balance for all factors, the negative balances for water and nitrogen being small.

**Table V.—Mean Daily Balances on the Tube Feeds**

<table>
<thead>
<tr>
<th></th>
<th>Diet A</th>
<th>Diet B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Controls</td>
<td>Controls</td>
</tr>
<tr>
<td>No. of subjects</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>Mean duration (days)</td>
<td>0.4 - 0.6</td>
<td>0.79 - 0.21</td>
</tr>
<tr>
<td>Sodium (mEq)</td>
<td>-17 - 7</td>
<td>11 - 6</td>
</tr>
<tr>
<td>Nitrogen (g.)</td>
<td>-0.01 - 2.21</td>
<td>1.07 - 0.53</td>
</tr>
<tr>
<td>Mean weight loss (lb.)</td>
<td>0.67</td>
<td>0.05</td>
</tr>
<tr>
<td>Loss of lean</td>
<td>66</td>
<td>16</td>
</tr>
<tr>
<td>Muscle mass (g.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Of the patients analysed six died (30%) as compared with a total annual mortality in the unit of 38 in 150 (25%), and the mean duration of balance was 8.3 days, as compared with an overall duration in all patients admitted to the unit of six days. These figures indicate that the patients analysed represented a rather more severely ill group than the average of those admitted. Patients fed for shorter periods had less serious illnesses and were less likely to require prolonged ventilation, and the shorter duration of external balance made interpretation of data less informative. No patient presented here had balance data compiled for less than four days.

**Discussion**

The problem of diarrhoea with the original Complan–lactose diet required urgent resolution. Small laboratory animals whose diet is changed abruptly to one of low roughtage content often develop severe intractable diarrhoea (G. A. J. Pitt, personal communication, 1964). Though increasing the osmolality of tube feeds may produce diarrhoea (Masterton et al., 1963), that of the Complan-lactose diet was not high. Lactose intolerance in adults, however, is being increasingly recognized since the demonstration of absent or markedly reduced lactase activity in small-bowel biopsies from many patients with lactose-induced diarrhoea (Holzel et al., 1959; Auricchio et al., 1963; Dahlqvist et al., 1963). It has also been shown that a considerable number of normal adults are intolerant of lactose because of a deficiency of jejunal B-galactosidase from prolonged milk or lactose deprivation (Cuatrecasas et al., 1965). This has since been confirmed by others, who quote an incidence of about 35% (Haemmerli et al., 1965; McMichael et al., 1965) as compared with the 55% found by Cuatrecasas et al.

In this study, investigation into the precise cause of the diarrhoea was less important than the early design of a satisfactory diet from this complication. The modifications were therefore introduced together instead of in series, and the revised diet was used forthwith. With diet B the incidence of diarrhoea was less than 5%.

In patients on diet B the small mean negative nitrogen balance indicated only trivial loss of the lean muscle mass, and the positive balances for sodium and chloride reflected adequate supplementation of the diet with electrolyte according to the predicted deficits on admission. The diet has proved clinically satisfactory in the management of some 230 patients admitted to an intensive-care unit.

**Summary**

External metabolic balance methods have confirmed that a tube feed of milk powder and glucose is able to maintain metabolic balance in patients with various serious illnesses admitted to an intensive-care unit. Corrected nitrogen balance showed only trivial loss of the lean muscle mass, in spite of the serious illnesses treated. The incidence of diarrhoea with a previous feed containing lactose was substantially reduced, and clinical observations confirmed that the diet was easy to organize, reduced the frequency of metabolic complications, and shortened convalescence.

The work was aided by grants from the Research Committee of the United Liverpool Hospitals, and the Polio and Cancer Research Club of Liverpool.

**References**


**Preliminary Communications**

**Ultrasound in Diagnosis of Liver Disease**

[WITH SPECIAL PLATE]

**Brit. med. J., 1966, 2, 1368-1369**

Two-dimensional ultrasonography has been used in medical diagnosis for some years. The various visualization systems can be classified into two main groups. In one group the ultrasonic transducer moves in a water-bath, which provides the acoustic coupling with the patient. This is the method of Howry and Bliss (1952), Baum and Greenwood (1961), Gordon (1962), and Kossof et al. (1964). In the other group the transducer is passed across the skin, which is coated with oil to ensure acoustic coupling. This method was developed by Donald and Brown (1961). Holmes et al. (1965) have described an apparatus similar to that of Donald and Brown. The present report is based on results obtained with a contact scanner, which, however, differs mechanically from the earlier systems. The scanning apparatus has been described elsewhere (Wells, 1965).

The echo information obtained during a scan is presented in the form of a brightness-modulated display on a cathode-ray tube. The information is integrated photographically to provide a two-dimensional ultrasonogram.

The clinical results described in this article were all obtained with an ultrasonic frequency of 2.5 Mc/s. Correction for tissue attenuation so that equal interfaces produce equal registrations, independent of depth, is especially important when scanning a relatively homogeneous organ such as the liver. This correction is applied by an electronic device which increases the sensitivity of the receiver with time, so that echoes which originate deep inside the patient are amplified more than those which are produced near the probe. For the examples presented here the sensitivity setting of the machine was kept constant.
Patients with enlarged livers can be scanned through the abdominal wall. In patients with normal-sized or small livers the organ lies within the thoracic cage, and it is necessary to scan through an intercostal space. In such cases the patient lies on his left side on a trolley, and the upper border of the liver-dullness is percussed. An intercostal space over the liver is outlined with a skin pencil, and scanning is carried out through this space, as shown in Fig. 1. It is important that the probe does pass over a rib, as ultrasound is absorbed rapidly in bone. Liquid paraffin smeared on the skin provides coupling with the probe. Widening of the intercostal space may be accomplished when necessary by placing a firm pillow under the patient. The patient is positioned by adjustment of the trolley so that the probe can be moved along the intercostal space.

The probe is placed in contact with the skin immediately beyond the posterior edge of liver-dullness. The scan is made by rocking the probe on the skin, and slowly moving it along the line of the intercostal space, while a Polaroid camera records the echoes which appear on the display. The best results are obtained when the probe is kept in contact with the skin. The duration of the scanning process is usually about 20 seconds, and it is necessary to take a number of scans, with a range of sensitivities in several intercostal spaces, in order to complete the examination.

**RESULTS**

Typical scans are shown in Fig. 2 (Special Plate). For example, the normal scan (Fig. 2a) is of a healthy 29-year-old man. The principal feature is that the liver area is transonic. Transonic is the term used to describe an area which transmits ultrasound but which does not give rise to echoes.

Fig. 2b is an intercostal scan of a 20-year-old woman in hospital for reassessment of cirrhosis of the liver. This condition had been diagnosed eight years previously by liver biopsy, when she presented with jaundice and marked hypergammas-globinaemia. The liver was enlarged and firm to 8 cm. below the costal margin. The scan shown in Fig. 2c was taken parallel to and below the costal margin of a 75-year-old man with an enlarged irregular liver, due to metastases from carcinoma of the stomach.

Finally, a transverse abdominal scan (Fig. 2d) of a 54-year-old woman with polycystic liver disease is shown. Confirmation of the diagnosis was obtained by aspiration of the fluid from many cysts to relieve pain, and by an intravenous pyelogram showing polycystic kidneys.

**DISCUSSION**

We have shown that ultrasonics can be used to detect certain abnormalities of the liver, and that these can be differentiated from the normal. The virtues of the examination are that it seems to be harmless to the patient and the result can be obtained quickly. Unlike liver biopsy it is painless and without the complications of this procedure (Sherlock, 1963). Hepatic scintillography is also useful in detecting solitary and diffuse hepatic lesions (Taplin et al., 1955; Wagner et al., 1961) but necessitates giving a radioactive isotope to the patient. Scintillography cannot distinguish cystic from solid lesions.

At the present time the performance of the equipment is not completely constant, and this sometimes makes it difficult to compare one scan with another. Examination of the liver is particularly sensitive to this kind of variation. Frequent recalibration of the sensitivity is necessary to achieve consistent results. However, we believe that improvements in the stability of the echo-processing equipment will enable the technique to play a useful part in the diagnosis of certain forms of liver disease.

We are indebted to Dr. H. F. Freundlich and Mr. M. A. Bullen for their help and support in this investigation. The skill of Mr. G. P. Garland in constructing the scanner is gratefully acknowledged. The electronics unit was supplied by the Kelvin Electronics Company, and we are grateful to the Company's engineers for much useful advice. The work was made possible by the financial support of the Medical Research Council and the Board of Governors of the United Bristol Hospitals.

**REFERENCES**


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Fig. 2.—A. This pattern occurs in many scans, and is presumably anatomical in origin. AL: Liver area, showing abnormal echoes. AW: Abdominal wall. C: Cyst. CW: Chest wall. L: Transonic liver area. LA: Artifact echoes from lung. P: Probe artifact. PW: Posterior liver wall. R: Right side of patient.

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