

# Thermal Angel®

## Blood and IV Fluid Infusion Warmer



**Surg-26**  
Alternate to Ranger Fluid Warmer

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### Comparison of the Thermal Angel Blood and IV Fluid Warmer to other blood warmers

#### Summary of Blood Warming Products (extensive details further down page):

Properties	Sims Hotline Fluid Warmer*	Arizant Bair Hugger Ranger Fluid Warmer**	Thermal Angel Blood Warmer TA-200***
<b>Temperature Control</b>	Indirect, circulating water	Indirect, warming plates	<b>Direct</b> , measures temperature of fluid
<b>Warm Up Time</b>	6-8 minutes	2-3 minutes	<b>45 seconds</b>
<b>Set Up Time</b>	2-4 minutes	2-4 minutes	<b>30 seconds</b>
<b>Disposable Sets</b>	Requires special tubing	Requires proprietary cassette	<b>No</b> special tubing
<b>Portable</b>	No. Requires AC	No. Requires AC	<b>Yes</b> . 12 volt battery
<b>Weight</b>	13 lb.	8 lbs.	<b>9 oz.</b>
<b>Flow Rate</b>	1-83 ml/min	KVO-150 ml/min (standard flow cassette)	<b>2-150 ml/min</b>
<b>Maintenance Required</b>	Yes	Yes	<b>None</b>

#### Normothermic Fluid Delivery Comparison:

Using data published by the manufacturers of the Hotline and Ranger blood and iv fluid warming systems, performance is directly compared to the innovative **Thermal Angel Blood Warmer** performance, up to the highest published flow rate for the Hotline. As illustrated below, the Thermal Angel has the most consistent normothermic performance across these blood warmer flow rates. The low mass heaters, stainless steel fluid path inside the unit, short fluid delivery path and calibrated smart microprocessor control of the Thermal Angel Blood Warmer help to provide a superior normothermic fluid delivery to the patient.

Note that at lower flow rates, the water bath of the Hotline fluid warmer causes unnecessary fluid overheating while the Ranger cassette technology delivers fluid well below normothermic temperatures. At higher flow rates, the water bath of the Hotline fluid warmer likewise causes low temperature fluid delivery. These inadequate output temperatures are the result of the technology involved in these older designs.

The Thermal Angel Blood Warmer contains innovative technology that can deliver fluid close to the 38°C normothermic temperature across this range of flow rates.

Furthermore, these temperatures are measured at the patient infusion site, and do not accurately represent the true temperature of the fluid inside the Hotline fluid warmer or Ranger fluid warmer before it travels down the long fluid delivery path. Therefore, the temperature of the fluid inside the Hotline and Ranger is higher than shown below. Conversely, the Thermal Angel's fluid delivery path is only 9 inches (TA-9EXT or TA-9EXTNF), so the true temperature of the fluid inside the Thermal Angel Blood Warmer is extremely close to the output temperature, thus not overheating the fluid to compensate for long tubing distance to the patient.



**Military Medical Product of the Year**

Thermal Angel named "Military Medical Product of the Year".

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Testimonials

Hello, I just wanted to let you know what a truly wonderful piece of equipment the Thermal Angel is!!! It is literally a lifesaver. I was an ER nurse for many years and was use to using the fluid warmers in the hospitals, which are large, difficult to use and slow...

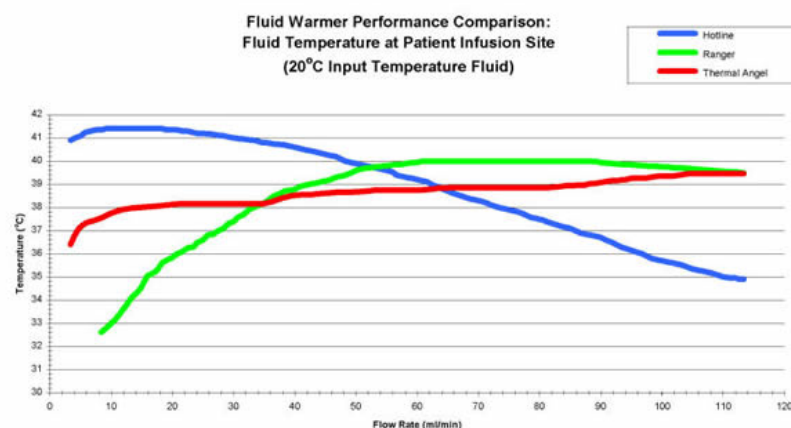
**Cindy Spencer**  
Flight Nurse, Air Evac Lifeteam XI  
[read testimonial](#)

I had the opportunity to use your product last week here in South-central Alaska. A car ran off the road into a local river, broke through the ice and completely submerged both passengers.

**William Chadwick**  
Fire Chief, Girdwood Alaska  
[read testimonial](#)

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Information Newsletters



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#### Data Sources:

**Hotline** Marketing Literature, Chart Title "HOTLINE Fluid and Blood Warmer Infusate Delivery Temperature" [42 degree Celsius HOTLINE Water Bath Temperature – measured at the patient end of the 2.4 m (8 ft.) L-70 disposable tubing set], Level 1, Inc. (Smiths Medical).

**Ranger** Marketing Literature, Chart Title "Ranger System Performance" [Fluid temperature at end of patient line], Augustine Medical, Inc.

**Thermal Angel** Test Data, Fluid temperature at patient end of standard 9" extension line (TA-9EXT), Estill Medical Technologies, Inc.

#### Initial Heating Performance:

Unlike many other fluid warming systems, the smart microprocessor control of the **Thermal Angel Blood Warmer** ensures that fluids are not overheated under initial heating or stop flow conditions. Since the Thermal Angel Blood Warmer has temperature sensors located directly in the fluid path and is checked 5000 times per second, the microprocessor is able to make extremely quick and accurate decisions regarding fluid temperature control.

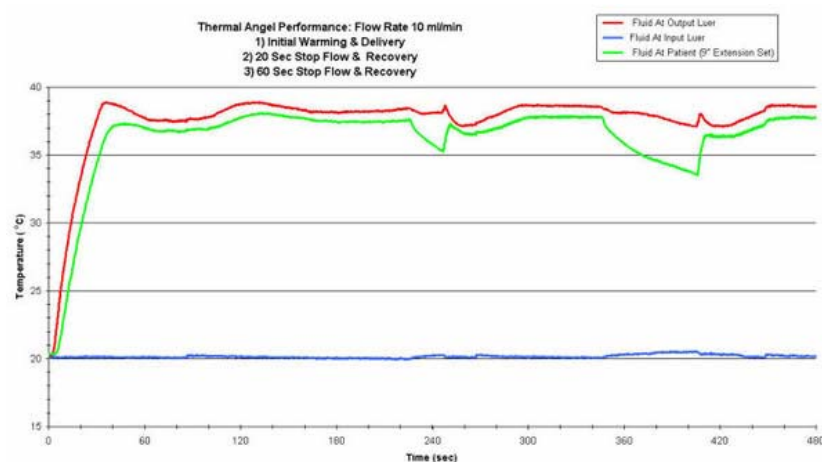
As illustrated below, the Thermal Angel's innovative technology provides conservative control of fluid temperatures during initial fluid warming. Within the nominal 45 second warm up time, normothermic temperatures have been achieved both for fluids exiting the device and for fluids entering the patient infusion site. As shown, despite the initial rapid temperature rise, the smart microprocessor avoids overheating the fluid by quickly recognizing that normothermic temperature has been achieved and responding appropriately.

#### Stop Flow Conditions and Rapid Response:

The Thermal Angel's innovative heater and control technology ensures quick and accurate control of fluid temperature under stop flow conditions.

In the example below, fluid flow was first stopped at approximately 230 seconds for a duration of 20 seconds. Once fluid flow was resumed at the original 10 ml/min flow rate, the volume of fluid contained within the heated fluid path passed through the device. Since the heater mass is so small, there was very little residual heat transferred to the fluid path during this stop flow period. This can be seen in the very small temperature rise of the fluid at the output luer, demonstrating how the **Thermal Angel Blood Warmer** heaters were immediately shut off under stop flow conditions. Also shown below is a longer stop flow scenario that begins at 350 seconds for a duration of one minute. Noteworthy in both stop flow conditions is the lack of any temperature spike for the patient, a conservative clinical result that was designed into the Thermal Angel Blood Warmer temperature control system.

Under stop flow conditions, the patient first experiences a brief cooler fluid temperature followed by a quick rise back to normothermic temperature when flow is resumed. The innovative Thermal Angel Blood Warmer technology clearly avoids overheating during stop flow conditions.



[Click [graph](#) for enlarged version]

#### Changing Flow Rates and Rapid Response:

The smart microprocessor control of the **Thermal Angel Fluid Warmer** ensures that fluids are never overheated during changes in flow rates. The innovative Thermal Angel technology provides the unique ability to quickly and accurately respond to both increases and decreases in flow rate.

Illustrated in the example below is a Thermal Angel Blood Warmer that had already been delivering fluid at a 10 ml/min flow rate when the data collection began.

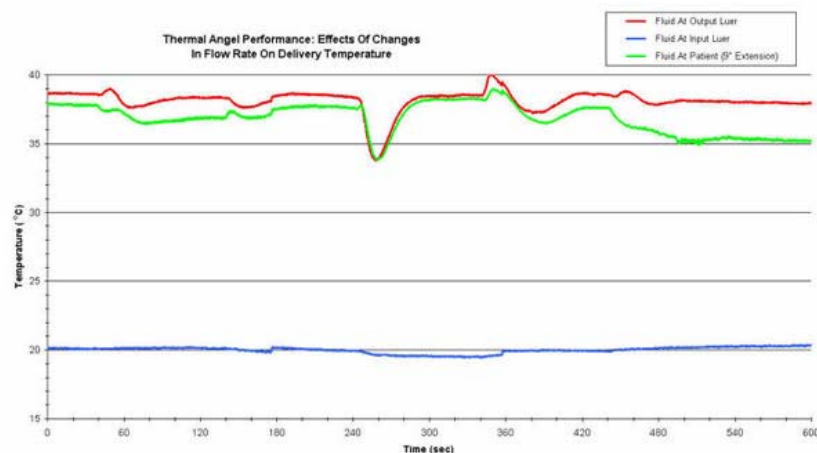
After approximately 20 seconds into collecting the performance data, the flow was decreased to 5 ml/min. Note the quick response to this slight flow rate change, and the subsequent rapid achievement of stable delivery temperature. Due to ambient cooling of the extension set, the delivery temperature at 5 ml/min was slightly lower than that at 10 ml/min.

At approximately 130 seconds, the flow rate was increased back to the original 10 ml/min. Note again the quick response and temperature adjustment.

The flow rate was further increased to 50 ml/min at approximately 240 seconds. Sensing a more drastic downward change in temperature, the control system quickly increased the fluid path heating. Within 45 seconds, the patient connected to the Thermal Angel would be experiencing stable normothermic fluid again. Note the only very slight ambient cooling of fluid due to the 9" extension set at 50 ml/min flow rate.



Downward again to 10 ml/min, the flow rate was adjusted at approximately 340 seconds. Even with this 80% reduction in flow rate, the fluid temperature at the patient infusion site varied only slightly until it was quickly stabilized again.


Finally, a further 80% decrease to the minimum specified Thermal Angel IV Warmer flow rate of 2 ml/min was conducted at approximately 440 seconds after data collection began. No overheating is experienced at any change in flow with the Thermal Angel, making this innovative technology a superior clinical choice for fluid warming.



[Click [graph](#) for enlarged version]

#### Detailed Fluid Warmer Specification and Characteristics Comparison:

	Sims Hotline Fluid Warmer*	Arizant Bair Hugger Ranger Fluid Warmer**	Thermal Angel Blood Warmer TA-200*** 
<b>Heating Technology</b>	Circulating Water	Warming Plates	<b>Smart Dry Heat</b>
<b>Fluid Path Delivery</b>	Indirect  Proprietary tubing connected to circulating water.  Promotes significant source of heat loss from water bath to infusion site (8 feet distance).  If proprietary tubing is unavailable then warmer can not be utilized.	Indirect  Proprietary cassette is placed between warming plates.  Promotes significant source of heat loss from warming plates to infusion site (3 feet distance).  If proprietary cassette is unavailable or if cassette flow rate capacity is different than required, warmer can not be utilized.	<b>Direct</b>  Smart Design: The Thermal Angel combines both the heating technology and fluid path into a single disposable unit.  <b>No proprietary tubing.</b>  Thermal Angel extension set minimizes heat loss from warmer to infusion site (9 inches).  Thermal Angel may be utilized with any IV tubing that has a standard luer fitting.
<b>Measurement and Control of Fluid Temperature</b>	Indirect  Temperature sensors are placed within the circulating water. The sensors measure the temperature of the water but fail to measure the temperature of the output fluid.  Output fluid temperature is controlled 8 feet from infusion site.  Unit must overheat fluid temperature (42°C), recognizing that its fluid path and distance from the infusion site are major factors for heat loss.	Indirect  Temperature sensors are placed within the warming plates. The sensors measure the temperature of the warming plates but fail to measure the temperature of the output fluid.  Output fluid temperature is controlled 3 feet from infusion site.  Unit must overheat fluid temperature (41°C), recognizing that its fluid path and the distance from the infusion site are major factors for heat loss.	<b>Direct</b>  <b>Temperature thermistors are placed directly inside the fluid path.</b> The thermistors directly measure the temperature of the output fluid nearly 5000 times per second, and automatically adjust the heaters based on flow rate or input fluid temperature.  Output fluid temperature is controlled <b>9 inches from infusion site.</b>  <b>No need to purposely overheat fluid temperature.</b> Direct temperature measurement and ability to warm close to infusion site allows the Thermal Angel to minimize common heat loss factors.
	Sims Hotline Fluid Warmer*	Arizant Bair Hugger Ranger Fluid Warmer**	Thermal Angel Blood Warmer TA-200*** 
<b>Ability to Handle Flow Rate Variations (Mass of Heater Technology)</b>	Slow response to variations in flow rates. Significant mass is present in water bath.  Stop flow situation: Sudden decrease in flow rate means additional heat is absorbed into the fluid path. Unit must regulate temperature spike by waiting for heat	Slow response to variations in flow rates. Significant mass is present in warming plates.  Stop flow situation: Sudden decrease in flow rate means additional heat is absorbed into the fluid path. Unit must regulate temperature spike by	Thermal Angel responds quickly to variations in flow rates. <b>Minimal mass</b> is present in the flex heaters.  Stop flow situation: Heaters immediately shut off under stop flow conditions. The Thermal Angel Blood Warmer was designed with minimal mass in the heating technology to help avoid adding extra heat into the fluid path in a stop flow. The Thermal Angel directly regulates the fluid output

	to dissipate through ambient surroundings.	waiting for warming plates to dissipate heat through ambient surroundings.	temperature nearly <b>5000 times per second</b> and can adjust to significant changes in flow rates because of the minimal mass.
	Low to high flow situation: Sudden increase in flow rate requires that additional heat must be generated through large mass of circulating water. Fluid output temperature is not normothermic until these drastic changes have stabilized and been transferred to the fluid.	Low to high flow situation: Sudden increase in flow rate requires that additional heat must be generated through large mass of metal warming plates. Fluid output temperature is not normothermic until these drastic changes have stabilized and been transferred to the fluid.	Low to high flow rates: Heaters immediately increase temperature upon increased flow rates. The Thermal Angel heat flex circuit is tightly bonded to the fluid path via a sonic weld process, ensuring a rapid warm up for any flow rate adjustment. The unit checks its output temperature nearly <b>5000 times per second</b> and can adjust to significant changes in flow rates by directly affecting the heat applied to the small mass of the heater technology, resulting in very rapid changes to the controlled output fluid temperature.
<b>Portable</b>	No	No	<b>Yes</b>
	Constrained to AC power outlet. One more piece of equipment to add into limited power plug space.	Constrained to AC power outlet. One more piece of equipment to add into limited power plug space.	Its small size ( <b>9 inches</b> ) and weight ( <b>9 ounces</b> ) allows warm fluids to be infused in locations, departments and environments never serviced before.
	<b>Sims Hotline Fluid Warmer*</b>	<b>Arizant Bair Hugger Ranger Fluid Warmer**</b>	<b>Thermal Angel Blood Warmer TA-200***</b>
<b>Portable (Cont.)</b>	Constrained to IV pole mount.  Bulky size reduces available work area.  Physically adds additional barrier between caregiver and patient.	Constrained to IV pole mount.  Bulky size reduces available work area.  Physically adds additional barrier between caregiver and patient.	 <b>Not constrained</b> to IV pole mount.  <b>No AC power constraint.</b> No more fighting over limited plug space.  Small size and weight ensures minimal obstruction between caregiver and patient.
<b>Power Requirement</b>	AC Power	AC Power	<b>Rechargeable Battery</b>
<b>Weight</b>	11 lbs.	8 lbs.	<b>9 oz.</b>
<b>Size</b>	Mounted to standard 6 ft. IV Pole	Mounted to standard 6 ft. IV Pole	<b>9 inches</b>
<b>Flow Rate</b>	1-83 ml/min	KVO-150 ml/min (standard flow cassette)  150-500 ml/min (high flow cassette)	<b>2-150 ml/min</b>
<b>Calibration Required</b>	Yes  Annual calibration of fluid tank, electronics and sensors is required.  Calibration equipment must be purchased from manufacturer at additional cost.	Yes  Annual calibration of warming plates and sensors is required.  Single use calibration cassette must be purchased at additional cost.  Requires Biomedical	<b>No</b>  At the factory, every Thermal Angel Blood Warmer undergoes a three stage calibration process involving actual fluid administration at various flow rates.  Calibration and flow rate testing procedures must achieve and maintain manufacturing

	Requires Biomedical technician to perform calibration.	technician to perform calibration.	specifications before the unit is released for sterilization.  <b>Since the Thermal Angel Blood Warmer is disposable, it is discarded</b> after single patient use, negating any need for further calibration.
<b>Maintenance Required</b>	Yes  Daily maintenance check for contamination of water supply and external connections.  Quarterly sterilization	Yes  Daily maintenance check for build up on plates.  Daily external cleaning of unit connections.  Monthly sterilization.	No  No maintenance.  No cleaning.  <b>Discard after each use.</b>
	<b>Sims Hotline Fluid Warmer*</b>	<b>Arizant Bair Hugger Ranger Fluid Warmer**</b>	<b>Thermal Angel Blood Warmer TA-200***</b>
			
<b>Training Procedures</b>	Unintuitive Design.  Must learn pre-operational procedures.  Must learn operational procedures.  Must learn post-operational procedures.  Must learn calibration procedures.  Must learn sterilization procedures.  Must learn maintenance procedures.  Difficult to find reference material for each of the training procedures.	Unintuitive Design.  Must learn pre-operational procedures.  Must learn operational procedures.  Must learn post-operational procedures.  Must learn calibration procedures.  Must learn sterilization procedures.  Must learn maintenance procedures.  Difficult to find reference material for each of the training procedures.	Intuitive Design.  <b>No</b> pre-operational procedures.  5 quick operational steps.  <b>No</b> post-operational procedures.  <b>No</b> calibration procedures.  <b>No</b> sterilization procedures.  <b>No</b> maintenance procedures.  <b>Easy to understand instructions</b> printed on label, packaging and insert; available for web download  <b>On-line Video based training</b>
<b>Set Up Time</b>	2-4 minutes	2-4 minutes	<b>30 seconds</b>
<b>Warm Up Time</b>	6-8 minutes	2-3 minutes	<b>45 seconds</b>
<b>Priming Volume</b>	20 ml	44 ml (standard flow cassette)  90 ml (high flow cassette)	<b>8 ml</b>
<b>Mounting Options</b>	IV pole  Must be near power outlet.	IV pole  Must be near power outlet.	Thermal Angel can double as an arm board near the infusion site (minimal heat loss) or may be placed away from the infusion site (increases heat loss).  Additional attachment options include: IV pole, gurney, wheel chair, supply carrying case.

**No limits.**

\* Specifications Source: ECRI's "Healthcare Product Comparison System", December 2002; Brochures; People often describe this as the Sims Level One or Sims Level 1, but that is a different product from the Hotline.

\*\* Specifications Source: ECRI's "Healthcare Product Comparison System", December 2002; Brochures

\*\*\* Specifications Source: Estill Medical Technologies, June 29, 2004

\*\*\*\* Sometimes Arizant Bair Hugger is spelled incorrectly as Bear Hugger. Arizant used to be know as Augustine Medical.

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