square root of the mean on the assumption of the law of small numbers are significantly different[2] (diff. = .73 ± .19) if we make a rough estimate throwing all the variability on to the observed value of σ. On the other hand, for the three distributions for each of the three years, we have for the means and variances m = 3.00, $\sigma^2 = 2.68$; m = 2.83, $\sigma^2 = 2.70$; m = 2.49, $\sigma^2 = 1.93$, which indicates that in each year the distribution is subnormal. Even if these three distributions be thrown together despite the inter-year differences of m, the resulting distribution is subnormal, with m = 2.77, $\sigma^2 = 2.48$. Thus there is evidence that the variation is less than that due to chance, as well as evidence that the variation is greater than that due to chance, entirely apart from the evidence of the correlations cited above.

At the time Gafafer and Doull were writing (1933) the analysis of variance had hardly got into the literature.[3] It would appear that this method of analysis might be one very appropriate to the discussion of their exceptionally good data. If we consider that the number of colds n_{ij} of the ith person in the jth year ($i = 1, 2, \ldots, 111$; $j = 1, 2, 3$) consists of one part appropriate to the individual, one appropriate to the year and a residual independent of both, Table 1 may be constructed:

TABLE 1

	Sum of squares	Degrees of freedom	Mean square
(1) Between year means ..	15.2	2	7.60
(2) Between person means .	480.7	110	4.37
(3) Residual fluctuations ..	330.8	220	1.50
Total $S(n_{ij}-n)^2$	826.7	332	...

The values of the mean squares indicate that the variation from year to year ($\sigma_y = 2.8$), poorly established because of the small number of degrees of freedom, is considerably larger than the variation ($\sigma_p = 2.1$) between persons; but as the ratio 7.60 : 4.37 of the variances is not significant, one may not claim the difference as meaningful.

Compared with the residual variance 1.50, both that between years and that between persons is significant, for the former at around the 1 per cent. level and the latter at well below that level. The evidence is therefore corroborative of that offered by the inter-year correlation coefficients to the effect that there is significant evidence that the distribution of colds was not by chance but was affected by an inter-individual variation of resistance to the common cold or by some systematic influence which simulated it, such as a higher exposure rate among some than among others of the persons under observation.

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[2] Although the distribution seems to be very significantly hypernormal, the chi-square test applied to it gives a variety of results from P = .05 to P = .50, according to the manner of grouping, and fails to indicate in any clear manner that the fit is significantly bad.

[3] R. A. Fisher, "Statistical Methods for Research Workers," 1925, and subsequent editions, Chapter VII; G. W. Snedecor, "Calculation and Interpretation of Analysis of Variance and Covariance," 1934; G. U. Yule and M. G. Kendall, "An Introduction to the Theory of Statistics," 1937, pp. 444–449. Reference should also be made to two articles by J. O. Irwin, *Jour. Roy. Stat. Soc.*, London, pt. II, 1931, 284–300, *ibid.*, Supplement, 1: 1934, 236–251.

RESUSCITATION APPARATUS

THE recent controversy between the late Professor Yandell Henderson and Council on Physical Therapy of the American Medical Association contains a most unhappy and serious implication. It would appear, from the matter presented, that the recovery of the asphyxiated patient turns exclusively upon the operation of mechanical gadgets designed to meet and overcome all conditions accompanying the unconscious state. If the patient recovers, he has been saved; if he dies, he was beyond all hope of rescue.

This implication would seem to confirm the layman's everyday observation, the patient with a persistent headache, an abdominal pain or a fracture is a serious medical problem. He demands, and if it is available he receives, the best medical care obtainable. But should unconscious or respiratory failure supervene, his condition is suddenly simplified to a point where the police, the fire or the consolidated gas squad is all the assistance required. If the squad can bring or borrow an inhalator or a resuscitator, everything is perfect. Or—

If a child inhales a peanut or a pin, he is hustled off to the hospital and receives every advantage of the bronchoscopic clinic. Should he be so unfortunate as to inhale something larger, a marble or a chunk of meat, he is no longer in need of medical help. Everything will be solved if the suck and blow apparatus used last week in the stevedore down the street can be secured.

Asphyxia-conscious physicians are well aware of the phenomena which occur between the onset of unconsciousness and the death of the patient. They are prepared to control and to direct these phenomena. Treatment must necessarily vary with the stage of asphyxia treated. The depressed, the spastic and the flaccid patient each requires a different approach. It is frequently fatal to attempt to fit the desperately ill patient into treatment suited to the patient who is merely depressed. It would seem as reasonable and in many cases safer to attempt to employ a mechanical robot for a brain operation, on the basis of electrical potentials, than it is to attempt to subordinate respiratory rate and rhythm in a patient about to die.

Controversy over mechanical gadgets plays directly

into the hands of commercial interests, without contributing to the problem at issue. It is most regrettable that medical leaders and respected medical groups should be betrayed into a position where their directive influence deteriorates to the level of the pros and cons of a mechanical gadget. Yandell Henderson was perfectly correct when he said that resuscitators killed thousands of patients—not as bullets do directly, but by providing a gesture and alibi for the correct treatment required.

Instead of such unfortunate emphasis, therefore, why not put more emphasis on the problem requiring treatment? While it is granted that this would be out of place in clinical disease involving biochemical reactions, extending over a period of time, it is quite in order in conditions in which mechanical problems are involved, where a life may be saved or lost in a few minutes.

Radio, aerodynamics and many other skills are quickly picked up by lay men and women. Why not popularize the mechanics of asphyxiation? Not as heretofore by a frozen drawing of the respiration, but as the very much alive mechanism which depends upon reflexes and normal muscles for protection and which presents, progressively, a totally different problem, when asphyxia has put these protective factors out of commission and blocked the airway with blood, vomitus or other foreign matter. Any one with ordinary mechanical sense could promptly improvise relief for these situations once they are understood. He would soon know as well or better than a salesman whether or not a given resuscitator was of much use to him. Why not debunk the mystery of the mechanics of asphyxia?

The informed layman will have little difficulty in appreciating that an air line which is blocked can not function, that an obstruction can sometimes be bypassed more easily than it can be overcome. He will understand how gas pressure in the nose and mouth can blow vomitus or blood which may be in it into the windpipe. He can observe a change in the color of the patient as well as any one, if he is instructed to look for it.

The entire approach to the devastating problem of asphyxia should be revamped. What is treated should become the important thing. Thousands will continue to die until the patient and not the apparatus becomes the issue.

It is respectfully suggested that the Council on Physical Therapy or the Council on Medical Education issue a statement covering the presently accepted views relating to the pathological physiology of asphyxia, *i.e.*, the stages of asphyxia, the signs which accompany each of these stages, the indications for the correct treatment of each stage, the simplest means by which these indications may be met. A patient about to die is entitled to the maximum effort in rescue; after this consideration the late effects of such treatment are to be considered and measured. The indications for treatment are clearly indicated in the pathology of each stage; any experienced pneumatologist (gas therapist) is familiar with the care of the unconscious patient.

When the needs of the patient are clearly stated by a recognized authority and the simplest means of meeting these needs are described, resuscitation equipment will automatically fall into line in response to the law of supplying what the informed public demands.

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WITH interest I read the reply of the Council on Physical Therapy of the American Medical Association to the late Yandell Henderson's attack on the Pulmotor and its successors. It is possible that this article, as it appeared in SCIENCE, December 24, 1943, was the old warrior's last use of his mighty battle-axe —and I honor it.

A controversy between advocates of what Henderson terms "suck and blow" on one side and advocates of insufflation on the other side is only of recent date, but the actual fight against suction to the lungs has been going on for thirty years. A sharp battle line could be drawn between Roth-Draeger, the German originators of the Pulmotor, Coryllos, the lone proponent, and now the council on one side and the three opponents of negative pressure, Meltzer, Henderson and Flagg, on the other side. During this thirty-year period "suck and blow" was several times knocked out but was always revived. At present the survival of the fittest seems indefinitely dated ahead.

Considering that Yandell Henderson spent practically half of his lifetime in research on the subject of resuscitation and its kindred, and that his devotion to the study of the physiology of respiration was truly scientific, the reply of the council doesn't seem to me a scientific repartee. The council argues on the principle of "the proof of the pudding is in the eating" when asserting that, statistically, resuscitation apparatus applying positive and negative pressure has never killed a patient nor injured respiratory organs. On that basis the council is fully justified in considering the principle as workable and in accepting the apparatus in question, but as an argument against Henderson's assertions it is far from the point.

Only in one instance the council uses a basic figure. It is the reference of a safe positive pressure to the lungs of 13 mm. Hg., and this is conspicuously a factor to which Yandell Henderson paid less attention than to other factors. What he was mostly concerned with

when warning of the dangers of the "suck and blow" resuscitators was the factor of negative pressure to the lungs and the impossibility to synchronize with the patient's respiration.

The first warnings on these features appeared in the report of the Bureau of Mines in 1914.[1] It was the report of the committee on resuscitation that "killed the Pulmotor," and Henderson from then on stood up for the findings then established. It would be of interest at this time to know whether the Bureau of Mines had any reason to alter their opinion since then and whether eventually they give the principle of "suck and blow" a right to be.

One of the committee of 1914 was the late Dr. S. J. Meltzer, of the Rockefeller Institute, and it was his disbelief in the safety of negative pressure to the lungs and his belief in the necessity to synchronize which led him to develop the simple, safe and inconspicuous method of resuscitation known as the Meltzer method. It is on the principle of pharyngeal insufflation with a limited safe pressure, leaving deflation to the natural contraction of the chest wall, first published in the *Journal* of the American Medical Association, May 10, 1913, and later adopted by Henderson and Haggard, by the Society for the Prevention of Asphyxial Death, by many specialists on respiration and, with modifications, used by many institutions all over the world.

Naturally an apparatus built on the principle of insufflation only is not as impressive as an apparatus built on the principle of positive and negative pressure. It is human nature, without sufficient thought, to be impressed by the performance of a device apparently so similar to the functions of human respiration. The fact that human respiration is just the reverse, that it is done with negative pressure at inspiration and positive pressure at expiration, while the pumping apparatus applies positive pressure at inspiration and negative pressure at expiration is not considered or I will say not even recognized.

With all due respect to the council, I still believe in Yandell Henderson.

RICHARD FOREGGER

NEW YORK, N. Y.

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W. T. PORTER

DOVER, MASS.

GENERAL BIOLOGY

THE distinction between the "biological sciences" and the "physical sciences" emphasized by Professor Shull in a recent number of SCIENCE,[1] is a very excellent one. Since it raises the biological sciences to a level where each is commensurate with the exact ones, "physics, chemistry, mathematics, meteorology, geology, astronomy, etc.," the distinction has a most attractive sound to teachers and workers in the less exact, biological subjects. Carried to its logical conclusion, colleges and universities should be reorganized, either by amalgamating the physical sciences into one department or by elevating zoology and botany, perhaps also physiology, genetics, microbiology, ecology, etc., each to full departmental importance. Psychology and anthropology, already full departments in many institutions, might be considered parts of this group.

In the first alternative, it would undoubtedly be necessary to "concoct" a "hodge-podge" course as an "extraction of all" the physical sciences, presenting it as an introduction to these subjects. Since Professor Shull deplores "general biology," so too he would unquestionably object to such a course as "gen-

[1] U. S. Technical Paper No. 77.

[1] See footnote to page 2 of a paper on "The Teaching of Physiology," *Philadelphia Medical Journal*, September 1, 1900.

[1] SCIENCE, n.s., 99: 199, 1944.