sensors. Two different thermistor sensors and one thermocouple sensor device were selected for the laboratory comparison study.

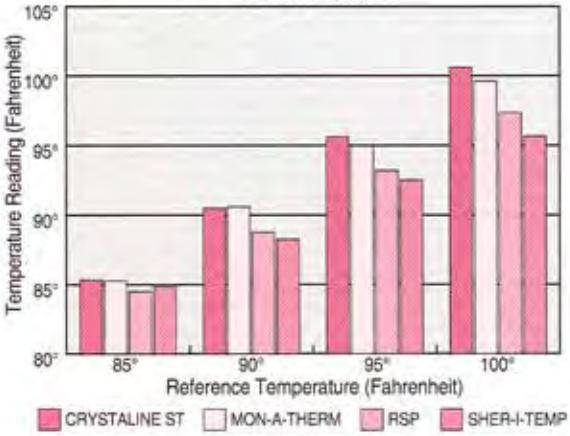
A temperature-controlled steel plate was used as a reference temperature device. Accuracy and response time tests were conducted at 85°F, 90°F, 95°F and 100°F.

The accuracy test included six sensors from each test group. In each round of testing the four devices were allowed to adjust to the temperature setting for five minutes before comparisons were recorded. At lower temperatures there was no significant difference in accuracy among the devices, but at the higher temperatures the Crystaline ST readings were significantly more accurate than the two thermistor sensors and comparable to the thermocouple-based sensor (Graph 1).

Graph 1

**Mean Temperature Reading**

Based on 6 replicates




The response time tests included five identical sensors from each manufacturer. One sensor at a time was tested at each 5°F temperature change increment, using a stopwatch to record the lapsed time from the base temperature of 80°F to the change temperature. The Crystaline ST responded consistently faster than the electronic devices for each change in temperature setting. All three of the other sensor devices had increasingly longer response times as the temperature gradient increased (Graph 2).

## The Importance Of The Results.

The superior performance of the Crystaline ST Indicator in accuracy, and even more so in response time, was most evident at 90°F, 95°F and 100°F—the typical range of skin temperature readings.

This means clinicians can rely on the liquid crystal device for fast and reliable information.

In addition to Crystaline ST's overall better performance, it is also the least expensive device tested.

## An All-Around Better Way To Measure Temperature.

This accuracy and response time research is just one example of a growing list of studies conducted on Sharn's liquid crystal temperature devices with favorable results over other methods of skin temperature measurement.

In addition, the Crystaline ST Indicators are less than a third the cost of thermistor sensors and less than half the price of thermocouple-based sensors, making them an affordable choice for any procedure. Nor do they require the capital investment of an electronic monitor. Multiple Sharn indicators can easily be used to determine the extent of a nerve block, or for other pain management therapeutic or diagnostic techniques.

More and more hospitals, surgery centers and pain management clinics across the country are relying on Sharn liquid crystal temperature indicators. Study the benefits yourself by calling 1-800-325-3671.

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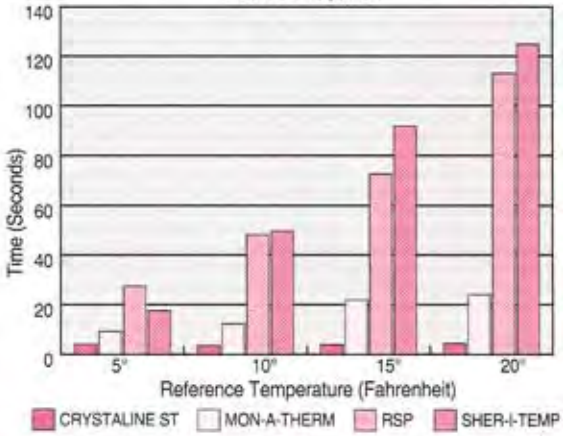
Graph 2

**Mean Response Time**

Based on 5 replicates




*Study conducted by Bernard F. Krause, PhD, supported by a grant-in-aid from Sharn, Inc. Statistical data analysis was performed by Independent Market Research (IMR), Tampa, Florida. Study on file.

Tested temperature devices included Crystaline™ ST liquid crystal indicator (Sharn, Inc.), RSP™ thermistor sensor (Respiratory Support Products, Inc.), SHER-I-TEMP™ thermistor sensor (Sheridan Catheter Corp.), and Mon-a-therm™ thermocouple-based sensor (Mallinckrodt, Inc.)

THE SHARN REPORT
VOLUME 2 NUMBER 1

# One Liquid Crystal Device Rated More Accurate and Consistent Than Others In CITECH Study.

A recent laboratory study was conducted by The Center for Information on Technology for Health Care (CITECH)[1] to compare the consistency and accuracy of six liquid crystal temperature indicators[2]. All of these devices are commonly applied to the foreheads of surgical patients to monitor temperature trending during surgery and recovery. They may also be left on the patient for extended periods for continuous temperature measurement.

Crystaline™ Indicator, Model 5101

## Methodology Simulated Clinical Usage

A method was developed to simulate the way these devices would be used clinically, with the front surface exposed to room air and the back surface exposed to the temperature being monitored. The indicators were affixed to the inside of closed-end aluminum cylinders, allowing them to remain dry and exposed to room air while the outside of the cylinder was immersed in a temperature-controlled water bath to within a half-inch of the top.

Each of the products tested incorporates a temperature offset so that the displayed value is close to the patient's core body temperature. The core temperature offset is not necessarily identical in different brands of liquid crystal indicators, a factor that could cause their readings to differ.

However, it would be expected that all samples of a given brand would yield the same readings in the same bath, and that because the temperature of the three baths were 1°C apart the readings of each brand would be 1.0°C apart in each of the three baths.

## Only One Device Yielded Consistently Reliable Results

Ten samples of each product were tested at three temperatures in sequence—36.0°C, 37.0°C and 38.0°C. The actual bath temperatures were 2.5°C lower than these values to reflect a core temperature offset.

Although three of the six brands tested gave consistent readings with each of the 10 samples tested, only the Sharn Crystaline Indicator yielded consistently accurate readings that reflected the 1.0°C difference between each of the three baths. (See Chart)

The Crystaline Indicator is the only liquid crystal temperature device that was both accurate and consistent in the range tested.

The testing agency drew no conclusions regarding the clinical significance of the results.

1. CITECH, A Nonprofit Agency, 5200 Butler Pike, Plymouth Meeting, PA 19462, March 1993. Full study available upon request from Sharn, Inc.
2. Products tested were the Sharn Crystaline™ 5101, the Baxter Feverscan™, the Hallcrest Clinitemp™, the Omni Therm Omni-OR™, the Seven C's E-Z Temp™, and the Trademark Stat-Temp™ II.

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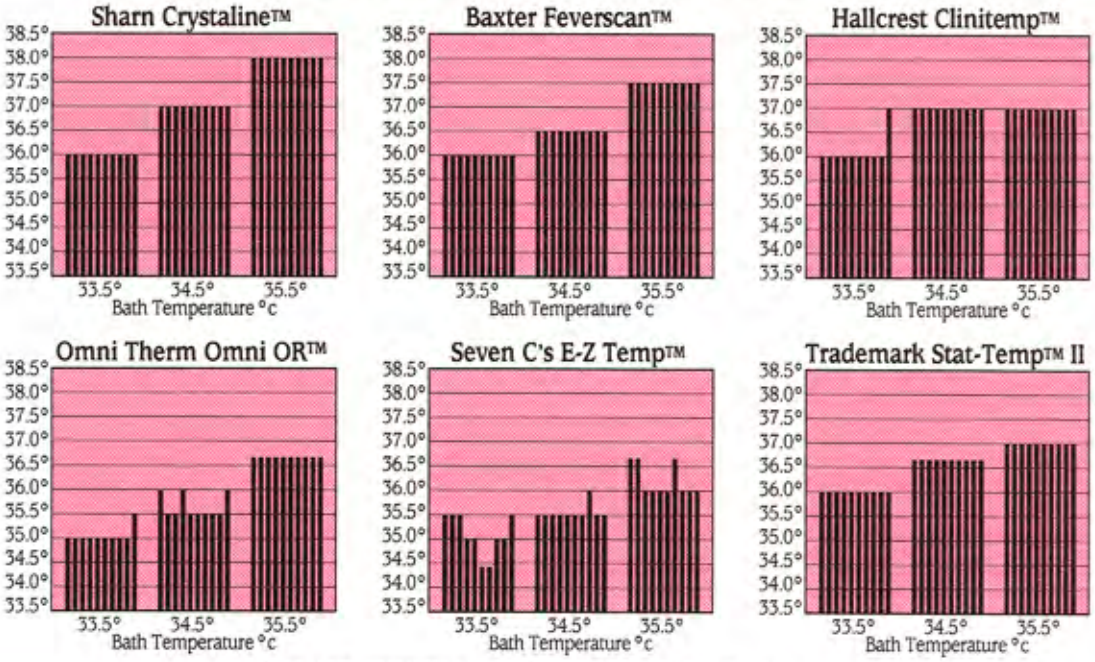
## Static Temperature Test Results

Core Adjusted Liquid Crystal Indicators – 10 Tests Per Product At Each Bath Temperature.




All readings converted to °C for purposes of comparison.

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# Sharn Temperature Indicators Rated Most Reliable In Recent University Study.

## Tests Show Wide Variance In Temperature Readings Among Competitors.

Recently, the College of Medicine at the University of Florida tested the reliability of several leading liquid crystal temperature indicators (LTCIs)[1] In the study, readings were taken while a reference temperature bath was raised at intervals of 1°C or 2°F.

In most cases, results with the same type of LCTI varied widely over the temperature range tested. But before questioning the validity of all liquid crystal temperature indicators, it should be pointed out that one indicator performed significantly better than the rest.

The Crystaline™ Temperature Indicator from Sharn was consistently accurate — within a range of one-half of one degree Fahrenheit. (See chart.)

This means Crystaline offers the security of knowing that the temperature change indicated is an accurate reflection of the temperature change of the patient. And that's a vitally important consideration when choosing a temperature indicator.

## Crystaline. The Inexpensive, All-Around, Every-Patient Temperature Strip.

The Crystaline Temperature Indicator is a simple adhesive strip applied to the patient's forehead. Using the precise sensing capacity of a new, more advanced form of liquid crystal, it measures surface temperature and gives you a core-adjusted reading in clearly marked degrees.

Crystaline also offers one of the widest temperature ranges available. And because it requires no intubation or monitor hook-ups, Crystaline can go where your patient goes.

## Crystaline Tracks Patients From Pre-Op Through Recovery And Beyond.

While temperature monitoring in the holding area has traditionally been done orally, there can be inconsistencies between readings, especially when more than one person is doing the monitoring. With the Crystaline Indicator, temperature readings are consistent and quick.

In the operating room, temperature monitoring during even short surgical procedures has become so important that many hospitals have made it a standard of care. Not only are Sharn's temperature indicators inexpensive and convenient, recent studies have found them to be more reliable than rectal or axillary probes for trending core temperatures[2] and in some cases, preferable to esophageal probes[3]

During recovery, there can be substantial periods of time when patients are not monitored for temperature. With the Crystaline Indicator in place throughout surgery and recovery, there are no interruptions in the temperature monitoring of a patient.

## High Reliability At A Low Cost.

Using a Crystaline Indicator offers the temperature trending needed for most surgical procedures at a fraction of the cost of traditional methods of temperature monitoring.

Not surprisingly, thousands of hospitals across the country are now monitoring temperatures with Crystaline Temperature Indicators from Sharn.

*Crystaline. A Better Measure Of Protection.*

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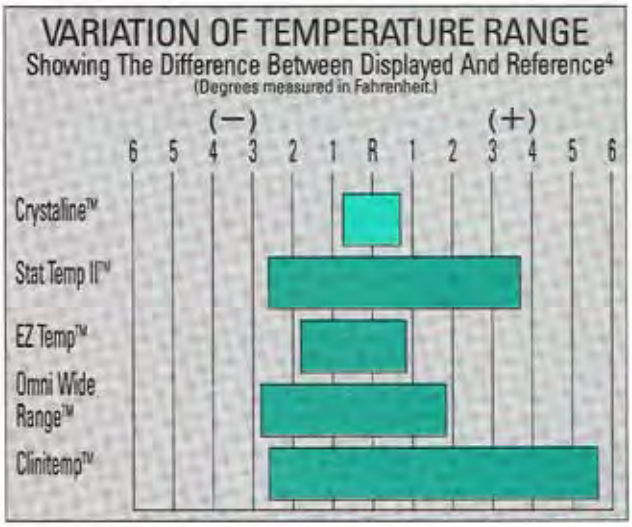



[1] Testing results published in *Anesthesiology*, V 73, No 3A, Sept. 1990, in an article titled "Measurement Offset With Liquid Crystal Temperature Indicators." Tests were conducted by T.S. Shomaker, MD, and D.G. Bjoraker, MD, Dept. of Anesthesiology, University of Florida College of Medicine, Gainesville, FL 32610.

[2] Allen G.C., Horrow J.C., Rosenberg H., "Does Forehead Liquid Crystal Accurately Reflect 'Core' Temperature?" CAN J ANESTH 1990; 37:659-62

[3] Brull S.J., O'Connor T.Z., Poglitsch E., Kosswig R., Silverman D.G. "Comparison of Crystalline Skin Temperature to Esophageal Temperatures During Anesthesia." Presented ASA Convention 1990.

[4] Reference temperature is the mean offset temperature, based on eight readings, arrived at independently for each product.

# Sharn Temperature Indicators Measure Up To Esophageal Probes In Kaiser Study.

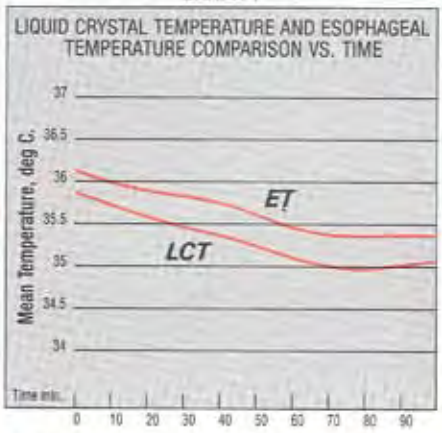
## Data Show No Statistical Difference In Temperature Readings.

At the Department of Anesthesia at the Kaiser Permanente Medical Center in Anaheim, California, an enlightening clinical study was performed. The Crystaline® Temperature Indicator, a simple adhesive strip applied to the patient's forehead, was tested for consistency and accuracy against an esophageal probe, an invasive and substantially more expensive method of temperature monitoring during surgery.

A total of 28 intubated, anesthetized patients ranging in ages from 19 to 62 years were tested.

In the study, temperatures from both the esophageal probe and the Sharn Indicator were taken at ten-minute intervals postinduction/intubation. Depending on the length of the surgical procedures, as many as 10 paired readings were taken.

GRAPH 1




## Monitoring The Results.

The results confirmed what the anesthesiology department had suspected. When based on the duration of the surgical procedure, there was no significant difference between the esophageal probe and the inexpensive, non-invasive Crystaline strip. (See Graph 1.)

Furthermore, there was no statistical difference between successive temperature readings from the Crystaline Indicator when compared to successive readings from the esophageal temperature device. In other words, both devices were shown to trend temperature changes in a similar manner. (See Table 1.)

TABLE 1

Comparison of differences for successive temperature readings.

Paired samples t-test: Z5 = LCT
Z3 = ETP

| Variable | Number of Cases | Mean | Standard Deviation | Standard Error |
|---|---|---|---|---|
| Z5 (LCT) | 214 | −.0874 | ±.177 | ±.012 |
| Z3 (ETP) | 214 | −.0822 | ±.168 | ±.011 |

| (Difference) Mean | Standard Deviation | Standard Error | 2-Tail Corr. | 2-Tail Prob. | t Value | Degrees of Freedom | 2-Tail Prob. |
|---|---|---|---|---|---|---|---|
| −.0051 | ±.194 | ±.013 | .368 | .000 | −.39 | 213 | .699 |

According to the study, "It is our opinion, that for all clinical purposes, LCT (Sharn Inc.) provides a level of accuracy in measuring body temperature comparative or equal to esophageal stethoscope probes".*

## An All-Around Better Way To Measure Temperature.

The Kaiser research is just one example of a growing list of clinical studies conducted on the Crystaline Temperature Indicator from Sharn. All with the same results.

For reliability and consistency of temperature monitoring, Crystaline Indicators measure up to the most respected methods in surgical practice today. And they have a number of important advantages.

First, they are less than a third of the cost of esophageal probes, making them ideal for any surgical procedure, no matter how simple or short in duration.

And because they are non-invasive, with no hookups or hangups, they can go wherever patients go, from pre-op to surgery, recovery and beyond. The reliable, uninterrupted monitoring not only makes things easier for anesthesia, but provides an important level of safety for patients.

## Crystaline. The One More Hospitals Are Sticking With.

More and more, hospitals across the country are relying on the Crystaline Temperature Indicator from Sharn. Study the benefits yourself by calling 1-800-325-3671. Like clinical studies prove, no other method of temperature monitoring measures up.

## Crystaline. A Better Measure Of Protection.

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*Results from a clinical study conducted by David C. Bohner, CRNA, Department of Anesthesiology, Kaiser Permanente Medical Center, December, 1991.

9234

# Yale Study Shows Sharn Temperature Indicators Comparable To Esophageal Probes.

## Temperature Readings Virtually Identical In Head-To-Head Tests.

When the Yale University School of Medicine compared a Sharn Crystaline™ temperature indicator to an esophageal temperature probe, the premise was a simple one. Could an inexpensive, non-invasive crystaline strip achieve the same level of consistency and accuracy as a more expensive, invasive esophageal probe?

The study was conducted at the Yale-New Haven Hospital and compared temperature readings in 127 patients undergoing general anesthesia for a variety of surgical procedures. After intubation, an esophageal temperature probe was put in place per clinical practice. Then, a Sharn temperature strip was placed on the patient's forehead. Temperatures were recorded at 10 minute intervals for 90 minutes and temperature differences and variations were compared. When the testing was complete, the results were so close they were almost identical.

The mean esophageal and crystaline temperature differences at any measured time point were consistently within .3 degrees Fahrenheit. (See Table)

**Mean ET-CT Temperature Difference (degrees Farenheit)**

TABLE 1

| Time | Mean ± SD | Median | 5–95th %ile |
|---|---|---|---|
| 5 (min) | −0.23 ± 1.4 | −0.3 | −2.5 to 2.1 |
| 15 (min) | −0.29 ± 1.5 | −0.4 | −2.5 to 2.4 |
| 25 (min) | −0.30 ± 1.5 | −0.4 | −2.5 to 2.2 |
| 35 (min) | −0.22 ± 1.5 | −0.3 | −2.5 to 2.3 |
| 45 (min) | −0.30 ± 1.5 | −0.5 | −2.4 to 2.3 |
| 55 (min) | −0.21 ± 1.6 | −0.3 | −2.6 to 2.4 |
| 65 (min) | −0.26 ± 1.6 | −0.4 | −2.8 to 2.6 |
| 75 (min) | −0.27 ± 1.6 | −0.5 | −2.6 to 2.6 |
| 85 (min) | −0.26 ± 1.6 | −0.5 | −2.7 to 3.0 |

As the study notes, "the data suggest that new crystaline temperature devices correlate highly with esophageal temperatures". And the results "suggested a close relationship between the two temperature monitoring devices".

Esophageal probe users should also pay special attention to this passage from the study: "Crystaline temperature indicators may also be preferrable if circuit warmers were used during clinical anesthesia, as esophageal probe accuracy could be influenced by the temperature of the inhaled gases".*

In other words, if your esophageal probe is being used in conjunction with a circuit warmer, there's the possibility that the temperature readings you're getting are wrong.

## The Importance Of The Results.

By proving that the Sharn Crystaline Temperature Indicator is as reliable a temperature trending device as an esophageal temperature probe, this study has important implications for hospitals everywhere.

Consider, first, the fact that Crystaline Temperature Indicators are noninvasive and can be used with all types of surgeries and anesthesia techniques.

Secondly, Crystaline Indicators are inexpensive, costing approximately one-third the price of esophageal probes.

One more advantage of Crystaline is that it allows for continuous temperature monitoring — from the beginning of surgery through recovery and even on to the floor. No interruptions means greater patient safety.

## Crystaline. The Inexpensive, All-Around, Every-Patient Temperature Strip.

Join the thousands of hospitals across the country now monitoring temperatures with Crystaline Temperature Indicators from Sharn. For noninvasive, inexpensive and reliable temperature measurement, studies prove that no other type of temperature indicator measures up.

## Crystaline. A Better Measure Of Protection.

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*Testing results published in a report titled "Comparison Of Crystaline Skin Temperature To Esophageal Temperatures During Anesthesia", October, 1990. Authors S.J. Brull, M.D., T.Z. O'Connor, M.P.H., E. Poglitsch, M.P.S., R. Kosswig, D.G. Silverman, M.D., Anes. Dept., Yale University School of Medicine, Yale-New Haven Hospital, New Haven, CT 06510.

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# Tests Among Pediatric Patients Show Sharn Temperature Indicators Compare Favorably With Esophageal Probes.

## University Study Finds Virtually No Difference In Temperature Readings.

In August, 1991, a study was conducted at the School of Allied Health Professionals at Virginia Commonwealth University. Its aim was to determine whether a difference existed between esophageal probe and liquid crystal temperature measurements in pediatric surgical patients.

The test was an important one. If research could support the idea that the liquid crystal temperature indicator (LCTI) was as accurate a measuring device as the esophageal temperature probe (ETP), the LCTI could boast a number of advantages over the ETP.

As the study's researcher points out, "first, the LCTI is noninvasive. A noninvasive temperature monitor can be used with *all* types of surgeries and anesthetic techniques."

"Secondly, the liquid crystal temperature indicator is inexpensive. The LCTI does not require a display unit or any maintenance. It is the only temperature monitoring modality available that does *not* require some type of display device."

"LCTI allows for continued temperature monitoring from the beginning of the surgery, through the recovery period, and can go with the patient to their room. This is of particular importance in smaller infants, where as mentioned earlier, life threatening temperature decreases can occur during transport periods."*

## The Study And Its Convincing Results.

Conducted at a small university-affiliated children's hospital, the study used a sample that consisted of 30 pediatric patients between the ages of 5 months and 12 years.

The subjects were brought to the operating room for a variety of orthopedic surgeries. Temperature readings were recorded every 5 minutes for 60 minutes on each subject, using both an esophageal probe and the Crystaline™ brand liquid crystal temperature indicator from Sharn.

The results were conclusive. When comparing the Crystaline LCTI readings and the esophageal temperature readings, "there was no significant difference in actual temperature readings, mean values, or trends in measurement patterns

Consider both the medical and cost advantages associated with using an LCTI indicator, like the Crystaline, and you'll understand why this is important news for hospitals everywhere.

## Crystaline. The Inexpensive, All-Around, Every Patient Temperature Strip.

A simple adhesive strip, the Crystaline is applied directly to the patient's forehead. In a matter of seconds, the temperature indicator's advanced form of liquid crystal measures surface temperature and gives a core-adjusted reading in clearly marked degrees.

## High Reliability Without The High Cost.

Using a Crystaline indicator offers the temperature trending needed for most surgical procedures at a fraction of the cost of traditional methods of temperature monitoring.

That's why today more and more hospitals are making the same discovery as the recent study discussed in this report. For noninvasive, inexpensive and reliable temperature measurement, no other temperature indicator measures up to Crystaline.

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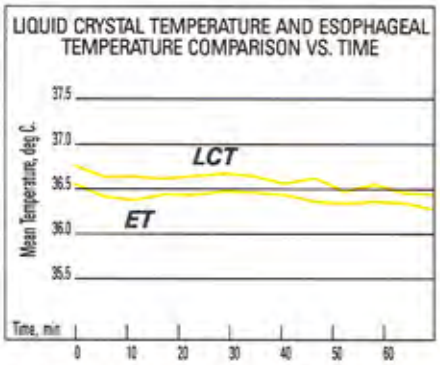


*Testing results published in the thesis "A Comparison Of Esophageal Temperature Readings And Liquid Crystal Temperature Readings In The Pediatric Population", August, 1991. Tests conducted by Catherine M. Wisniewski, Virginia Commonwealth University, School of Allied Health Professions in the Department of Nurse Anesthesia.

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