oppose it during late inspiration with \( W_s \) (ie, \( W_{s5} = W_r \) and \( W_{s5} \) = 0) was a reasonable approximation of this ideal system (Fig 2B).

Subsequent human subject studies were performed in part to test the mechanical model results which were based on this reasoning. It is possible that another PS system which initiates, maintains and/or terminates pressure sooner would be better suited to this function, but the PS system used was not variable in this way.

Regarding the study of human subjects, it is true that work on the lung is \( f(P_{aw} - P_{atm}) \) dV. However, this work is a sum of work done by the subject \( f(P_{aw} - P_{atm}) \) dV and the work done by the CPAP system \( f(P_{aw} - P_{atm}) \) dV. We were interested in the work done by the subject on the lung and artificial airway and, therefore, measured \( f(P_{aw} - P_{atm}) \) dV. This rationale has been previously outlined.

Dr. Simmons questions our use of \( \Delta P_{ES} \) rather than absolute \( P_{ES} \). If one uses absolute values of \( P_{ES} \) in computing work, one includes quantities of elastic energy transferred from the chest wall to the lungs, in addition to work done by inspiratory muscles, thereby overestimating the latter (Campbell diagram).

We did not use the chest wall PV curve to calculate the elastic portion of inspiratory work (Wiel). We assumed that, in any one subject, the PV characteristics of the chest wall were constant between studies for practical purposes. Since the FRC did not change by the design of the study (subjects were trained to maintain \( V_t \) constant), this component of elastic work was common to all conditions of measurement. Therefore, changes in work due to airway mechanical factors could be reliably compared. As an approximation, the Wiel can be estimated as: \( W_{el} = \frac{V_t}{C} \) (C = lung compliance; \( V_t \) = tidal volume). This method of work estimation neglects the PV curve of the chest wall in calculating \( W_{el} \) and, in essence, uses \( \Delta P_{ES} \) for calculation of elastic work as we have done. Other studies, including that which we cite to reference normal work values in the discussion, have measured work in this manner.

In reference to the matter of work on the chest wall, work done by inspiratory muscles to overcome the flow-resistance of the chest wall accounts for only a small portion of the work done by the inspiratory muscles as long as \( V_t \) does not exceed 50 percent of the vital capacity and cannot be directly measured using dynamic PV curves. It is usually neglected in similar studies of work. The comments dealing with figure 7 do require clarification. In graphing our PV relationships, pressure and volume were plotted at 0.1 sec intervals (see legend). With added airway resistance (eg, 7 mm endotracheal tube and ventilator circuit, Fig 7B), \( \Delta P_{ES} \) quickly changed from positive to negative at end-inspiration and early expiration. The absolute peak \( V_t \) and \( \Delta P_{ES} \) at the exact point of end-inspiration was, therefore, often not plotted. Such plots cannot be used to evaluate accurately dynamic compliance of the respiratory system, but have a minimal effect on work measures (areas described by the plots). In fact, in the case of added PS (Fig 7C), \( \Delta P_{ES} \) was often a negative value at end-inspiration as PS was transmitted to the pleural space.

Although Dr. Simmons takes great exception to our measurement and interpretation of work values, he fails to note another measure of patient effort, peak changes in \( \Delta P_{ES} \) during inspiration. These data (Fig 9) parallel those of work (Fig 6) with \( P_s \) increasing by magnitudes similar to those of work in the presence of airway resistances. As with work, these increases are eliminated by application of appropriate levels of PS.

Finally, as can be seen from Figure 8 in our paper, the "optimal PS" values determined in our human subjects studies were consistent with relationships of \( V_t/T_t \) to "optimal PS" values derived from the mechanical model, supporting its validity.

We believe that our results support our conclusions that PS can compensate for additional work due to the resistance of artificial airways.

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The Role of Transthoracic Needle Biopsy
To the Editor:

The recent article by Levine et al (Chest 1988; 93:1152-55) on the usefulness of transthoracic needle biopsy (TTNB) in the evaluation of a solitary pulmonary nodule (SPN) presents very important data, but I believe that the statement that "TTNB is a valuable procedure in patients with a SPN in whom fiberoptic bronchoscopy is negative" is not supported. If one is faced with a patient who has a pulmonary nodule and nondiagnostic flexible bronchoscopy, the major decision to be made is whether thoracotomy is necessary for diagnostic purposes. This decision is based solely on the likelihood that the lesion is malignant. If the clinical features of the case do not indicate clearly that the lesion is benign (eg, significant central calcification) then the usefulness of the needle biopsy is solely in its ability to prove that the patient has a benign lesion and therefore does not require thoracotomy. The data presented shows that TTNB is unlikely to do this, although results might differ in a population with a higher incidence of benign lung nodules.

A patient is benefited by a needle biopsy only if a benign diagnosis is made or if an indeterminate diagnosis on needle biopsy, along with the clinical data, is sufficient to preclude the need for thoracotomy. This procedure is also useful in the occasional patient who refuses to undergo a thoracotomy without proof that he has a malignancy, or a slightly more common situation where the patient is a high medical risk and one would prefer not to send him for thoracotomy without definite evidence of malignancy. Except in these particular situations, it seems to me that the procedure adds no useful clinical information.

Ralph E. Binder, M.D., F.C.C.P.
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To the Editor:

As Dr. Binder suggests, the "value" of a procedure cannot be assessed in black and white, but in shades of gray. We are talking about specific patients in specific parts of the country, not "cases of SPN."

Given that view, we do regard TTNB as a valuable procedure. Many patients we see prefer to know that they have a malignancy before submitting to a costly, painful procedure (which carries more risk than TTNB) like thoracotomy. We do not feel it is inappropriate for patients to refuse thoracotomy until TTNB is done. In fact, we think their desire to know as much as they can is appropriate. As our data show, TTNB often answers the patient's question. Further, as Dr. Binder notes, there are patients in whom
thoracotomy is quite risky. In these, TTNB again may have substantial value.

What our data do not answer—and we hope someone will—is whether two (or more) negative TTNBs grant sufficient guarantee of benignity that follow-up is justified. Only future studies can indicate whether this is rational.

Again, the words "patients who refuse" are difficult for us to accept. We feel patients are entitled to all non-surgical means available for defining the need for surgery before they decide what to do. Indeed, even some with negative bronchoscopy/TTNB elect to do so; with full information at their disposal, we feel it is their decision. Thus, we never have patients who "refuse," we have many who make choices that we, under similar circumstances, might not make. But we defend their right to do so.

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Biopsy Sampling Techniques

To the Editor:


The pathologist has an important role to play in the management of small biopsies. His presence is particularly important at the time of image-guided biopsies. He can examine the specimen immediately microscopically and determine whether the tissue is adequate for pathologic diagnosis or any additional needle pass is necessary. The pathologist can also determine whether core-cutting biopsy is required to supplement aspiration cytology.

Our method of tissue preparation from needle aspirates differs from that described by Wang et al. We do not use any anticoagulants or normal saline solution. Any blood plus tissue fragment aspirated into the syringe is immediately ejected into 7.5 percent buffered formalin solution. When properly fixed, blood and tissue fragments will be glued together using 3 percent agar and the cell block processed for paraffin section. Fixing the tissue in 7.5 percent formalin solution instead of standard 10 percent formalin solution offers better nuclear morphology, which has not been too good judging from figure 3 of Dr. Wang's article.

Tissue and blood in the needle itself is squirted directly onto a glass slide. Excess blood is reaspirated, and excess tissue is picked up with a wooden applicator and transferred to the formalin fixative, leaving an optimal amount on the slide for a smear to be prepared, using the air-dried rehydration technique.

The above technique has allowed us to obtain adequate tissue for pathologic diagnosis in almost all instances using short beveled tip 22G thin-walled Chiba needle, supplemented only in selected cases by cutting biopsy with 21G Surecut needle (TSK modified Menghini aspiration biopsy set).

We agree with Dr. Wang that directing a thin flexible needle such as the 22G Chiba needle is more difficult than a rigid needle. However, a limited degree of steering is possible by changing the direction of the bevel. We release the negative pressure maintained on the aspiration syringe before withdrawing the needle to avoid aspiration of air into the syringe, which would make tissue retrieval difficult.

The 21G Surecut needle, though sparingly used, appears to be particularly suitable for transthoracic core-cutting biopsy since the syringe-needle combination forms a closed system with the needle stylet attached to the syringe plunger, obviating the danger of air embolism. Vacuum can be maintained by a locking mechanism on the plunger. Its operation appears to be simpler than that of the thicker needles described in Dr. Wang's article. A 7 percent chest intubation rate for pneumothorax as quoted in his paper constitutes a not insignificant morbidity. Use of finer needle for biopsy may give a lower complication rate.

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To the Editor:

I have read the letter by Kung and Fung et al from the Institute of Pathology and Institute of Diagnostic Radiology, Queen Elizabeth Hospital, Hong Kong, with great interest.

We agree that the pathologist plays a very important role in percutaneous needle aspiration, especially when the specimens obtained are very small. Moreover, when the probability of obtaining diagnostic material on one or two passes with the needle is not very high, it may be necessary for the pathologist to be present to examine the specimen from each pass. In our series, however, the yield from one or two passes with the spinal or dual needle was very high, and the specimens obtained were large enough to allow histologic as well as cytologic examination with routine processing in almost every case. We believe that our technique was the most important factor contributing to this high yield. The needles used were rigid enough to allow precise guidance of and sufficient caliber to obtain substantial specimens. The needle was attached to the suction syringe with a flexible connecting tube, allowing the operator to manipulate the needle more precisely and to appreciate the firmness or density of the tissue at the needle tip. With these measures we found it unnecessary for the pathologist to be present during the procedures.

Fung et al used a syringe-needle combination with a needle stylet attached to the syringe plunger. This system obviates the danger of air embolism. However, we have found this system to be cumbersome, and instead use the connecting tube between the needle and syringe to overcome this problem. Dr. Fung also used a syringe with a locking mechanism on the plunger. We use a regular syringe so that the operator can apply and feel the suction with his free hand.

The third paragraph concerning the method of tissue preparation from fine needle aspiration is very good. There are numerous ways of preparing a needle aspiration specimen when it is tiny. Fung et al have described a very fine technique to prepare small specimens for histologic examination. It is worthwhile to point out that, in our study, histologic specimens were attempted in every patient. In only one case was it necessary to add blood to the specimen to glue the tiny fragments together for histologic examination. The result of this procedure is shown in figure 3, in which the original slide showed adequate nuclear morphology.

Fung et al indicate that they obtain adequate tissue for pathologic diagnosis in almost all instances using a thin-walled Chiba needle. We would be most interested in a report of these data. More importantly, comparative studies of the efficacy and safety of the fine Chiba needle and 21G Surecut needle are necessary.