Middle Articles

CONTEMPORARY THEMES

Automation on a General Medical Ward: Monitron System of Patient Monitoring

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Summary: In a study of the value of monitoring apparatus the temperature, pulse rate, and blood pressure were recorded automatically on 107 patients. Though the patients found the equipment tolerable, it is considered that the advantages to the patient were found to be too few to justify the purchase of this equipment for use on a general medical ward.

Introduction

Monitron is a system of patient monitoring that has been devised by the Biomedical Engineering Division of the Medical Research Council. A detailed description of the apparatus is given by Wolff (1966a), who defined patient monitoring as "the acquisition, processing, display, and recording of physiological information from a hospital patient" (Wolff, 1966b). It was thought that monitoring might have a part to play in a number of different situations—namely, in intensive care, intermediate care, and the near convalescent state—besides possible application in diagnosis and in outpatient work. Accordingly, trials of the apparatus are under way in various centres.

This report relates experience gained with first-generation equipment (mark I), which has been modified in some respects in the second-generation (mark II) equipment now commercially available (T.E.M. Instruments Ltd., Gatwick Road, Crawley, Sussex), in an intermediate care situation—namely, a male general medical ward.

How the results might have differed with the newer equipment is mentioned below.

The usefulness and limitations of this type of equipment should be critically considered and widely publicized before its introduction becomes widespread. Similarly, a baseline should be drawn, so that the effect of modifications on the equipment's performance can be assessed quantitatively and be compared with that of others.

Description of Apparatus

The system may be described under four headings: attachment of the patient, the bedside unit, the displays, and the printer.

Attachment of Patient

In this trial the temperature, blood pressure, and heart rate derived from the electrocardiogram (E.C.G.) were monitored. Temperature transducers are available for measuring skin or rectal temperature, but for routine purposes skin temperature only was recorded. The thermister temperature probe is insulated by a covering of three layers of flexible plastic foam to limit conduction of heat, and interleaved with aluminized polyethylene to prevent radiation of heat. This insulating material is also incorporated into an elastic belt held together by a Velcro fastening, which has attached to it a multiway socket from which a lead runs to the bedside unit. Into the multiway socket the temperature transducers and an E.C.G. lead can be plugged. The use of a belt ensures that any strain on the lead running between patient and bedside unit is taken by a firmly anchored point and not by the transducers. The site chosen for the recording was a 4 in. (10 cm.) square area on the anterior abdominal wall. Since the lead leaves the body in the region of the umbilicus, which is the least mobile part of the body, the limbs are therefore left free.

Heart Rate and E.C.G.—The E.C.G. is picked up by chest electrodes which are similar to those described by Fluck and Burgess (1966) and attached in a similar way. To provide good electrical contact small sponges impregnated with a saline and agar mixture are used instead of electrode jelly. The three wires from the electrodes run over the chest surface to the multiway connector on the abdominal belt through a gland containing a diode protection circuit. This gland serves the dual function of protecting both the patient from any high voltages that might inadvertently arise in the lead to the patient and the apparatus from the high voltages used in defibrillation.

Blood Pressure.—The Godart haematonograph has proved the best apparatus for monitoring blood pressure without resorting to intra-arterial puncture (De Dobbeleer, 1965). The model used has a cuff with two compartments, attached in the usual way with a Velcro fastening. From the cuff a twin tube runs, looped through the abdominal belt, to the machine at the bedside. At preset intervals the proximal compartment of the cuff is inflated to above systolic pressure, the inflation pressure being preset manually. The cuff is then slowly deflated until pulsations are first detected in the lower compartment. The pressure in the upper compartment then represents systolic blood pressure. Deflation continues, and so long as the occluding pressure exceeds diastolic blood pressure the interval between arrival of the pulse wave at the upper and lower compartments is appreciable, but at the point when the occluding pressure equals the diastolic pressure the pulse wave velocity increases, and there is then no detectable time lag between its arrival at the two compartments of the cuff. This change in pulse wave velocity is detected and the pressure at which it occurs is the recorded diastolic pressure.

Other Transducers.—Transducers are available for measurement of intravascular pressures, and these are being used in conjunction with Monitron at other centres. Ultimately it may be possible to monitor blood gases continuously, or perhaps blood sugar or other blood constituents with suitable transducers, and since the system is flexible enough such data may also be displayed and recorded.

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Bedside Unit

The bedside unit consists of a cabinet which will accept up to five "normalizers." A normalizer is a plug-in circuit which converts the signal from whatever transducer is in use to a standard analogue form which operates the displays and the printer. The ultimate aim is to have a "library" of normalizers, enabling a whole variety of physical and biochemical measurements to be monitored and recorded. In addition, the unit has outputs for bedside or distant display of the E.C.G. on an oscilloscope, and also enables permanent recordings of the E.C.G. display to be made. Furthermore, an audible and visual alarm system is based on any two of the five factors monitored. The visual alarm flashes a red light, both on the bedside unit and on the displays, and the audible alarm consists of a hooter on the bedside unit that can be switched off if necessary. Since the alarm limits are preset and not easily altered they usually operate when the heart rate is about 40 to 160 beats per minute and the systolic blood pressure about 80 mm. Hg.

Displays

The displays on Monitron consist of vertical columns of light which can be seen equally well by day or night, and whose height is proportional to the value of the criteria being monitored. An opaque horizontal movable marker shows the upper and lower limits of normality set for a particular patient, and the relation between the current value and the normal range is seen at a glance. The process of translation to a numerical value and comparison with other numerical values representing the normal range is not necessary with this mode of display, and thus rapid assimilation of the presented data is possible.

Printer

The conventional nursing temperature chart has been used as the basis for recording with the Monitron system since nurses and doctors are already familiar with its format, and it is of a convenient size to be incorporated into the patients' hospital notes as a permanent record. The time-scale of the chart runs for 25 hours, from 9 a.m. to 10 a.m. the next day, allowing a period of one hour between 9 and 10 for chart changing. The chart is divided into sections for recording the five measurements.

Charts in the mark I equipment are stored in a rack in the printer from which it is possible to select one for observation at any time. When printing occurs the appropriate chart is selected by a juke box mechanism and placed on the printing deck. Five ink-impregnated Nylon pens are triggered in turn to print a dot in the appropriate section of the chart, the position of this being determined by a Servomechanism operating the pen carriage and controlled by the output of the relevant normalizer. With the multipatient printer a simple mechanical fault, such as a chart being put back into the store incorrectly, will prevent printing of the data of all patients being monitored. More recent equipment which records data from one patient only will avoid this.

Technique of Evaluation of Equipment

For every patient monitored a card was filled in daily, recording the number and type of technical faults and of crises and the number of false or true alarms. In addition, the patient's reply to a standard question regarding any discomfort caused by the monitoring apparatus and his attitude towards it was recorded. Finally, the most senior nurse on duty was asked a standard question about the usefulness of the previous day's monitoring, and her reply was noted. The printed record was scrutinized and the number of observations and artifacts recorded.

Patients Monitored

During the period under survey 107 patients were monitored for a total of 631 patient-days. Thirty-seven different principal diagnoses had been made for these patients. Of the 42 patients with ischaemic heart disease, who were monitored for a total of 235 days, most had myocardial infarction. The average duration of monitoring was 5·9 days, the shortest a few hours, and the longest 29 days.

All types of patient have been monitored, from the very ill patient, either shocked or unconscious, to the ambulant patient. In the latter case patients were shown how to unplug themselves from the bedside unit to allow them to use the toilet and leave the bedside. Convalescing patients were often monitored sitting out of bed. While the patient is absent the printer records "patient absent" in a separate section of the chart. The frequency of this recording is a measure of the mobility of the patients in this study.

Patients' Reaction to Monitoring (Table I).—On most days during this survey the patients said that the monitoring equipment attached to them was either comfortable or tolerable, while on only a few was the equipment said to be uncomfortable. On three occasions only were transducers pulled off by the patient. It was expected that quarter-hourly measurement of blood pressure would be uncomfortable, but, surprisingly, most patients quickly became used to the repeated automatic inflation of the cuff, and there was no significant difference between the response to the question regarding comfort with and without blood pressure monitoring. From daily questioning of patients the impression was gained that the most uncomfortable piece of equipment attached to patients was the oxygen mask. Thus, acceptance of Monitron by patients is not a problem.

TABLE I.—*Patient's Reaction to Monitoring*

Physical Comfort	No. of Days	%	Mental Attitude	No. of Days	%
Too ill to say ..	47	7·5	Too ill to say ..	45	7·2
Painful	1	0·2	Physical rejection	3	0·5
Uncomfortable ..	43	6·8	Irritation ..	27	4·3
Tolerable	181	28·7	Toleration ..	195	30·9
Comfortable ..	359	56·8	Appreciation ..	361	57·1
Total ..	631	100·0	Total ..	631	100·0

Technical Faults

One or more faults occurred on 42% of patient-days, an average of 0·57 fault per patient-day. Thus with three patients being monitored at least one fault daily would be expected. The chart printer was the commonest single source of faults (38·5%), which were mainly of a mechanical nature and concerned the handling of the charts (Table II). The other electrical parts of the system, however, gave rise between them to 17·6% of all faults—namely, the normalizer 2·5%, the displays 9·2%, and the E.C.G. oscilloscopes 5·9%. The most important group of these concerned the attachment of patients (43·9%) (under the headings "transducers" (21·8%) and "cables and connectors" (22·1), see Table II).

TABLE II.—*Technical Faults*

	No.	%
Transducers	78	21·8
Cables and connectors ..	79	22·1
Normalizers	9	2·5
Display	33	9·2
E.C.G. display	21	5·9
Printer	138	38·5
Total	358	100·0

With mark II equipment it is hoped that there will be far fewer printing faults with *single-patient* printers, and that the redesigned displays will be more reliable. This still leaves, however, a hard core of faults associated with attachment of the patient which cannot at present be easily reduced and which will severely limit the overall reliability of the apparatus and its alarm systems.

Crises

A "crisis" has been defined either as a deterioration in a patient's condition or as the onset of a dysrhythmia which requires medical treatment to terminate it. Thus the occurrence of frequent multifocal ventricular extrasystoles in a patient with myocardial infarction constitutes a crisis, though without E.C.G. evidence there would be little to suggest a clinical deterioration.

Out of a total of 43 crises occurring in monitored patients, all but two were in the first seven days of monitoring and 17 (39·5%) were in patients with ischaemic heart disease (Table III). This latter result was proportional to the total monitoring time spent on these patients (37·3% of 631 days). Dysrhythmias were the commonest cause (27·9%) and cardiac arrest the next commonest (16·2%). Twenty-one (48·8%) of these crises were recognizable—if the patient himself was not being watched—by observation of the E.C.G. display and the temperature, pulse, and blood pressure measurements. In no instance was early warning of a crisis given by the monitoring apparatus, and in 22 (51·2%) cases if the apparatus alone had been observed, the crises would have gone undetected. In only 41% did a crisis trigger the alarm system. Thus more than half of all crises failed to give any warning, and even if the E.C.G. and information displays had been continually watched these would still not have been noticed.

TABLE III.—*Nature of Crises in Monitored Patients*

	No.	%
Cardiac arrest	7	16·2
Dysrhythmia	12	27·9
Hypotension	5	11·6
Hypertension	4	9·3
Pain	4	9·3
Haemorrhage	2	4·7
Dyspnoea	4	9·3
Convulsion	1	2·4
Other	4	9·3
Total	43	100·0

To quote Wolff (1968) again: "A monitoring or measuring installation is essentially a communication system between the patient and the staff responsible for his care. However clever the equipment technically in terms of zero stability, accuracy, and linearity, if it fails to communicate at the vital time it has failed utterly."

Alarms

In the latter part of the study the alarm system was in use only for a total of 349 patient-days. There were altogether 279 alarms, of which 65% were false, due to movement artifacts, disconnexion of the transducers, and other technical faults. Of the 98 true alarms caused by actual deviation of the heart rate or blood pressure outside the limits that had been preset only 12 were in fact the result of a crisis.

If the alarm limits are set too widely apart moderate changes in the measurements associated with a critical state will fail to trigger the alarm, and if set too close together the alarm will be triggered by what are really physiological variations. When, as here, only 4·3% of all alarms are the result of a crisis and the others are entirely false or due to physiological variations in monitored factors, then the alarm, when triggered, evokes no sense of surprise or urgency and goes unheeded. Furthermore, whereas one false alarm per day may be acceptable if one patient is monitored, three false alarms per day are unacceptable if three patients are monitored, and will bring the alarm system into disrepute. As the number of monitored patients in one area increases, therefore, so must the accuracy of the alarm system increase until ideally every crisis triggers an alarm and every alarm is the result of a crisis. Monitron falls short of this ideal by a long way, since only 41% of crises triggered alarms and only 4·3% of alarms were the result of a crisis. This alarm system performance is better, however, than with other equipment studied (Rawles and Crockett, 1969).

Nurses' Reaction to Monitoring

Though it is difficult to measure usefulness, the ward sisters' daily replies to a standard question on the usefulness of Monitron constitute a rough quantitative assessment. The commonest reply was that the apparatus was of some use (51·2% of patient-days), and rated better than this on 184 days (29·2%) and worse on 124 days (19·6%) (Table IV).

TABLE IV.—*Ward Sister's Assessment of Usefulness of Monitron*

	Ischaemic Heart		Other Diagnoses		Total	
	No. of Days	%	No. of Days	%	No. of Days	%
Invaluable	15	6·4	8	2·0	23	3·7
Very useful	80	34·1	81	20·4	161	25·5
Some use	109	46·3	214	54·1	323	51·2
No value	28	11·9	73	18·4	101	16·0
Nuisance	3	1·3	20	5·1	23	3·6
Total	235	100·0	396	100·0	631	100·0

χ^2 30·15. $P < 0·001$.

By means of the χ^2 test its usefulness was assessed as significantly higher for patients with ischaemic heart disease than with all other diagnoses put together ($P<0·001$). Similarly, the usefulness of the system was greater when the alarms were in use than when they were not ($P<0·001$).

Printed Record

Of 42,000 measurements of skin temperature of the anterior abdominal wall 4·85% were obvious artifacts recognizable by visual inspection of the record. Similarly, of some 50,000 measurements of pulse 4·24% were artifacts. A much higher proportion of artifacts were recorded when blood pressure was measured—namely, 13·8% of systolic values and 14·2% of diastolic, out of some 14,000 recordings.

If the proportion of artifacts in a record rises above about 15% the overall trends in the record become difficult to discern. In this respect temperature and pulse records were usually satisfactory. Blood pressure records, however, often had an unacceptable number of artifacts owing to involuntary movements of the patient during recording, which detracted considerably from the usefulness of the records.

Patients with Myocardial Infarction

Of the 42 patients with ischaemic heart disease, who were monitored, most had a myocardial infarction. The continuous display of the E.C.G. was a great advantage, even though it was not observed all the time. The nurses on the ward had been taught enough elementary electrocardiography to enable them to recognize abnormal rhythms and extrasystoles. The high standard of observation and nursing care which is possible in a coronary care unit where there is a higher ratio of nurses to patients all the time has not been possible.

Despite prompt treatment of dysrhythmias when they were seen, and resuscitation by a cardiac arrest team, the mortality

figure for 80 patients was 23, or 28·8%. This compares most unfavourably with the figures from coronary care units, the best of which is 13·4% (Aber *et al.*, 1969). Our experience in this respect is similar to that of Hubner *et al.* (1969), who found that the provision of E.C.G. monitoring apparatus on a general ward did not lower the mortality, which in their series was 25%.

One advantage to the patients is that sleep is much less disturbed when blood pressure and other measurements are recorded automatically rather than manually.

Effect on Work-load

In three surveys made on the ward where Monitron was installed the proportion of the nurses' time spent in taking measurements was estimated at 3·9%, 4·1%, and 4·2% respectively. Thus if Monitron did all the measurements on all patients in the ward not more than 5% of the nursing time could be saved. This amounts to 75% of one whole-time nurse's time, there being the equivalent of 15 whole-time nurses working on the ward.

With only 3 out of 25 patients on the ward attached to Monitron the support of a visiting technician was required to carry out maintenance work and to correct some technical faults which could not be rectified on the spot. If all patients were monitored a full-time technician would therefore certainly be required, and thus no overall labour-saving would result, since a nurse would simply be replaced by a technician.

On the other hand, each patient attached to Monitron could have his temperature, pulse, and blood pressure measured 96 times daily, the only additional staff needed being a technician. If this number of measurements were done by nurses 30 full-time nurses would be required to take them alone. Whether an increased quantity of data is helpful is discussed below.

A survey on our intensive care unit has shown that there, too, the proportion of the nurses' time spent taking measurements (5·3%) is too small for automation of data collection to make a major impact on the work-load.

Can Nurses use Monitron ?

Monitron aims to do what has hitherto been a nursing task, and it should be usable by nurses. Nurses working regularly on the ward have learned to attach patients to the apparatus and to change the charts. They are able to recognize the need for reattachment of electrodes, but when minor breakdowns occur they are entirely dependent on technical help. Many of the nurses working on the ward are either in training or are part-time, and therefore spend too little time there to pick up a working knowledge of Monitron ; it must be admitted that the first impression that Monitron gives is one of great complexity.

Instruction of nurses in a group in the use of Monitron also proved to be surprisingly difficult administratively, since they all work different shifts and have different off-duty days. No time during working hours is set aside for trained nurses to receive formal systematic instruction, and student nurses are being taught with a particular syllabus and examination in view. It will be at least 10 years before monitoring techniques are incorporated into any syllabus of instruction for nurses.

Increased Data and Patient Management

Monitron can take more measurements on one patient in a day than could previously have been taken on all 25 patients in the ward in a day. Does this surfeit of information help ?

Temperature.—If temperature measurement is simply viewed as a screening technique to detect the presence or absence of fever, the frequency of measurement by conventional means could, in fact, be reduced with no loss of accuracy (Sims, 1965). In a large hospital 300 nursing-hours a year were saved by such a reduction.

Pulse Rate.—An extra 90 or so recordings of pulse rate a day have not been found to give additional help in the management of the patient.

Blood Pressure.—It has been of interest to note the blood pressure during sleep and at other times of day. In the control of hypotensive therapy careful estimation of lying and standing blood pressures four or five times a day was of more use than 96 recordings done when the patient's position was not recorded. In any case 15% of these recordings were spoiled by artifacts.

A Disadvantage

During the conventional " T.P.R." round a good nurse with a five-shilling thermometer does far more than collect physiological data. She assesses the patient's level of consciousness, mood, accuracy of cerebration, and general level of activity. Other features, such as pallor, cyanosis, and heavy sweating, will be brought to her notice. She may be asked for a bottle or bedpan, or be able to reassure and comfort the patient as she passes by. The inability of Monitron to do any of these things except record temperature, pulse, and blood pressure, means that it is still necessary for the nurse to do a round to make personal contact with the patient and also to make these unconscious observations.

Economics

At Kettering the equipment is worth about £9,000—that is, £3,000 per bed. Simple E.C.G. monitoring apparatus is available at about one-tenth of this cost. Had this amount been spent on nurses' salaries five extra nurses could have been employed for two years. (Five full-time nurses are needed to provide 24-hour cover.) It is felt that the patients who have been monitored would have derived more benefit from the shared services of an extra nurse than from Monitron. In this two-year period the mark I equipment that has been evaluated has become obsolete.

Conclusions

From this experimental study of the Monitron apparatus several points emerged ; firstly, that the measurement and recording of temperature, pulse, and blood pressure on a general medical ward can be automated. The patients in whom this is of most use are those with myocardial infarction, since it is the display of the E.C.G. that is the most valuable aspect of the Monitron system and the least expensive, its cost being only about a tenth of that of the whole apparatus. It must be pointed out, however, that monitoring patients with myocardial infarction did not reduce the mortality rate, since neither the patients nor their E.C.G. displays were continuously observed. Secondly, the alarm system fell far short of the ideal of a one-to-one relation between alarms and crises. This was due not only to technical shortcomings but also to the failure of the system to react to those important dysrhythmias not associated with a gross change in heart rate. Thirdly, no significant saving in labour resulted from the use of this equipment. Finally, when the cost of the equipment and the present financial state of the Health Service are considered, the advantages to the patient are too few to justify its use on a general medical ward. Moreover, greater benefit would have resulted

for these same patients if the money used to purchase this equipment had been spent on simple oscilloscope E.C.G. displays and the provision of more nurses for continuous surveillance of ill patients.

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CONFERENCES AND MEETINGS

European Association for the Study of the Liver

[FROM A SPECIAL CORRESPONDENT]

The fourth meeting of the European Association for the Study of the Liver was held in Vienna from 5–7 September under the presidency of Professor H. Thaler. An account of some of the topics considered is given below.

Hepatic and Bilirubin Metabolism

Dr. S. LIE (Oslo, Norway) reported the use of human fibroblasts in tissue culture in the study of toxic effects of bilirubin when given bound to albumin in different molar ratios. With a molar ratio of 1:1 little toxic effect was observed, but with higher ratios cell death occurred similar to that found when free bilirubin was added. Each molecule of albumin combines with two of bilirubin, but this evidence suggested that only the first molecule bound is detoxified. This was in accord with clinical experience of exchange transfusion in erythroblastosis, which is usually necessary when the serum bilirubin exceeded 20 mg./100 ml., which approximates to a molar ratio of bilirubin to albumin of 1:1.

Dr. H. GERDES (Marburg/Lahn, Germany) described how he had evaluated the effects of hepatic damage on pituitary A.C.T.H. secretion and its hypothalamic regulation. All 10 patients with cirrhosis studied had had a subnormal adrenocortical response to vasopressin, and the normal rise of 11-desoxycortisol in the plasma after metapyrone had been absent in 8 patients. This suggested impairment of release of pituitary A.C.T.H. release by the hypothalamic "corticotrophin releasing factor."

Professor M. COPPO (Modena, Italy) described studies in patients with Burka's syndrome, an ill-defined condition in which abdominal pain and nausea is associated with hepatomegaly in patients many of whom have had biliary-tract surgery in the past. The hepatocytes contain dark-brown pigment, similar under light microscopy to the pigment seen in the Dubin–Johnson syndrome, but on electron microscopy substantial differences in the pigment ultrastructure were observed, suggesting that the two conditions were quite distinct.

Dr. K. KITANI (Copenhagen, Denmark) described a new method for measuring the lipid content of the liver. He showed that the solubilities of ^{133}Xe and ^{85}Kr in post-mortem samples of liver tissue could be correlated with the fat content in patients with both normal and fatty livers. After simultaneous administration of these two isotopes by retrograde injection through a hepatic venous catheter it was possible by surface counting to calculate the fat content and the hepatic blood flow per gramme tissue weight. If the total hepatic blood flow was also determined, the total liver lipid and the liver weight could be assessed.

Effect of Phenobarbitone

Dr. P. GLOGNER (Marburg/Lahn, Germany) showed that when albino mice were given phenobarbitone synthesis of cholesterol by the liver was inhibited during the first week. The total liver cholesterol remained unchanged, since the release into the blood was reduced, and, indeed, the plasma cholesterol was significantly lower. After three weeks, however, cholesterol production and hepatic content became increased relative to the control group.

Dr. P. BERTHELOT (Paris, France) reported studies of the mechanism of phenobarbitone-induced hypercholeresis in the rat. This was associated with an increase of a bile-salt-independent fraction of bile. The mean bile-salt concentration in the treated rats was lower than in the control animals, while the total bile-salt output in bile was the same. Canalicular bile flow was estimated by measuring ^{14}C-ethythritol clearance. The bile-to-plasma ratio approximated closely to unity in both control and treated groups, indicating that this fraction of the bile was derived from the hepatocytes.

Gilbert's Syndrome

Dr. M. BLACK (London, England) reported that phenobarbitone therapy had reduced hyperbilirubinaemia in four patients with Gilbert's syndrome. The handling of ^{14}C bilirubin disappearance curves was also improved. There was no change, however, in the hepatic conjugating enzyme, bilirubin U.D.P.-glucuronyl transferase, and the mechanism of the decrease in jaundice was uncertain.

The subsequent discussion made it clear that phenobarbitone had many effects on the liver cell, both in inducing enzymes and in increasing the flow of bile. The enlargement of the liver following phenobarbitone administration appeared to be due during the first week to an increase in the size of the individual liver cells (related to the increase in smooth endoplasmic reticulum). Thymidine uptake increased after two weeks, indicating that by this time an increased number of cells was contributing to the hepatic enlargement.

Effect of Drugs

Dr. A. E. JONES (London) had made paired studies of albumin and fibrinogen metabolism, using the ^{14}C carbonate method, in patients with cirrhosis. Prednisolone treatment was consistently associated with an increase in the plasma concentration (1–13%) and the rate of synthesis (33–193%) of albumin. This showed that patients with hepatocellular disease could respond to a stimulus by increasing the rate of synthesis even when this was initially low. No effect on fibrinogen metabolism had been observed.

Dr. N. CARULLI (Modena, Italy) reported his studies of the recently described microsomal ethanol oxidizing system (M.E.O.S.) during chronic ethanol administration in rats. Compared with controls, the alcohol-treated rats showed a considerable increase in M.E.O.S. activity. Similar increases had been observed in other microsomal enzymes. Clearance of ethanol from the blood after an intravenous dose was increased in the alcohol-treated group. These findings were consistent with the known increase in alcohol tolerance of chronic alcoholics. No histological evidence of alcoholic liver damage was observed in the treated rats.

In the subsequent discussion Dr. H. POPPER (New York, U.S.A.), pointed out