patterns of medical care; in these studies the common-sense approach is supplanted by accurate information to be used for organizing and providing services in accord with patient needs. These studies identify the characteristics of the patient population, their patterns of obtaining care, and the factors that determine their patterns of care, and show that use of medical services follows definite patterns and is not a random affair.

Avedis Donabedian (University of Michigan) outlined the components of the medical care process—recognition of need for care by the patient or those who are responsible for him; the decision to seek care; the process of seeking care; assuming the sick role; diagnostic and therapeutic decision-making by the providers of care; relations between the patient and the providers of care; relations among the multiple sources of care and the recipient; maintaining care; and, finally, terminating care. The quantitative aspect of the medical care process is reflected in studies of the use of medical services. The qualitative aspect is reflected in research in the quality of care, either with respect to process or end results.

Kerr L. White (Johns Hopkins University; chairman of the seminar) presented an overview of research in patient care, which he considers but one component of the entire system of health services. The system has five major components which may be studied—personnel; institutions; organization and administration; financing, payment, and economics; and objectives. Research in medical care may be directed at one of five levels in the entire system—patients' need for care, patients' demand for services, use of the services, outcome, and satisfaction. Similar to other forms of research, the design and methods are determined by the units to be observed—episode of illness or of care, the "visit" or "admission," the patient and his care in time and place, the disease, the family, the institution, or the community. The denominator of any study must be clearly defined because the research so often consists of comparisons between otherwise similar groups. The techniques of epidemiology are most useful here.

Research in medical care uses four types of data—administrative, personal, medical, and behavioral. The major sources of bias in research in patient care are selective bias, the uncertainty effect, the Hawthorne effect, the placebo effect, observer variation, observer error, and sampling errors. Research in patient care can be classified broadly into two major types—the case history method and the cohort method. Within the broad classification, there are four types of studies: descriptive, not based on specific hypotheses, and involving observation of unplanned events; analytic, based on specific hypotheses and observation of unplanned events; experimental, directed by specific hypotheses and using controls to deal with irrelevant variables; and evaluation studies, which require stated objectives and often must rely on comparison groups rather than true controls.

The primary emphasis in patient care research should be on "research." It is irrelevant to debate whether "laboratory" research is more scientific or important than "patient-care" research. Each requires knowledge and critical application of both the rules of logic and the methods of science. Lacking these, an activity may well advance "patient care" but it is not "patient-care research."

PAUL J. SANAZARO
Association of American Medical Colleges, 2530 Ridge Avenue, Evanston, Illinois

Nucleation Phenomena

Theoretical and experimental aspects of nucleation phenomena were reviewed at an international symposium held at Case Institute of Technology, Cleveland, Ohio, 7–9 April 1965. The major areas covered were atmospheric and solid state physics, analytical and physical chemistry, metallurgy, ceramics, polymer science, and biological systems. In addition to the 10 invited review lectures, 26 short papers covering recent research in the field were presented.

In the opening lecture W. Dunning (University of Bristol) outlined the current status of classical nucleation theory. He pointed out that the best correlation between theory and experiment can be expected for tightly bound clusters where partition functions can be evaluated. He also suggested that new experimental techniques currently being developed should enable a critical evaluation of cluster theories within the next decade.

The problem of nuclear size in the weak interaction limit was also discussed by J. Cahn (M.I.T.). His formulation, developed from a consideration of the spinodal, led to a formalism postulating the development of periodic concentration fluctuations. In the extreme weak binding limit, therefore, the issue of critical nucleus size, with its corresponding physical enigmas, is avoided. Periodic spinodal composition fluctuations have now been observed in many systems, including the inorganic glasses and metal alloys.

Several papers were presented in the area of statistical methods. F. Goodrich (California Research Corp.) demonstrated that it should be possible in certain cases to determine the kinetics of the nucleation and growth stages by a statistical analysis of the particle size and its standard deviation. This approach is still in its initial stages and, as Goodrich pointed out, is in need of experimental tests. Although an initial paper on the subject has been published, the method was unfamiliar to many scientists present and as a result of the presentation, several participants in the area of ceramics and metals expressed an interest in applying this analysis to data which had been accumulated, but which were not amenable to standard approaches. Thus, it appears that the symposium in at least one case did fulfill its aim to bring the theoretician into contact with experimental data and vice versa. In a contributed paper on irreversible thermodynamics, K. Russell (M.I.T.) showed that subcritical growing nuclei follow a reaction path which is one or two degrees cooler than the ambient temperature. This point seems particularly interesting in view of the controversy which existed a few years ago on the relative temperatures of molecular clusters.

The experimental technique which appears to be emerging as a new method of evaluating nucleation theories is the use of nozzles for condensing vapors. Several papers were devoted to the experimental design, data, and theory of operation for such nozzles. Up to now, however, definitive data are only starting to be obtained. D. Turnbull (Harvard University) felt that experimental studies of crystal nucleation from liquids could also yield suitable data for an assessment of nucleation theory. He reviewed the main methods of studying melt-solid transitions.

Most of the other papers fell into one of two categories. In the first category, experimental evidence was compared with theory which was considerably modified for application to the

particular system. As an example, J. Hoffman (National Bureau of Standards) described the application of nucleation theory in polymer crystallization. This is a new field which has been developing rapidly in the past few years and has given rise to a much greater understanding of the relation between solid state structure of polymers and their mode of crystallization. Another area where theoretical and experimental developments have run parallel is that of heterogeneous vapor deposition, particularly the deposition of metal atoms. J. Hirth (Ohio State University) reviewed this area and felt that classical theory represented the situation fairly well. This view is in strong contradiction to some recent theories and some lively discussion ensued over the value of using contact angles as a suitable thermodynamic parameter. Although there was a sharp division of opinion on this point, Hirth adequately summarized the situation by saying that the contact angle could be considered as a rug under which many of the uncertainties could be conveniently swept.

In the second category, emphasis was on experimental data which could be related to essentially unmodified theory. S. Mossop (Commonwealth Scientific and Industrial Research Organisation, Australia) reviewed the current status of knowledge in cloud physics. He commented that only in recent years have fundamental studies enabled a quantitative approach to be formulated for cloud nucleation. This comment was amplified later in the proceedings when some recent experimental studies of water vapor condensation were outlined. A. Nielsen (University of Copenhagen) reported continued studies relating precipitation of sparingly soluble salts to the Volmer-Becker-Döring formulation; he mentioned recent successes in unraveling the role of homogeneous and heterogeneous nucleation in precipitation studies. Nielsen suggested that the relative solvation of ions affects the kinetics of nucleation; he illustrated this effect with recent results. The role of nucleation processes in ceramics and noncrystalline solids was considered by R. Maurer (Corning Glass Research Laboratories), and was extended by an interesting contribution from J. Hammel (Pittsburgh Plate Glass Company). The degrees of quenching possible in glass transitions enable quite extensive nucleation studies, both homogeneous and heterogeneous, to be carried out.

In diversifying the areas of interest

at this symposium, the organizers included physiological nucleation processes; bone mineralization and gall stone formation were considered. The former area was reviewed by M. Glimcher (Harvard University), and his discussion turned out to be one of the highlights of the symposium. A brisk discussion following this paper centered around the form of calcium phosphate which nucleates at serum *p*H. Some of the participants felt that octocalcium phosphate was a metastable precursor to bone mineral; Glimcher felt that hydroxyapatite nucleated directly. Both factions agreed, however, that in physiological processes the nature of the initiating nucleus was dependent upon the protein substrate.

From general comments and discussion following the papers it seems that at least one of the major symposium aims, that of improving communication between various areas of nucleation study, was attained. The symposium was sponsored jointly by the National Science Foundation and Case Institute of Technology. Abstracts of the proceedings may be obtained from the undersigned.

A. G. WALTON
Department of Chemistry,
Case Institute of Technology,
Cleveland, Ohio

Forthcoming Events

June

19. Academy of **Tuberculosis Physicians**, New York, N.Y. (G. P. Bailey, 1295 Clermont, Denver 20, Colo.)

20. Society of **Vascular Surgery**, annual, New York, N.Y. (W. S. Edwards, Dept. of Surgery, Medical College of Alabama, Birmingham)

20–22. Society for **Investigative Dermatology**, 26th annual, New York, N.Y. (H. Beerman, 255 S. 17 St., Philadelphia, Pa.)

20–23. American Soc. of **Agricultural Engineers**, 58th annual, Univ. of Georgia, Athens. (J. L. Butt, P.O. Box 229, St. Joseph, Mich.)

20–24. American Soc. of **Mammalogists**, Winnipeg, Manitoba, Canada. (B. P. Glass, Dept. of Zoology, Oklahoma State Univ., Stillwater 74075)

20–24. American Soc. of **Medical Technologists**, Cincinnati, Ohio. (R. Matthaei, Suite 25, Hermann Professional Bldg., Houston, Tex. 77025)

20–24. American **Nuclear** Soc., 11th natl., Gatlinburg, Tenn. (ANS, 244 East Ogden Ave., Hinsdale, Ill.)

20–24. **Air Pollution Control** Assoc., 58th annual, Toronto, Ont., Canada. (M. Katz, Dept. of Natl. Health and Welfare, 45 Spencer St., Ottawa, Ont.)

20–24. **Aerospace**, conf., Houston, Tex. (T. B. Owen, Douglas Aircraft Co., 300