

Special Article

Teaching Anesthesia to Undergraduate College Students

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After an examination of the present and future status of the specialty in the city, a group of Cleveland anesthesiologists has introduced anesthesiology into the undergraduate curriculum at Case Western Reserve University. The program satisfies the academic requirements of premedicine and provides an education of high quality for intermediate anesthesia personnel. At the two- and four-year levels of the program, certification for employment is awarded to intermediate and advanced physician assistants in anesthesiology. In addition, students concurrently earn academic credits which are negotiable toward advanced study in medicine and related fields. (Key words: Education; Anesthesiology; Manpower; Physician assistants; Nurse anesthetists.)

In 1969, a group of Cleveland anesthesiologists representing private and academic sectors of the specialty began discussing personnel requirements for the metropolitan area. While the group felt the need for more anesthesiologists, it also recognized an additional need for an intermediate category of anesthesia personnel. Out of the deliberations of the group grew a pilot educational program which is now in its second year and which is the subject of this report.

The tasks performed by anesthesiologists, nurse anesthetists, and others in the specialty can be grouped into categories according to an ascending order of responsibility: 1) simple functions that require little formal education; 2) intermediate functions executed in response to general and specific direction; 3) complex functions that require integrating a

variety of medical information; making rapid diagnostic and therapeutic decisions, and assuming the responsibility for the patients' well-being and life. There is little need to discuss the extremes of this simplified spectrum; both are well established in the specialty and are represented in any department which has aides, cleaning personnel, and anesthesiologists. Today, the nurse anesthetist probably best represents the intermediate group in those situations where nurse and physician anesthetists work in a team.

What would constitute the necessary and desirable educational requirements for this intermediate group? Tasks that fall into the intermediate group demand an understanding of physics, chemistry, physiology, and pharmacology, as well as certain clinical syndromes that can be identified by pattern recognition (*e.g.*, detection of arrhythmia via electrocardiography). Even so briefly outlined, this educational content readily fits into the framework of American college education; it is less demanding than medical school, more demanding than high school, yet parallels the depth and complexity of other areas currently offered to baccalaureate candidates. College students now learn enough chemistry to understand acid-base balance and enough biology to understand the principles of electrocardiography or pulmonary physiology. To provide intermediate anesthesia personnel with this necessary background (*e.g.*, chemistry, biology) outside the college education places an unreasonable and unnecessary burden on teachers who must supply this, in addition to specialty education.

In recognition of these problems, the group of Cleveland anesthesiologists designed a bac-

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TABLE 1. The Negative ("No's") Aspects (Employability/Educational Advancement) of Existing Alternatives* Compared with the Baccalaureate Degree in the Health Sciences

Upon Completion of	Diploma-specific Immediate Employment	Diploma-specific Advanced Education	General Advanced Education
High school	No	No	Yes
A.A. (R.N. or I.T.)	Yes	No	No
B.S. (R.N.)	Yes	Yes	No
C.R.N.A.	Yes	No	No
B.A.-B.S. (Premed.)	No	Yes	Yes
Health Science B.S. (Anesthesiology)	Yes	Yes	Yes

* A.A., Associate in Arts degree (two years of junior college). R.N., registered nurse; I.T., inhalation therapist; C.R.N.A., certified registered nurse anesthetist; B.A.-B.S., Bachelor of Arts or Science (usually four years of college).

calabre anesthesia curriculum in close cooperation with Case-Western Reserve University. A curriculum was developed to satisfy the following conditions:

- 1) Lead to a Bachelor of Science in Health Sciences (Anesthesiology) degree. This designation was chosen to offer other specialties the option of developing similar curricula and entering their specialties into the parentheses.
- 2) Meet the standards of the University, insure easy transferability of credits, and provide sufficient academic credits to satisfy the admission requirements of most American medical schools.
- 3) Contain sufficient didactic hours in anesthesiology to insure that graduates could manipulate all concepts pertinent to the tasks specified for intermediate personnel. These tasks have been defined and are under continuous redefinition in an ongoing examination of anesthesia tasks in Cleveland. (See Tasks, levels 3 and 4, in Analysis of Manpower in Anesthesiology, by Gravenstein, Steinhaus, and Volpitta, ANESTHESIOLOGY 33:350-357, 1970.)
- 4) Contain sufficient practical-laboratory hours to teach the technical skills needed to deal with anesthesia equipment, monitoring equipment, ventilators (i.e., the technical aspects of anesthesia).

5) Provide clinical experience in which each student would be matched with an individual practicing anesthesiologist for education in the clinical setting.

6) Allow sufficient elective hours to assure a well-rounded education rather than vocational training superimposed upon minimal college requirements. Twenty-one academic semester hours have been made available for electives, and students are encouraged to use the majority of this elective time in advanced courses in the humanities and liberal arts rather than in the sciences. Yet, it is possible for selected students to apply these electives toward chemistry/biology, etc., to obtain a double major (e.g., in a pure science and anesthesiology).

Some additional considerations deserve mention:

Employability

Table 1 presents an outline of certain facets of high school, junior college, college, and medical education.

The high school graduate does not typically possess specialty knowledge that can be negotiated into a specific job. The same is true of the average premedical graduate, who may have majored in biology or chemistry. In table 1 this is shown under the category of "diploma-specific employment." Students with degrees in biology or zoology quickly realize that employers in these areas most often seek candidates with graduate education. Indeed, in the early seventies, the 50 per cent of all premedical students who are successful in entering medical school look upon their degree/major merely as a stepping stone and not as a preparation for an intermediate career. Conversely, students who fail to gain admission to medical school are at a disadvantage, because their degree does not usually lead to degree-related employment.

Educational Mobility

Nursing schools and junior colleges with specialty-directed vocational education (e.g., inhalation therapy) assure the student of diploma-specific employment upon graduation. Nonetheless, "vocational" college educations have a drawback. In many institutions, much

of the curricular content lacks sufficient calibre to be universally accepted by other schools or colleges. Thus, "Chemistry for Inhalation Therapists," is usually not accepted in lieu of an introductory college chemistry course. The baccalaureate degree in inhalation therapy or nursing sacrifices academic mobility in exchange for employability. Consider two typical examples: 1) even an academically gifted graduate of a college of nursing (B.A. degree) will find it very difficult to gain entrance into medical school; 2) a graduate of a two-year vocational nursing or inhalation therapy college (A.A. degree) will find it difficult to obtain a baccalaureate degree by adding only two more years of college education.

The Case-Western Reserve University Program

The introduction of the anesthesia curriculum into the undergraduate College required lengthy discussions. Proposals were prepared and submitted to curriculum committees and faculty; ultimately these underwent much revision and resubmission. This process was facilitated by the deliberations of an interdisciplinary committee in the health sciences, which formulated the overall concept. The President of the University then appointed a Task Force containing representation from Liberal Arts, Biology, Dentistry, Nursing, the Medical School, and the specialty. The Task Force developed the curriculum, presented it

TABLE 2. Bachelor of Health Science (Anesthesiology), A Four-year Curriculum, Course Requirements (Semester Hours)

General		Related Field	
English	3	Calculus	8
Social Science	6	Biology	8
Humanities	6	Chemistry	
		(includes organic)	16
Electives	21	Physics	8
TOTAL	36	TOTAL	40
Anesthesia			
*H.S. 101	—Introduction to Medicine Text: no single text		2
H.S. 210	—Respiratory Physiology Text: Comroe: The Physiology of Respiration		3
H.S. 202	—Cardiovascular Physiology Text: Guyton: Textbook of Medical Physiology		3
H.S. 211(3)—212(3)	—Clinical Laboratories (Correlated with H.S. 201—202) Text: Syllabi in progress		6
H.S. 301	—CNS Physiology Text: Guyton: Textbook of Medical Physiology		3
H.S. 302	—CNS Pharmacology Text: Goodman and Gilman: The Pharmacological Basis of Therapeutics		3
H.S. 311(12)—312(12)	—Clinical Preceptorship Text: Wylie-Churchill-Davidson; syllabi in progress		24
		TOTAL	44

* H.S. 101, etc., are course designations from the University catalog and refer to Health Science. The 100 series generally is taken by freshman, the 200 series by sophomores, etc.

to the University Curriculum Committee and Faculty, then supervised its formal institution into the University catalog.

During this period, questions were raised concerning the propriety of taking young college students with no previous medical experience into a hospital and bringing them into contact with patients. Since no guidelines in this area existed, the committee decided to offer, as a prerequisite to clinical contact, a two-semester-hour course entitled "Introduction to Medicine." The course was designed to expose the student to the general scope of medicine, the ethics and morality of medicine, the sensitivities of patients, the organization of medical care, and the major issues facing medicine today. From students participating in this introductory session, suitable candidates for admission into the specialty portions of the curriculum are selected. Of course, all students in the program must

first be acceptable to the university as undergraduates.

The program's curriculum is shown in table 2. Examples of content in different sections are given in tables 3 and 4. The level of teaching is exemplified by exam questions taken from a mid-term examination in H.S. 201 (Respiratory Physiology, see table 2).

The first students to enter the program registered for an "Introduction to Medicine" in the Spring semester of 1971. The class was composed of 35 students, of whom 29 applied to enter the specialty portion of the degree program. Fifteen of the 29 were accepted; 13 actually registered for the first specialty-semester (201 and 211); one dropped out because of academic difficulty. The range of grade-point averages in this class of 12 students, now in their third semester (202 and 212), is 2.00-3.77 (4.00 = A, i.e., the highest grade). The mean grade-point average of the class is

TABLE 3. Sample Course Content (Each Roman Numeral Represents One Hour of Instruction)

1971	Introduction to Medicine (H.S. 101)
February 10	I. Organization of Living Systems and Their Diseases II. The Nature and Origin of Drugs
February 17	I. History, Yield and Status of Autopsy II. Ethics in Human Experimentation
October 25	Pulmonary Physiology (H.S. 201)
November 1	I. Work of Breathing, Respiratory Failure II. Care of Respiratory Failure Patients III. Ventilators, Ventilation Strategies
	I. Anesthesia and Respiration II. Uptake and Distribution III. Acid-Base I (the first of six hours)
1972	Cardiovascular Physiology
February 8	I. Cholinesterase, Adrenergic Mechanisms II. Cardiac Action Potential, Excitatory-Conductive System III. Cardiac Contractile Mechanisms
February 15	I. Cardiac Cycle and the Heart as a Pump II. Regulation of Cardiac Function III. Hemodynamics, Vascular Distensibility
September 7	Clinical Laboratories
February 23	I. Anesthesia Equipment II. Anesthesia Circuits I. E.K.G. and Patient Monitoring II. Respiratory Care, Blood Gas Analyses

TABLE 4. Sample Exam Questions (H.S. 201)

An individual has a shunt of 20% of his cardiac output. His lungs are mechanically ventilated with large tidal volumes and high inspiratory pressures. His shunt is then found to be reduced to 10%. This has probably occurred because

(Select the *one* correct answer)

- A. after mechanical ventilation deadspace is increased.
- *B. mechanical ventilation opens collapsed areas of lung, permitting those areas to participate in ventilation again.
- C. mechanical ventilation increases perfusion.
- D. mechanical ventilation increases P_{CO_2} .
- E. high airway pressures improve perfusion.

(W = 1; R = 11.†)

Pulmonary blood flow is greatest

(Mark A if 1,2,3, are correct; B if 1,3; C if 2,4; D if 4 only; E, any other combination.)

- *1. in West's zone III
- *2. where arterial pressure exceeds venous pressure which exceeds alveolar pressure.
- *3. in the bases of the lungs.
- 4. where alveolar pressure exceeds arterial pressure which exceeds venous pressure

(W = 2; R = 10.†)

* Correct response.

† Indicates numbers of wrong and right responses to these questions in the first class of 12 students.

2.91 (3.2 = Dean's list at C.W.R.U.). We believe that three or four of these students will be successful in their application to medical school and that the remainder will enter the specialty on the intermediate level.

In the Spring of 1972, "Introduction to Medicine" was offered for the second time, and 84 students were registered. Of these, 45 have applied for admission to the specialty courses which will begin again in the Fall of 1972. The range of grade-point averages of current applicants is 2.25-4.00, with a mean average of 3.10.

The program has proved surprisingly attractive to students of this university and to many others (more than 1,000) from all over the nation who have written for application information. Such an overwhelming response can be attributed to several factors. Most pre-medical students are uncertain of gaining entrance into medical school. Should they fail, they immediately face employment problems. A program that provides for employment without jeopardizing the opportunity to enter medical school is attractive. For many years, students have emphatically requested relevance in their studies. The anesthesia pro-

gram offers such relevance while maintaining high academic standards. Students are motivated by the clinical orientation of the program. As a result, there is little doubt why acid-base chemistry is significant or why discussions in Biology of ionic balance in cells might be important. Others point out that every student should learn more human physiology than is commonly taught in undergraduate schools, and that an opportunity to learn this physiology from physician-teachers in college is exciting and stimulating. All students who have selected medicine as their profession would like to come in contact with the career environment as early as possible. Here, an undergraduate curriculum offers an opportunity to enter the system.

The anesthesia program at Case Western Reserve University is considered a pilot program by the University and by those who participate in it. Should the hypothesis that the program provides an attractive route for educating intermediate anesthesia personnel or premedical students in general be rejected, the program can be abandoned without sacrifice by the students. They would still have a

valid baccalaureate degree, and the education offered in the program would surely be beneficial. However, even before the first class has completed the program, several students have been offered positions by anesthesiologists in Ohio. Other specialists are examining the format closely and, at the time of this writing, Obstetrics/Gynecology has submitted a curriculum patterned after it.

In discussions regarding the program, questions concerning legal problems, insurance coverage, the proper composition of the anesthesia team, etc., invariably arise. At this point, we do not wish to discuss these items. Suffice it to say that solutions to these questions can and will be found should the conceptual and educational principles of the approach prove sound.

Obstetrics

LIDOCAINE AND FETAL PHYSIOLOGY Fifteen experiments were done on eight sheep fetuses whose gestational ages were 120 to 143 days (term is approximately 145 days). The injection of lidocaine, 1 or 2 per cent, in doses of 14.3 to 36.8 mg/kg fetal weight resulted in significant changes in fetal heart rate, EEG, and cerebral blood flow. Significant bradycardia, not influenced by vagotomy, occurred. The electroencephalogram showed slowing, slowing followed by an isoelectric (flat) record, or low-voltage fast activity. Cerebral blood flow decreased, but cerebral metabolism was unaffected. All three values returned to normal within 20 minutes of injection. No attempt was made to quantitate blood levels of lidocaine, so no statement of a critical level of lidocaine beyond which physiologic alterations would be expected can be made. (Mann, L. I., and others: *The Effect of Lidocaine on Fetal Heart Rate and Fetal Brain Metabolism and Function*. *Am. J. Obstet. Gynecol.* 112: 789-795, 1972.)

Obstetrics

DRUG THERAPY IN PRE-ECLAMPSIA Fifty-two patients in labor with severe pre-eclampsia were treated by intravenous infusion of diazepam and hydralazine. The results of this treatment were compared with the results of two other methods of treatment, a lytic cocktail regimen, and rectal Avertin (tribromethanol). The maximum total dose of diazepam was 300 mg, given in a 21-hour period. The maximum total dose of hydralazine was 280 mg, and the average dose was 75 mg. The treatment was directed toward ensuring a sleepy, rousable patient with a blood pressure below 150/100 mm Hg. Furosemide (Lasix), 40-80 mg, iv, was also given, for edema, and meperidine, 50-100 mg, im, was used for pain.

Avertin was freshly prepared and given rectally in full obstetric dosage according to the manufacturer's instructions. The "lytic" regimen consisted of meperidine (100 mg), chlorpromazine (50 mg), and promethazine HCl (50 mg) in 500 ml of 5 per cent dextrose solution, with the drip rate adjusted to keep the blood pressure below 140/90 mm Hg.

Diazepam and hydralazine gave significantly better control of blood pressure than either of the other regimens, with no adverse reaction except a tendency to hypothermia in the newborn. No patient developed eclampsia during diazepam-hydralazine treatment, but one patient had a seizure during the "lytic" regimen and another seizure after Avertin treatment. (Joyce, D. N., and Kenyon, V. G.: *The Use of Diazepam and Hydralazine in the Treatment of Severe Pre-eclampsia*, *J. Obstet. Gynaecol. Br. Commonw.* 79: 250-254, 1972.)