NITROGEN METABOLISM, CALORIC INTAKE AND WEIGHT LOSS IN POSTOPERATIVE CONVALESCENCE*

A STUDY OF EIGHT PATIENTS UNDERGOING PARTIAL GASTRECTOMY FOR DUODENAL ULCERS

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THE SCIENCE OF NUTRITION has not until recently engaged the serious attention of the surgeon. This is attributable to several factors. The nausea and vomiting, the impairment of appetite and the derangement of digestive processes caused by anesthesia, and the pain and the emotional stress connected with an operation, and by the operation itself, are not conducive to healthy alimentation. Added to this may be mentioned the fear on the part of the surgeon of placing food into a viscus which has been the site of a recent operation. However, since the usual surgical case requires dietetic restriction only for a few days postoperatively, and since most patients come to operation with enough body stores to tide them over this lean period, the surgeon has rarely been impelled to regard nutrition as a matter of any urgency.

The work on the rôle of hypoproteinemia in surgical conditions by Jones, and his coworkers,[1] Ravdin, and his associates,[2,3] Koster and Shapiro,[4] and Hartzell, and his coworkers,[5] the study by Cuthbertson,[6] in England, of nitrogen loss, sometimes called the "toxic loss of nitrogen," and by Elman,[7] and Brunschwig, *et al.*,[8] in this country, and the demonstration by these last two workers of the safety and feasibility of intravenous alimentation, constitute a new chapter in surgery. The work of these men has, at last, linked surgery with the basic work of pioneers like Van Slyke, Rose, Whipple, Madden, Weech and others.

While it is true that most surgical patients need little nutritional attention, there are surgical conditions in which the maintenance of the nutritional state is a matter of grave importance. One of these conditions is peptic ulcers. Thus, Riggs, Reinhold, Boles and Shore[9] found statistically significant deficiencies in serum total protein, albumin and vitamin C concentrations in a group of 52 cases of peptic ulcer. Many of these ulcer patients, either as a result of dieting or of repeated bleeding, have lost considerable weight, with the blood protein at or below the lower limit of normal, and the body stores well depleted. Some lend themselves to preoperative "building up,"

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but others may require emergency operations while in their depleted state. If a major operation, such as gastrectomy, is performed upon these patients, there is added to the "toxic loss of nitrogen" the partial starvation imposed by a highly restricted postoperative regimen, which further depletes the body tissues, interferes with healing, and may lead to wound dehiscence. An example of this is D. R., reported in Table I.

In the present study the nitrogen balance was determined in eight cases of duodenal ulcers who had undergone partial gastrectomy. They were divided into two groups: four cases who were given the postoperative ward routine of infusions, occasional blood transfusions, and a gradually increasing oral feeding. This may be called the control group. In the other group of four cases, a high caloric and high nitrogen feeding was given to replace or more than replace the nitrogen loss, so that at the end of the postoperative period of 10 to 12 days, a nitrogen surplus was accumulated in the body. In addition to the nitrogen balance, both the body weight and the plasma proteins in both groups were determined periodically throughout the convalescent period. The fluid intake and output were followed and the caloric and sodium chloride intakes were noted. The chief sources of nitrogen loss were recorded. Also noted, but not objectively studied, was the "strength" of the patient. The number of days of hospitalization of one group was compared with that in the other.

Tables I to IV each represents a control case; Tables V to VIII each a high nitrogen feeding case. Graphs a, b, c and d in Figure 1 are records of the control group, and corresponding graphs in Figure 2, of the feeding group, showing the important representative findings.

EXPERIMENTAL CONSIDERATIONS

Preoperative Preparation of the Patient.—The patients in the control group each had a Levin tube introduced through one of the nares into the stomach for decompression of this viscus by the Wangensteen suction apparatus during the first four to six postoperative days. In the feeding group the Levin tube was replaced by a double-lumened tube, adopted from a Miller-Abbott tube in such a way that one barrel was longer than the other by some ten inches. The shorter barrel was for suction and the longer for feeding. The ends of both barrels were perforated at several levels, in order to facilitate feeding and suction. During the operation, after the stomach was resected, and while the anastomosis was being made, the feeding barrel was introduced through the stoma into the jejunum, after which the operative routine was resumed. Immediately postoperatively, Wangensteen suction was made through the suction barrel, which lay in the stomach.

The Weight of the Patient.—The weights of the patients were taken on the Howe platform scales. In the case of preoperative weights it was a simple matter for the patients simply stood on the scale platform for the weighing. In the postoperative period, however, the matter of weighing was somewhat more complicated. If the patient was light: *i.e.*, not over 60

Kg., he was lifted by an orderly and the weights of both the orderly and the patient were taken, after which the weight of the orderly was then subtracted from the combined weight. If he was over 60 Kg., he was placed on a stretcher and the loaded stretcher was then weighed on two scales, the two front wheels on the platform of one scale and the hind wheels over that of another. The two scales used in this work were sensitive to within 25 Gm., so that where two scales were used, the sensitivity would be decreased by half, and the margin of error would be in the neighborhood of 50 Gm. Since it was not the absolute weight but the comparative readings taken over several weighings for the construction of the weight curve, which was important, this margin of error was not serious.

The Fluid Intake.—In the control group, the fluid intake was maintained mainly by intravenous infusions of 5 or 10% dextrose solutions in distilled water or in physiologic saline, some for the first four or five days and some for a longer period. Occasionally amigen solution was also given intravenously. The amount lost by gastric suction was replaced by a corresponding amount of saline, according to Coller and Maddock's[10] principle. This accounts for the large fluid and NaCl intake of the first four to six days in both groups. After the first four or five days, when fluid intake by mouth was being gradually increased, the infusions were tapered off correspondingly.

In the feeding group, the first two cases (A. V., Table V and F. R., Table VI) had a large number of intravenous infusions. In the last two cases, however, infusions were given only in the first postoperative 12 hours and thereafter the fluid intake was entirely given through the feeding tube or by mouth.

The Chloride Intake.—An attempt was made not to exceed the chloride intake of nine grams daily. However, the problem was complicated by the loss of fluid through the gastric suction. As stated above, the Coller and Maddock[10] principle required this amount to be replaced quantitatively in physiologic saline, and this accounts for the apparently unduly large amount of sodium chloride the first four to six days. However, a possible source of error is present in this volume-for-volume replacement. If the suction were continued while the patient took a drink of water, the drainage might contain less sodium chloride than was assumed in the Coller and Maddock principle and, consequently, the patient would be given more sodium chloride than he needed. In order to obviate this, the suction was turned off for half an hour after each drink. Whether in this time the water had all passed out of the stomach or become isosmotic with systemic fluids is not known.

The Caloric and Nitrogen Intakes.—In the control group, the caloric intake was derived from three sources: (a) Infusion of dextrose solutions, four calories being assigned to each gram of dextrose; (b) peptonised milk and the usual articles of soft diet, the caloric and nitrogen values of which were taken from the dietitians' chart; and (c) the few calories and small amount of nitrogen derived from the plasma proteins in the blood trans-

TABLE I

CASE OF D. R., MALE, AGE 50

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Chloride Intake Gm.	Cl. Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	Cum. N Status Gm.	P.P. Gm. % A/G	Wt. Kg.	Remarks
March 8													3.½.4	63.4	
9 to 10	3250	980	1300	20.25	870	2.8	7.983	.809	.593	9.466	− 6.666	− 6.666			Tr.—500 cc. W.B., Infusion; 2L.—10% dex.; 1L. saline.
10 to 11	3000	750	1200	18	1140	5.6	15.877	.771	.593	17.241	−11.641	−18.307			Tr.—500 cc. plasma—Inf.: 1L. 10% dex. in D/W; 1½ L. in saline.
11 to 12	3000	860	1000	9	800	0	10.995	5.656	.593	−17.244	−17.244	−35.551			Inf.: 1L. 10% dex. in D/W; 1L. in saline—1000 cc. H_2O by mouth.
12 to 13	3000	960	1050	9	800	0	6.227	7.665	.593	14.485	−14.485	−50.036	5.4	61.25	Inf.: Same as above.
13 to 14	3250	920	1240	18	800	0	7.583	1.297	.593	9.473	− 9.473	−59.509			Inf.: 2L. 10% dex. in saline. 1250 cc. H_2O by mouth.
14 to 15	3500	1050	1100	18	800	0	8.142	2.5	.593	11.235	−11.235	−70.744		59.15	Inf. as above. H_2O by mouth to volume.
15 to 06	2500	700	850	9	940	5.6	17.028	3.559	.593	21.18	−15.58	−86.324	5.25		Evisceration discovered 16th; re-sutured. Inf.: 2L. 10% dex. 1 in saline, 1 in D/W; Tr. 500 cc. plasma.
16 to 17	2250	0	1150	9	870	2.8	13.354	—	.931	14.285	−11.485	−97.809			500 cc. W.B. 1L. 105% dex. in D/W; 1L. in saline.
17 to 18	3820	—	1342	9	1231	6.97	6.886	—	.931	7.817	− .847	−98.656			2L. 10% dex. in D/W; Inf. Pep. milk by mouth 6 glasses; 500 cc. H_2O.
18 to 19	2200	—	855	9	1342	6.342	14.115	—	.931	15.046	− 8.704	−107.360	5.32		1L. 10% dex. in D/W; 1200 cc. Pep. milk. No manifest edema
19 to 20	3000	—	1107	11.88	1342	6.342	12.142	—	.931	13.073	− 6.731	−114.091	5.20	56.45	6 glasses milk + water. Wound shows no signs of healing.
Total		6220				36.454	120.332	22.25	7.875	−150.545					
Average		887				3.314	10.939	3.18	.716	− 13.686					
20—on soft diet + 500 cc. nutramigen.															
4—2													6.17	61	Wound begins healing March 24.
April 13													6.65	62.5	Discharged. Wound partially healed.

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TABLE II

CASE R. B., MALE, AGE 33

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl Intake Gm.	Caloric Intake	N Intake Gm.	N Output: Urinary N Gm.	N Output: Gastric N Gm.	N Output: Fecal N Gm.	N Output: Total N Output Gm.	N Balance Gm.	Cum. N Status Gm.	P.P. Gm. % A/G	Wt. Kg.	Remarks
May 11													6.15	64.32	
12 to 13	3250	450	1700	13.5	670	2.8	11.909	.841	.351	13.106	−10.306	−10.306			500 Tr. W.B. Inf. 1L. 5% dex. in saline; 2L. in D/W.
13 to 14	3850	920	1725	16.65	1468	6.92	16.917	1.113	.351	18.381	−11.461	−21.767			Tr. 350 cc. plasma. Inf. 500 cc. 5% amigen in 5% dex.; 2L. 10% dex. in D/W; 1L. ditto in saline.
14 to 15	3500	450	2200	13.5	1340	5.6	14.9	.330	.351	15.581	− 9.981	−31.748	5.64	61.6	Tr. 500 cc. W.B.; 250 cc. plasma. Inf. 2L. 10% dex. in D/W; 1L. in saline.
15 to 16	3250	1800	2000	11.25	870	5.6	16.812	1.975	.351	19.138	−13.538	−45.286			Tr. 500 W.B.; 1L. 10% dex. in saline. 2L. 5% dex. in D/W.
16 to 17	3250	0	2200	11.25	1210	8.8	17.757	—	.351	18.108	− 9.308	−54.594			Tr. 250 cc. plasma; Inf. 1000 cc. 5% amigen; 2L. 10% dex. in D/W.
17 to 18	2690	0	1800	13.25	1154	11.123	16.757	—	.351	17.108	− 5.985	−60.579		60.68	Tr. 250 cc. plasma; Inf. 2L. 5% amigen in 5% dex. 1L. 10% dex. in D/W. 440 cc. pep. milk.
18 to 19	2660	0	1500	5.94	1271	3.489	15.64	—	.351	15.991	−12.502	−73.081			Inf.—2L. 10% dex. in D/W.
19 to 20	1880	0	1650	7.92	692	4.646	13.42	—	.351	13.771	− 9.125	−82.206	5.52	60.00	4 cups tea with 1 teaspoonful sugar each. 880 cc. pep. milk.
Total		3620				48.978	124.212	3.259	2.808	131.184					
Average		905				6.123	15.462	.815		16.398					
20—on Sippy diet + 500 Gm. nutramigen.															
June 3													7.01	64.3	
June 5														64.8	Discharged.

TABLE III

CASE F. W., MALE, AGE 50

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Nacl Intake Gm.	Caloric Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	Cum. N. Status Gm.	P.P. Gm. % A	P.P. Gm. % G	Hem.	Wt. Kg.	Remarks
Dec. 13													4.1	2.4	25	57.97	
14 to 15	4250	880	1650	18	1010	14.8	11.944	.642	.692	13.278	+ 1.522	+ 1.522					Tr. 500 cc. W.B. Inf. 2L. 5% agimen and 5% dex. 1L. 5% dex. in 1L. saline.
15 to 16	3660	450	1500	9	600	0	10.964	.135	.692	11.791	−11.791	−10.269	5.5		32	57.71	2L. 5% dex. in saline. 1L. 5% dex. in H_2O; H_2O by tube = 660 cc.
16 to 17	2050	400	1500	0	80	0		.150	.692								600 cc. tea with 80 Gm. sugar. 1450 cc. H_2O.
17 to 18	2050	440	3550	0	80	0	25.886	.137	.692	26.173	−22.156	−32.425					Ditto.
18 to 19	2050		1230	0	700	4.017			.692				5.35		31	55.68	760 cc. pep. milk + H_2O + broth.
19 to 20	?		875	?	850				.692								1080 cc. pep. milk + broth + H_2O.
20 to 21			1000		850	17.123	23.754		.692	25.830	− 8.707	−41.132				55.68	Ditto.
21 to 22			1375		850				.692								Ditto.
22 to 23			1250		1130				.692				7.04		38		Ditto.
23 to 24			700		1900?	23.67	24.639		.692	26.715	− 3.045	−44.177					Soft diet (partially consumed).
24 to 25			1400		1900?				.692								Soft diet (partially consumed).
25 to 26			1350		1900	6.5	6.429		.692	7.121	− .621	−44.798				54.54	Soft diet (partially consumed).
28													6.8		39	53.52	
Total		2170				66.110	126.16	1.064	8.304	110.908							
Average		543				5.509	18.025	.216	.692	9.242							
Jan. 3																	Discharged.

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TABLE IV

CASE J. S., FEMALE, AGE 48

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl. Intake Gm.	Caloric Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	Cum. N Status Gm.	P.P. Gm. % A/G	Hem.	Wt. Kg.	Remarks
Dec. 9													7.48	43	85.23	
10 to 11	2500	1000	830	45	940	5.6	7.558	4.67	.22	12.448	− 6.848	− 6.848				In 1L. W.B.; 2L. 10% dex. in D/W.
11 to 12	3300	2650	725	9	1200	0	6.886	25.368	.22	22.474	−22.474	− 29.322				Inf. 3L. 10% dex. in D/W; 300 cc. H_2O by tube. 300 cc. H_2O by tube.
12 to 13	3050	(bloody) 1600	930	18	800											Inf. 2L. 10% dex. in H_2O; 600 cc. H_2O + 450 cc. tea.
13 to 14	3150	(bloody) 2650	850	9	600	0	37.58	39.368	.659	83.538	−83.538	−112.86				Inf. 1L. 5% dex. in saline; 1L. 10% dex. in H_2O; 1150 cc. H_2O and tea.
14 to 15	2800	1650	680	9	400										81.81	Inf. 2L. 5% dex. in H_2O; 1L. in saline· 800 cc. H_2O and tea.
15 to 16	?	—	950	?				0					6.34	38		4 glasses pep. milk; water and tea to 2500 cc.
16 to 17	?	—	1200	?	2220	14.27	41.87	0	.659	42.529	−28.259	−141.119				5 glasses pep. milk; H_2O and tea.
17 to 18	?	—	1100	?	?			0					6.12	37	80.00	4½ glasses pep. milk; H_2O and tea.
Total		9550				19.87	93.894	69.406	1.758	160.989						
Average		1950				3.974	11.737	17.451	.21	20.125						
18—On soft diet.																
21															81.36	
27													6.54	38	81.36	
Dec. 27																Discharged.

TABLE V

CASE A. V., MALE, AGE 47

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl Intake Gm.	Caloric Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	N. Deficit or Surplus	P.P. Gm. % A/G	Hem.	Wt. Kg.	Remarks
Mar. 31													6.57	69.77		
April 1 to 2	2250	825	650	11.25	470	2.8	3.764	2.100	.965	6.829	−4.029	− 4.029				Tr. 500 cc. W.B. 1L. 5% dex. in saline; 1L. ditto in D/W.
2 to 3	3800	1500	1050	13.50	4025	20.25	8.9	1.576	.965	11.441	+8.809	+ 4.78				750 Gm. nutramigen by mouth in 1500 cc. saline—water to make 3800 cc. Inf. 1L. 5% dex. in D/W.
3 to 4	4500	2600	700	18	4025	20.25	13.207	3.036	.965	17.208	+3.042	+ 7.82		69.8		Ditto—with 2000 cc. saline and H_2O to make 4500 cc.
4 to 5	4500	2800	1000	18	4025	20.25	10.6	2.615	.934	14.149	+6.101	+13.923	6.72			Ditto—with 2000 cc. saline and H_2O to make 4500 cc. Inf. 1L. 5% dex. in D/W.
5 to 6	4500	1700	1150	18	4025	20.25	10.787	1.667	.941	13.395	+6.855	+20.778		70.5		Ditto—with 2500 cc. saline and H_2O to make 4500 cc. Inf. 1L. 5% dex. in D/W.
6 to 7	3000		1900	18	4025	20.25	10.796		.941	11.737	+8.513	+29.291				Ditto—with 2000 cc. saline and H_2O to make 3000 cc. Inf. 1L. 5% dex. in D/W.
7 to 8	3000		1400	9	4025	20.25	10.358		.941	11.299	+8.951	+38.242	7.17	70.91		Ditto—with 1000 cc. saline and H_2O to make 3000 cc. Inf. 1L. 5% dex. in D/W.
Total						124.3	68.412	10.994	7.691	86.303						
Average		1121				17.757	9.773	2.199	1.099	12.329						
Apr. 19																Discharged.

TABLE VI

CASE F. R., MALE, AGE 55

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl Intake Gm.	Caloric Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	Cum. N. Status Gm.	P.P. Gm. % A/G	Hem.	Wt. Kg.	Remarks
June 5													6.76	46.5	48.2	
8 to 9	3250	2100	1700	11.25	1270	2.8	20.403	7.355	.254	28.012	−25.212	−25.212				Tr. 500 cc. W.B. with reaction. Inf. 2L. 10% dex. in D/W; 1L. ditto, in saline.
9 to 10	4000	1810	1600	27.0	1370	6.0	11.021	3.297	.254	14.572	− 8.572	−33.784				Inf. 1L. 10% dex. in D/W; 2L. ditto. in saline; 1L. 5% amigen.
10 to 11	4500	2010	840	22.5	4090	22.385	8.767	9.856	.254	18.877	+ 3.508	−30.276	6.12	38	46.9	2L. 10% dex. in saline; 700, Gm. nutramigen in 500 cc. saline; H_2O to make total 2500 cc.
11 to 12	4500	2000	1300	22.5	4320	27.031	7.5	3.736	.254	11.490	+15.541	−14.735				Inf. 1L. 10% dex. in D/W; 700 Gm. nutramigen in 880 cc. pep. milk; water to make 4500 cc.
12 to 13	4000	1200	1000	16.92	4320	27.031	8.172	2.382	.254	10.808	+16.223	+ 1.488				Inf. 1L. 10% dex. in D/W; 700 Gm. nutramigen in 880 cc. pep. milk; H_2O to make 4L.
13 to 14	3500	—	1250	7.92	4155	28.385	8.64	—	.887	9.527	+18.858	+20.346				750 Gm. nutramigen in 880 cc. pep. milk; water to make 3½L.
14 to 15	3000	—	1050	7.92	4150	28.385	7.835	—	.887	8.722	+19.663	+40.009	6.58	44	48.73	Ditto—water to make 3L.
15 to 16	3000		980	7.92	4150	28.385	7.64	—	.887	8.527	+19.858	+59.867				
16 to 17	3000		1100	7.92	4150	28.385	9.751	—	.895	10.646	+17.739	+77.606				
17 to 18	3000		1250	7.92	4150	28.385	8.642	—	.895	9.537	+18.848	+96.454				
18 to 19	3000		1040	7.92	4150	28.385	8.96	—	.895	9.855	+18.530	+114.984	6.84	46	52.15	
Total		9120				255.557	107.331	26.626	6.616	140.573						
Average		1824				23.222	9.766	5.325	.601	12.779						
June 25																Discharged.

TABLE VII

CASE V. B., MALE, AGE 39

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl Intake Gm.	Caloric Intake	N Intake Gm.	N—Output: Urinary N Gm.	N—Output: Gastric N Gm.	N—Output: Fecal N Gm.	Total N Output Gm.	N Balance Gm.	Cum. N. Status Gm.	P.P. Gm. %	A/G	Hem.	Wt. Kg.	Remarks
Nov. 10													3.95	2.6	45	64.54	
11 to 12	4500	950	900	13.5	3055				.7194								Inf. 1L. 10% amigen; 3L. 5% dex. in D/W; by tube 450 Gm. nutramigen in 500 cc. saline.
12 to 13	3500	1250	1180	18	3630	85.951	37.684	11.668	.7194	70.934	+15.017	+15.017					By tube 700 Gm. nutramigen —100 Gm. amigen in 2L. saline. Water to vol.
13 to 14	3500	1150	1200	18	3630				.7194				6.52		42		Ditto.
14 to 15	3000	650	860	9	3630				.7194								By tube 700 Gm. nutramigen; 100 Gm. amigen; 1000 cc. saline. Water to make 3L.
15 to 16	3000	450	800	9	3630	92.7	34.205	8.147	.7194	44.509	+48.191	+63.208					Ditto.
16 to 17	3000	400	860	9	3630				.7194								Ditto.
17 to 18	3000	—	940	9	3630				.7194				6.71		43	65.45	Ditto.
18 to 19	3000	—	800	9	3360	76.8	32.052		.7194	34.052	+42.748	+105.956					800 nutramigen in 1L. saline. Water to make 3000 cc.
19 to 20	3000	—	1400	9	4230				.7194								900 Gm. nutramigen in 1L. saline. Water to make 3L.
20 to 21	3000	—	1000	9	4700				.7194								1 Kg. nutramigen in 1L. saline and H_2O to make 3L.
21 to 22	3000	—	1000	9	4700	81	56.002		.7194	58.159	+24.998	+130.954					Ditto.
22 to 23	3000	—	1700	9	4700				.7194				6.93		44	69.25	Ditto.
Total		4850				336.451	159.943	19.815	8.633	207.654							
Average		808				28.037	13.329	3.303		17.304							

TABLE VIII

CASE P. F., MALE, AGE 41

Date	Fluid Intake Cc.	Fluid Output: Gastric Suction Cc.	Fluid Output: Urinary Vol. Cc.	Cl Intake Gm.	Caloric Intake	N Intake Gm.	—N—Output: Urinary N Gm.	—N—Output: Gastric N Gm.	—N—Output: Fecal N Gm.	—N—Output: Total N Output Gm.	N Balance Gm.	Cum. N. Status Gm.	P.P. Gm. % A/G	Hem.	Wt. Kg.	Remarks
Dec. 2													4.47/2.7	50	51.47	
3 to 4	4500	2400	15 5	31.5	3440	71.2	52.089	10.308	1.26	66.177	+ 5.023	+ 5.023				500 cc. W.B. (severe reaction) + 1L. 5% amigen; 1L. 10% dex. in saline + 600 Gm; nutramigen + 100 Gm. amigen in 1.5L. saline. Water to make 2.5L.
4 to 5	4500	2270	1620	27	3330				1.26				6.8	43		600 Gm. nutramigen; 150 Gm amigen in 3L. saline; H_2O to make 4500 cc.
5 to 6	4500	2140	1060	27	3330				1.26							Ditto.
6 to 7	4500	2070	950	27	3330	88.65	65.059	10.462	1.26	79.301	+ 9.349	+14.372			51.81	Ditto.
7 to 8	4500	2370	970	27	4035				1.26							750 Gm. nutramigen; 150 Gm. amigen + 3L. saline + H_2O to make 4500 cc.
8 to 9	4500	2450	1525	27	4035			5.154	1.26		+45.213	+59.585				Ditto; water to make 3500 cc.
9 to 10	3500	0	1120	9	4035	114.75	60.603		1.26	69.537						Ditto; amigen + nutramigen in 1L. saline; H_2O to make 3500 cc.
10 to 11	3500	0	1650	9	4035				1.26				6.7	41	52.73	Ditto.
11 to 12	3500	0	1050	9	4035				1.26							Ditto.
12 to 13	3500	0	1500	9	4035	153	83.99		1.26	89.030	+63.970	+123.555				Ditto.
13 to 14	3500	0	1650	9	4035				1.26							Ditto.
14 to 15	3500	0	1250	9	4035				1.26				6.81	42	55.68	Ditto.
Total						427.60	61.741	25.924	15.12	304.045						
Average						35.633	21.811	4.154		25.337						
Dec. 16																Discharged.

fusions, assuming that the total protein concentration was uniformly 7 Gm. per cent. Five hundred cubic centimeters of whole blood would thus yield about 250 cc. of plasma, which would contain 17.5 Gm. of proteins, equivalent to 70 calories and 2.8 Gm. of nitrogen. The protein contained in the hemoglobin of the transfused red cells was not included.

Like the daily fluid intakes, the daily caloric intakes in the control group fluctuated widely, from 80 calories for the 3rd and 4th days of F. W. (Table III) to 2,200 calories for the 3rd and 5th days of R. B. (Table II). In fact, R. B. had almost the basic caloric requirements throughout his convalescence, the only one who approached this caloric intake in the control group. The nitrogen intakes varied still more widely, ranging from 0 for three days for F. W. (Table III), for four days for J. S. (Table IV), and for four days for D. R. (Table I, to 11.11 Gm. for the 6th day for R. B. (Table II), the averages being 3.31, 6.12, 5.5 and 3.97 Gm. for these four cases, respectively.

In the feeding group, except for the first day in the case of A. V. (Table V), and the first and second days in the case of F. R. (Table VI), in all the other postoperative days the intake was on the luxury level. The respect for the tradition of withholding feedings for the first few days postoperatively in abdominal cases, accounted for the "lean" first day for A. V., and first two days for F. R. In our last two cases, V. B. (Table VII), and P. F. (Table VIII), feeding was started after the first 12 hours, which period may still be shortened, with courage gained from further experience. Except for the three "lean" days mentioned above, the caloric intake in this group ranged from 3,050 to 4,700 (V. B.) daily. It may be mentioned that this latter amount was given in response to complaints of hunger on the part of a patient, who was being fed 3,360 calories a day—a phenomenon connected with convalescence which bears further investigation.

The nitrogen intake in the feeding group, except for the three "lean" days mentioned, ranged from 20.25 Gm. (A. V.) to 38.25 Gm. daily for the 5th, 6th and 7th days of P. F. The average daily intakes were 17.7, 23.22, 28.05 and 21.81 Gm., respectively, for the four feeding cases.

In the feeding group, the caloric and nitrogen values were mostly derived from amigen and nutramigen* in the feedings, although dextrose and amigen injections and blood transfusions contributed some part of the first days' intake. Amigen is a casein enzymatic digestate containing approximately 85 per cent amino-acids and 15 per cent polypeptides, each gram yielding 3.4 calories and 0.12 Gm. of nitrogen. Nutramigen contains, in addition to amigen, dextri-maltose, a neutral fat, arrowroot starch, calcium gluconate and brewer's yeast, and minerals added to simulate the quantities present in cow's milk. Nutramigen has been developed as a food for infants and is marketed as such. It yields 4.7 calories per gram and contains 2.7 per cent nitrogen. In preparing the feeding, the amigen and nutramigen were mixed

* Both amigen and nutramigen were kindly supplied us by the Mead-Johnson Co.

with a convenient amount of physiologic saline or water to make the mixture easily instillable by means of a syringe through the feeding tube into the jejunum. The feedings were so spaced that from 50 to 150 cc. was given every hour. A larger amount might cause nausea and vomiting, either as a result of distention or of too rapid an absorption resulting in hyperaminoacidemia. The balance of the mixture was kept in the refrigerator, since it is a fertile medium for bacterial growth, and decomposition easily sets in.

Collection and Care of Specimens.—The 24-hour urine was preserved with thymol, measured, and kept on ice. In some cases in both groups, both urine and gastric suction specimens were sometimes pooled for two or three days and an aliquot part of the pooled specimens taken for nitrogen determination. In these instances the total nitrogen over the number of pooled days was recorded in the tables as one figure. The Wangensteen drainage (gastric suction) was preserved in sulfuric acid. Likewise preserved in sulfuric acid, were the stools collected and pooled over the study period. The discharges from the wounds were never large enough to be taken into consideration, random samples yielding negligible amounts of nitrogen.

The samples of blood for blood plasma protein determinations were taken in one of two ways. Where the specific gravity method of Barbour and Hamilton[11] was used, the anticoagulant used was heparin. Where a chemical method was used, the anticoagulant was sodium oxalate. The hematocrit was determined in the Sanford-Magath tube, and in most cases was read each time the plasma proteins were determined.

Chemical Methods.—As stated above, when the total plasma protein concentration only was needed, it was determined by the specific gravity method of Barbour-Hamilton,[11] using the apparatus designed by these authors. Where it was desired to obtain the albumin and globulin figures, the method of Wu and Ling as modified by Greenberg[12] was used.

In determining the nitrogen of the urine, stool and gastric drainage, the method of Rappoport as modified by Levy and Palmer[13] was used.

ANALYSIS OF THE TABLES

The fluid, caloric and nitrogen and NaCl intakes have been discussed in a foregoing section of this paper.

Fluid Output. (Gastric Suction)—By this item is meant the amount of drainage, in cubic centimeters, yielded by the Wangensteen apparatus each 24 hours. The suction was kept up for from four to seven days. The amount in cubic centimeters varied from a minimum of 400 cc. (V. B.) to a maximum of 2,800 cc. (A. V.). As mentioned before, this source of fluid loss complicated the problem both of fluid and of sodium chloride replacement. The drainage of J. S. contained visible blood for the second and third days. The amount of nitrogen lost from this source will be discussed under the heading of *"Gastric Nitrogen."* As a rule, the suction tube was left in place for a shorter time in the control cases than in the feeding cases, in whom it was needed for feeding.

Urinary Output.—As might be expected from what has been said of the fluid intake, there was more fluctuation of the urinary volume in the control group than in the feeding group. Generally speaking, however, the urinary volume was quite adequate. The smallest output was 650 cc. for the first day of A. V., the first feeding case, when no provision was made for the gastric drainage. The fluctuations in the control group existed throughout the course of the convalescence, while in the feeding group the urinary volume was fairly well stabilized to from 1,000 to 1,900 cc. after the gastric suction was discontinued. The widest fluctuations were in the case of F. W., a control case, whose output ranged from a low of 700 cc. to a high of 3,550 cc. Incidentally, he also had a low blood plasma protein concentration of 5.23 Gm.% at the time of this excessively high output.

Urinary Nitrogen.—In the control group, except for R. B., the nitrogen excretion in the urine averaged respectively 13.69, 15.46, 18.03 and 11.74 Gm. daily. These figures are in the neighborhood of urinary nitrogen figures given for the ten days of complete starvation, as found in Succi, Cetti and Levanzin.[14] They are, except for R. B., all above the 13 Gm. given as the nitrogen excretion of average persons. Brunschwig, *et al.,* gave figures for two cases of gastric resection, one, excreting 73.53 and the other 175.79 Gm. of nitrogen in ten days, averaging 7.35 and 17.58 Gm. respectively. Just how much of this excreted amount is "toxic loss," how much is starvation loss, as modified by previous undernutrition, is not clear.

In the feeding group, A. V. was taking an average of 17.78 Gm. of nitrogen and excreting an average of 11.21 Gm. daily; F. R. was taking in 23.22 and excreting 9.77 Gm. daily; V. B. was ingesting 28.04 and excreting 13.33 Gm., while P. F. was ingesting 35.63 and excreting 21.81 Gm. These figures suggest that A. V. and F. R. were ingesting perhaps less than they could fully utilize; that V. B. was perhaps getting the optimum amount, and that P. F. was perhaps ingesting an amount above the optimum. Both F. R. and V. B. had blood transfusion reactions, which no doubt accounted for the large amount of urinary nitrogen excreted during the days immediately following the transfusion. This would tend to introduce an error in the amount of nitrogen actually lost from the body.

Gastric Nitrogen.—This item represents the amount of nitrogen lost in the Wangensteen drainage. In the control group, the figures were, minimum .771 Gm. (D. R.), maximum 25.368 Gm. (J. S.), for any one day. The blood in the drainage of J. S. accounts for a part of this nitrogen. The average daily loss was 3.18, .815, .216 and 17.45 Gm. Aside from hemorrhage as a source of nitrogen loss, it is quite possible that the oozing of exudate from the operated viscus may also have contributed to this loss. In the feeding group, the average daily losses were higher, being 2.2, 5.33, 3.3 and 4.15 Gm., respectively, but how much, if any, of it represented refluxed feeding from the jejunum has not been ascertained.

Even taking the loss in the control group as the more nearly actual figure, it is clear that a considerable amount of nitrogen can be lost from this source.

Fecal Nitrogen.—The fecal nitrogen in both of these groups is low, with a tendency in the feeding group to be slightly higher. The only subject who almost approximated the classical average daily norm of 1.3 Gm. was V. B., in the feeding group, with an average of 1.25 Gm. of nitrogen excreted in the stools. In the control group, the lowest daily average was .21 Gm. (J. S.), and the highest 0.815 Gm. In the feeding group, the lowest daily average was 0.601 (A. V.) and the highest 1.26. These low figures are suggestive of the low fecal nitrogen excretion of Benedict's[15] subjects under prolonged restricted feeding.

Total Nitrogen Output.—The daily total nitrogen output averaged 13.69, 16.4, 9.24 and 20.13 Gm. daily in the control group, and 12.33, 12.78, 17.3 and 15.38 Gm. in the feeding group. In the control group, therefore, the average total nitrogen loss of two cases is significantly higher than that found in complete starvation. The day-to-day output, however, fluctuated a great deal, and in three out of four control cases there were always some days when the output was considerably higher than that found in starvation.

The Nitrogen Balance and the Cumulative Nitrogen Status.—Except for the first day in the case of F. W., none of the four cases in the control group achieved nitrogen balance during any of the days under study; the nearest approximation to a balance was a loss of 0.61 Gm. of nitrogen on the part of F. W. on the 12th postoperative day. The average daily nitrogen losses were 10.37, 10.28, 3.73 and 16.4 Gm. daily. The sum-total of these losses were 114.09, 82.21, 44.8 and 141.11 Gm., respectively. This cumulative deficit is entered under the column entitled "Cumulative Nitrogen Status" in the tables.

In the feeding group, except for the three days of withholding feeding, positive balances were registered on all the days. The cumulative nitrogen surplus, after subtracting the deficit of the three "lean" days, were 38.25, 114.88, 130.95 and 123.56 Gm., respectively. This surplus is also entered under the heading of "Cumulative Nitrogen Status."

The Hematocrit and Plasma Protein Determinations.—In the absence of blood volume determinations and in the presence of multiple infusions, especially in the control group, these determinations have been robbed of much of their absolute value. Generally speaking, however, the tendency of the plasma protein level was downward in the control group, and upward or relatively stationary in the feeding group. This finding in the feeding group is more significant than the figures in the control group because of the better regulated fluid intake and the comparative absence of infusions. The sharp upswing of the total plasma proteins and hematocrit from 5.35 to 7.04 Gm.% in the case of F. W. is a bizarre phenomenon. Whether it is due to an hemoconcentration or to a rise of blood proteins, even while the body was still losing nitrogen, is only a matter of speculation.

In the case of the hematocrit values, the tendency of both groups is to dip below the preoperative figures, showing that in spite of the transfusions, there is some loss of blood. This is particularly true with those cases in which there have been blood transfusions reactions (F. R. and V. B.).

The Weight Curve and the Cumulative Nitrogen Status.—If a table is constructed by posting the cumulative nitrogen status during the period in one column, the equivalent of this in body tissue in a second column, and the gain or loss of body weight in a third column, a better picture of the relationship of these three factors may be seen. The equivalent of the nitrogen gain or loss in body tissues is arrived at by multiplying the nitrogen deficit or surplus by the standard factor of 6.25, and multiplying the result, in turn, by five, assuming that the protein is deposited with 80 per cent water to form body tissues. Table IX represents this relationship in the eight cases studied.

Table IX

Patients	Cumulative Nitrogen Status Gm.	Body Tissue Lost or Gained Gm.	Body Weight Lost or Gained Gm.
D. R.	−114.09	−3455	−6950
R. B.	− 82.21	−2569	−4300
F. W.	− 44.8	−1397	−3430
J. S.	−141.13	−4410	−5230
A. V.	+ 38.24	+1195	+1540
F. R.	+114.98	+3593	+3950
V. B.	+130.95	+4092	+4710
P. F.	+123.56	+3861	+4210

It will be seen from the table that while no linear relationship exists between the nitrogen deficit or surplus and body weight loss or gain, yet the trends are roughly parallel. Figures 1 and 2 represent this relationship graphically. Both the charts and the tables show that in the control group there was a significant loss of body weight, while in the feeding group there was a significant gain. Another interesting point in connection with body weight in the control group is that it required a fairly long time for the initial weight to be restored. Thus D. R. on discharge, 35 days postoperatively, was still 900 Gm. under the initial weight; R. B. almost reached his initial weight three weeks postoperatively; F. W. two weeks postoperatively was still 4,450 Gm. under his initial weight; and J. S. on the 17th postoperative days was 3,870 Gm. below her initial weight.

Of the two cases in the control group who were followed for 12 days, D. R. lost 115 Gm. of nitrogen and 6,950 Gm. of body weight, and F. W. lost only 45 Gm. of nitrogen and 3,430 Gm. of body weight. It is interesting to observe that two fasters—Succi (Florence, 1888), in 12 days of complete fasting lost 134 Gm. of nitrogen and some 7,700 Gm. of body weight, while Levanzin lost, in the same period, 120.53 Gm. of nitrogen and 6,760 Gm. of body weight. The weight losses of three other fasters for 12 days were—Jacques (1888) 6,970 Gm., Beatue (1907) 6,410 Gm. and Schenk[14] (1906) 6,800 Gm. It is apparent that in spite of the infusions and transfusions given to the patients undergoing gastric resection, the nitrogen and body weight losses of some cases can approximate those of complete fasting.

Theoretically, the body weights of patients with hypoproteinemia may be higher than the actual weight, as a result of the loss in colloid osmotic pressure of blood proteins and the retention of water by the tissues (latent edema). In such a circumstance, the body weight would be sustained at a falsely high level, to undergo a sudden drop with restoration of colloid osmotic pressure to the blood. With D. R. there was no suggestion of this phenomenon taking place. With F. W., the only other patient with definite hypoproteinemia, the loss of only 260 Gm. of body weight in the first three days, in the face of a blood protein which fell from 6.3 to below 5.5 Gm. per cent, and the loss of 2,130 Gm. on the fourth day after the excretion of 3,550 cc. of urine on the previous day, is suggestive of this mechanism having been operative.

The Period of Hospitalization.—This study was not carried out with any planning, but was really an afterthought. A number of factors entered into determining when this period should be terminated, among them whether a patient has relatives at home to take care of him after his discharge. It is apparent that a patient living alone must stay in the hospital until he is stronger. In a future series, it is planned to have a better control of this factor. Meanwhile, the number of days of hospitalization of these two groups are interesting:

Control Group	Days
Name	
D. R.	35
R. B.	21
F. W.	21
J. S.	17
Av.	23.5
Feeding Group	
A. V.	22
F. R.	17
V. B.	14
P. F.	14
Av.	16.75 days

There is, thus, a shorter hospitalization period of 6.25 days in the feeding than in the control group.

Infusions and Transfusions: The number of infusions and transfusions administered to the patients in these two groups are shown in Table X.

TABLE-X

Control	No. of Days of Infusion	Total Infusions Given—L.	No. of Transfusions	Total Amount of Transfusions Blood Cc.	Plasma Cc.
D. R.	10	18	4	1,000 cc. W.B.*	1,000 cc.
R. B.	7	19.5	6	1,500 cc.	1,050 cc.
F. W.	2	7	1	500 cc.	
J. S.	5	12	1	500 cc.	
Feeding					
A. V.	2	3	1	500 cc.	
F. R.	4	12	1	500 cc.	
V. B.	1	4	0	0	
P. F.	1	2	1	500 cc.	

*W. B. = Whole blood.

It will be seen that both the number of infusions and transfusions were markedly reduced in the feeding group. This was also the experience of Stengel and Ravdin,[16] with their orojejunal feeding cases. In the last two patients, V. B. and P. F., the infusions were given in the first 12 postoperative hours, and V. B. had no transfusions, while the transfusion in P. F. as a result of the severe reaction seemed to have been more harmful than otherwise, reducing the hematocrit value significantly, and could well have been dispensed with. The greater comfort to the patient in the use of fewer infusions and the economic advantage of reducing the number of transfusions are considerable.

Postoperative Asthenia.—While the usual postoperative debility was present in the control group, it was interesting to note that it was minimal in the feeding group. This was most apparent in the last two feeding cases, V. B. and P. F., who got restless and asked to get up in a wheel chair on the eighth day. On the twelfth day they were helping move beds and weighing fellow patients. This absence of postoperative debility was also observed by Brunschwig, *et al.*, in one case, a patient who had gained 20.39 Gm. of nitrogen. Although this absence of asthenia seems to be definite in this series of four patients, it is still impressionistic. In a future series we propose to study this subject objectively.

Disadvantages of the Feeding Method.—The main disadvantage of this method of feeding is the discomfort caused by the presence of the nasal tube. This discomfort is relieved in 24 hours after the tube is removed. The other disadvantage is the objectionable taste of the mixture. When the mixture is administered through a tube, this difficulty is circumvented, but many patients rebel against taking it orally. If the patient is told that it is a "build-up medicine" which he will not have to take for more than a week (after the five to six days of tube feeding), however, he can usually be persuaded to "down" the mixture. Occasionally diarrhea occurs. Whether this is due to overfeeding or to other factors has not been determined.

In this series of four feeding cases, and in a large series of feeding with amigen and nutramigen to patients who were not under study, there was never any distention encountered.

DISCUSSION AND COMMENTS

The question arises, how does this attempt to maintain caloric and nitrogen equilibrium postoperatively differ from previous attempts? None of the technics employed in this study are essentially new. Various technics of postoperative tube feeding have been periodically reported. Elman and Brunschwig showed the feasibility of achieving nitrogen balance by parenteral feeding, and this has been repeated by Landesman and Weinstein.[17]

Stengel and Ravdin,[16] in 1939, and Ravdin and Stengel,[18] in 1940, reported an orojejunal method of feeding, using the Abbott tube, and an ingenious automatic feeding machine. Unfortunately, there was at that time no ready-made homogenous mixture available. Furthermore, no nitrogen balance was done, and without knowing the gravity of nitrogen losses, no adequate replacement could be given, particularly as these authors emphasized only the necessity of a basal intake.

The first point of departure in this work from previous work is the utililization of the absorbing surface of the reaches of the intestines beyond the point of operative trauma for the absorption into the system of a feeding mixture which requires the minimum of digestive effort. The combination of the feeding tube and this mixture obviates the difficulties which bar the way to immediate posoperative feeding, especially in abdominal cases, namely, the vomiting, anorexia and impairment of the digestive processes caused by an operation. The second point of departure is the strict adherence to a caloric and nitrogen intake, which would at least fully replace the losses resulting from the operation.

To rely solely upon intravenous alimentation to do this is to put to heroic use a method which, at best, must remain an excellent adjuvant. Elman and Brunschwig both realize this, Elman saying: "The purpose of parenteral alimentation, in surgery at least, is to clear temporary hurdles"; and Brunschwig, *et al.*, stated: "Minimal caloric requirements, including sufficient protein (as amino-acids), may be met by intravenous nutrition." Thus, in order to give 1,749 calories, and a nitrogen intake of 18 Gm., Brunschwig gave as much as 4,500 cc. of fluid intravenously in six hours, an amount which must tax the circulatory system by the production of an acute plethora. And, unfortunately, the caloric and nitrogen requirements postoperatively are not often basal, as has been demonstrated by Cuthbertson,[6] An analysis of the four cases reported by Brunschwig, *et al.*, as having registered a net gain of nitrogen ten days postoperatively, shows that only one achieved a positive nitrogen balance as a result of intravenous feeding. In Elman's report of 35 patients, in whom nitrogen balance was achieved by intravenous alimentation, only four postoperative cases were reported in detail, and in none of these four was a positive nitrogen balance consistently achieved. Recently, Gardner and Trent[19] found similar difficulty in maintaining nitrogen balance by intravenous alimentation in patients with large nitrogen losses postoperatively. If to this limitation may be added the dangers of pyrogenic reactions, and of phlebitis and thrombosis of veins, the restoration of whose patency is never certain and which could be conserved for use in greater emergencies, the present tendency to rely mainly on intravenous infusions to supply caloric and nitrogen requirements seems unjustifiable.

Finally, two further points must be emphasized. The first is that blood and plasma transfusions, dramatic as they are in the restoration of the blood volume in acute hypovolemia caused by hemorrhage or acute loss of plasma proteins, cannot be depended upon as the sole caloric and nitrogen supply for the body. Sachar, Horvitz and Elman[20] are of the same opinion, and a little arithmetical calculation will show the strength of this statement. As shown above, the amount of plasma proteins in 500 cc. of transfused blood will yield

70 calories and 2.8 Gm. of nitrogen. To supply the basic caloric requirement alone would require 26 transfusions a day! Were all the hemoglobin in the transfused blood also utilized for body energy, for which we have no evidence at present, only 55 Gm. of protein in the form of hemoglobin would

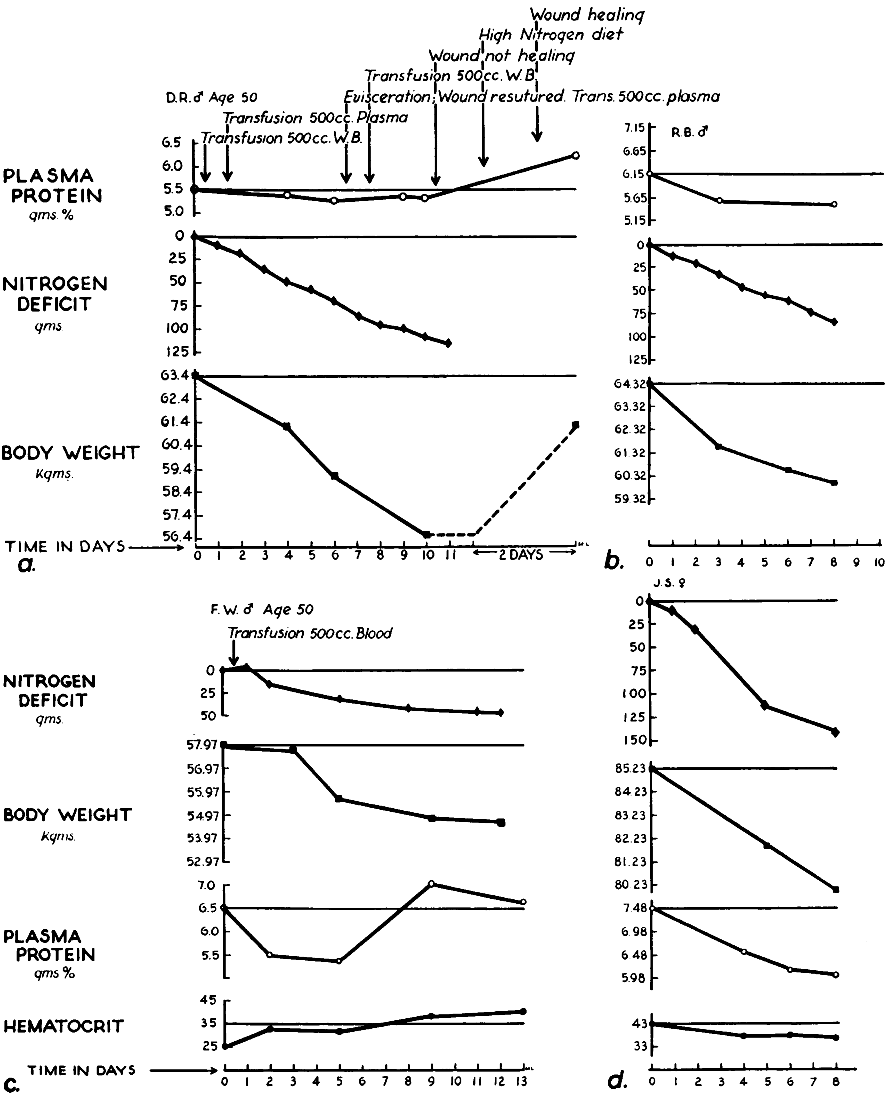

FIG. 1.—Panels a, b, c and d are graphic records of the plasma protein, nitrogen deficit, body weight and hematocrit curves (except two) of members of the control group; namely, of D.R., R.B., F.W., J.S., respectively. Note particularly the downward trends in both the nitrogen curve and the body weight curve.

be available, making a total of 72.5 Gm., and to satisfy the basal caloric needs under these hypothetic circumstances would require six transfusions a day.

The other point, which Case D. R. suggests, is that unless provisions are made for full caloric and nitrogen maintenance postoperatively, patients coming to operation with plasma protein concentrations near the "lower limit of normal" may be poor operative risks, for this so-called lower limit of normal already reflects some depletion of body proteins, which would be aggravated by the "toxic loss" of nitrogen and starvation incident to an

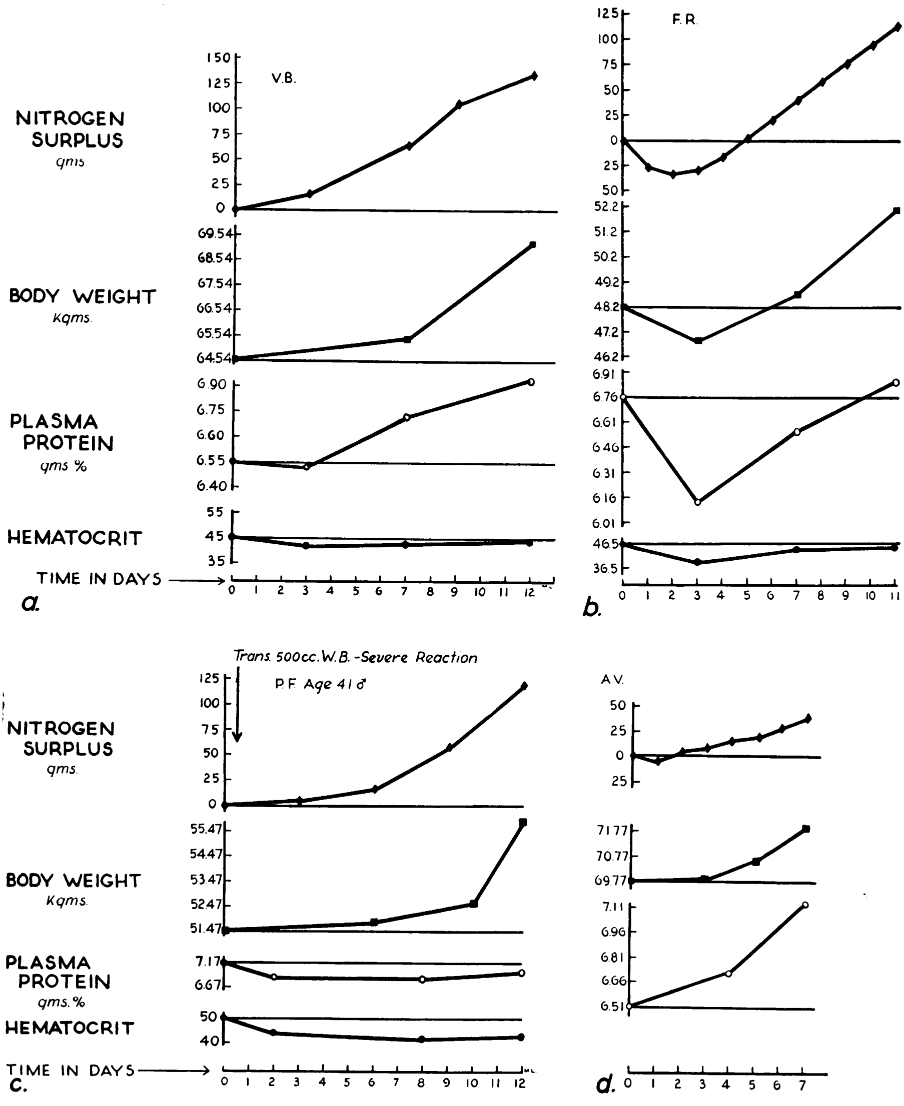

FIG. 2.—Panels a, b, c and d are graphic records of the nitrogen deficit, body weight, plasma protein and hematocrit (except one) curves of members of the feeding group, namely, of V.B., F.R., P.F., and A.V., respectively. Note the consistent upward trend in nitrogen surplus and body weight in all the four cases. The plasma protein curves are consistently upward in two and show a slight depression in two.

operation, leading to impaired wound healing. It may be safer for surgeons to set a higher "lower limit of normal" to surgical patients than is required in other specialties.

It must be emphasized that these four cases are only preliminary, and point the way to a wider application of at least full caloric and nitrogen replacement in surgical patients. A number of refinements have still to be worked out, among them suitable feeding technics for different types of cases, and the optimum postoperative intake, and objective tests for strength and endurance.

SUMMARY AND CONCLUSIONS

(1) The nitrogen balance, the body weight and the plasma proteins of four patients with duodenal ulcer, and undergoing partial gastrectomy, and treated postoperatively by the standard ward routine, were followed for from 7 to 12 days. There was found to be in all these cases a cumulative nitrogen deficit, a progressive loss of body weight and a suggestive progressive fall of plasma protein concentration.

(2) In another group of four patients with similar pathology, and undergoing the same operation, in whom the caloric and nitrogen balance was maintained by tube feeding with an easily assimilable feeding mixture, there were achieved a positive nitrogen balance, a cumulative nitrogen surplus, and a progressive rise of body weight and of plasma proteins. There also seemed to be the minimum amount of postoperative asthenia.

(3) The technics employed in this study were discussed, as well as the fallacy of expecting to maintain nutrition by blood transfusions, and the necessity of a higher "lower limit of normal" of plasma proteins for surgical patients.

(4) The preliminary character of this work is emphasized.

The authors wish to acknowledge their grateful thanks to Dr. Victor Carabba who performed a number of these gastrectomies.

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