TABLE 1. Successes and Failures in Entering the Chests of Young Patients in Two Age Groups Using Central Venous Catheters Placed from Different Entrance Sites

	Children of Ages		
	0–5 Years	>6 Years	Total
Entrance site right arm			
Success	22 (67 per cent)	30 (67 per cent)	52 (67 per cent)
Failure	11	15	26
Entrance site left arm			
Success	39 (49 per cent)	45 (68 per cent)	84 (58 per cent)
Failure	41	21	62
Entrance site right neck			
Success	19 (70 per cent)	18 (82 per cent)	37 (76 per cent)
Failure	8	4	12
Entrance site left neck			
Success	8 (57 per cent)	19 (95 per cent)	27 (79 per cent)
Failure	6	1	7
TOTAL	154	153	307

addition, some physicians still find the small risk associated with these approaches unacceptable in any patient. Consequently, percutaneous catheterization of subcutaneous veins in the antecubital fossa and neck is preferable in many instances. This study (from the Cardiac Surgery Service, Children's Hospital Medical Center, Boston, Massachusetts) was undertaken to determine whether there is a specific peripheral site from which the catheterization of central veins is more successful in children.

Three hundred and seven central venous catheters were placed in 266 children and young adults just prior to cardiac surgical procedures. The subjects ranged in age from 1 day to 23 years; most were children. The entrance site was noted upon the patient's arrival in the intensive care unit after operation. The location of the catheter tip was noted on the postoperative chest roentgenogram.

In children less than 6 years old, the right neck and right arm are the best sites for catheterization of the central veins of the chest ($P < 0.01$) (table 1). In patients more than 6 years old, the left neck and right neck are the best sites ($P < 0.02$). When all patients are considered together, the left neck and right neck are significantly better ($P < 0.05$) than sites in the arms.

The results of this study confirm what one might expect from a knowledge of anatomy. The right neck should always be a good site, as it has the straightest route to the right atrium. Similarly, if there is any difference in arm sites, the right arm veins lead most directly to the chest. A convenient way to remember the conclusions of this study is to recall that when one is about to place a central venous catheter in a patient less than 6 years old, the operator should stand at the patient's right side. When the patient is more than 6 years old, the operator should stand at the patient's head.

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Another Method for Distinguishing Arterial from Venous Puncture

To the Editor:—In a recent letter, Scamman[1] described a method for determining whether blood aspirated percutaneously for arterial blood-gas analysis is actually arterial or venous. We have used a method that we feel is superior in that it allows one to determine whether the sample is arterial before it is actually aspirated into the syringe.

The method involves the use of a 25-gauge butterfly needle and a 3-ml syringe. The needle with syringe is heparinized in the usual fashion. The syringe and needle are then separated and arterial puncture is performed with the butterfly needle. When the artery has been entered, blood will be seen to pulsate up the plastic tubing. When a vein has been punctured, the blood will gradually flow up the tubing. When entry into the artery is ascertained, the syringe is connected to the butterfly needle and the sample is aspirated.

In addition to assuring arterial puncture, the "butterfly" method has two other advantages over the standard approach. With the butterfly needle, small-gauge needles may be used (the smallest needle we have used has been a 25-gauge butterfly needle). In addition, a three-way stopcock can be attached to the end of the butterfly needle easily, allowing for more blood to be sampled once the blood sample for gas analysis has been obtained.

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*p*H Average Rebuttal

To the Editor:—In the recent dispute on the averaging of *p*H values, Giesecke[1] maintained that the average *p*H values should be obtained by first changing the *p*H to the real number by taking the antilog of the negative *p*H value, averaging, then converting back to *p*H by taking the logarithm. He presented an "experimental proof" for the above procedure by measuring the *p*H value of a mixture of equal amounts of five unbuffered solutions whose *p*H values were adjusted to 2.045, 3.114, 4.132, 5.192, and 6.063 by the addition of hydrochloric acid. The *p*H value of the mixture was 2.758, which did not fit the direct arithmetic mean of *p*H 4.109, while the antilog mean showed a perfect fit.

Unfortunately, his experimental design does not address the question to the problem of averaging *p*H. It also ignores the buffer action, as well as the effect of the ionic strength upon the *p*H, not to mention the fact that the *p*H of unbuffered solution has little meaning because it scatters a great deal and the accurate measurement of *p*H of pure water is next to impossible. Before going into the theoretical detail, the following experiment may be most informative for the present argument.

We carefully duplicated his experiment, only replacing hydrochloric acid with sodium hydroxide. With triply distilled water, we prepared each 100-ml solution of *p*H 5.85, 8.81, 9.87, 10.89, and 11.95. The *p*H 5.85 solution was obtained by simply exposing distilled water to air. We mixed 25-ml volumes of all solutions, and measured the *p*H of the mixture by a combination glass electrode and a Beckman *p*H meter. The resulting *p*H was 11.21.

According to the proposed antilog method, the mean *p*H should be 6.55, and the direct arithmetic mean gives a value of *p*H 9.48. The measured *p*H was not even near the antilog-averaged value or the directly averaged value. This is because the experiment is completely irrelevant to the *p*H average, and is essentially a titration of unbuffered water with acid or base, a meaningless procedure.

What Giesecke has observed (and we have repeated) is partly the effect of dilution of the ionic strength upon the *p*H of a buffer. Dilution of an acidic buffer shifts the *p*H to a higher value (his experiment), and that of an alkaline buffer shifts the *p*H to a lower value (our experiment) (see Appendix). Conversely, addition of a neutral salts such as sodium chloride shifts the *p*H of an acidic buffer to a lower value and the *p*H of an alkaline buffer to a higher value. Here, we refer to hydrochloric acid as a buffer because at the lower *p*H it exists partly in the conjugate form.

These effects occur due to the dependence of the activity coefficient, γ, of an ion on the ionic strength of the solution according to the Debye-Hückel theory (see Appendix).

Disregard of the buffer activity in the above-described experiments is obvious when one considers mixing of a highly buffered solution, say 1 M phosphate buffer, *p*H 6.8, and unbuffered water made acidic by the addition of hydrochloric acid, say to