Measurement of gastrointestinal transit using radioactive chromium

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Measurements of gastrointestinal transit until recently have used physical and chemical agents such as barium, bismuth, glass beads (Alvarez and Freedlander, 1924), or carmine (Mulinis, 1935).

Recently Whitby and Lang (1960) showed that chromic oxide (Cr_2O_3) mixes well with the gut contents, is relatively inert, and is not absorbed from the gastrointestinal tract. Using chemical methods for its estimation, they employed it as a marker in metabolic balance studies. It has also been shown that Cr^{51} tagged to red blood cells and given orally is not absorbed from the gut, 97% of the dose being excreted in the faeces (Cameron, 1960).

We decided, therefore, to investigate the use of sodium chromate ($\text{Na}_2\text{Cr}_2\text{O}_7$) labelled with Cr^{51} as an index of gastrointestinal transit as it promised to be simple to use and at the same time give a quantitative measure of several parameters of transit including the passage of the main bulk of the marker. Chromic oxide incorporating Cr^{51} has also become available, and this material has also been studied. In this communication the method of estimating gastrointestinal transit using Cr^{51} is described and its value discussed.

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METHOD

Cr^{51} is administered orally either as chromic oxide powder or sodium chromate solution, and all the stools passed during the next five to seven days are individually collected, dried in an oven at 170°F. for 24 hours, ashed and counted, using the method described by Cameron (1960).

A gelatin capsule, filled with 0.5 g. of chromic oxide, with an activity of 1 to 2 μc , is swallowed by the subject with a little water. Alternatively, sodium chromate is administered as a solution containing 1 to 2 μc of radioactivity made up to a volume of 3 ml. with tap water, this being the optimum volume for counting on our apparatus. The solution may be given in tomato juice, orange squash, or by itself, but the tube containing the chromate should be washed at least four times with water and the washings swallowed by the subject. Even after washing, the tube should be counted for residual radioactivity as we have found up to 5% of the dose left in the tube.

The use of a well type scintillation counter (ECKO) permits accurate results with only a small dose of Cr^{51} and in this study the dose was always less than 2 μc .

In order to assess the value of the method, the excretion of a dose of Cr^{51} has been estimated in 10 normal subjects, six receiving chromic oxide and four sodium chromate solution.

TABLE I
PERCENTAGE RECOVERY OF RADIOACTIVE CHROMIC OXIDE AND SODIUM CHROMATE AND TRANSIT TIMES
IN 10 NORMAL SUBJECTS

Subject	Material Used	Time to Initial Appearance (hr.)	Time to Maximal Appearance (hr.)	Time to Final Appearance (hr.)	% Recovery
1	Cr_2O_3	10	35	68	80
2	Cr_2O_3	17	41	95	80
3	Cr_2O_3	19	34	89	80
4	Cr_2O_3	22	35	72	80
5	Cr_2O_3	32	49	91	73
6	Cr_2O_3	41	41	96	88
7	$\text{Na}_2\text{Cr}_2\text{O}_7$	24	67	91	100
8	$\text{Na}_2\text{Cr}_2\text{O}_7$	24	73	165	85
9	$\text{Na}_2\text{Cr}_2\text{O}_7$	26	117	145	89
10	$\text{Na}_2\text{Cr}_2\text{O}_7$	28	46	95	80
	Mean Cr_2O_3				80.2
	Mean $\text{Na}_2\text{Cr}_2\text{O}_7$				88.5

FIG. 1. Excretion of Cr^{51} by two subjects. The points represent the percentage of the total dose excreted in each stool specimen passed after administration of Cr^{51} . The arrows indicate the maximum percentage excretion in the two subjects.

RESULTS

Table I presents the results of the study. The mean percentage recovery of radioactivity in the 10 experiments was 83.5% and the range 73% to 100%. The mean recovery of chromic oxide was 80.2% and that of sodium chromate 88.5%.

There was a wide variation in the time taken for the marker to appear, the time taken for it to disappear, and the time taken for the maximum quantity of radioactivity to be excreted. Eight of the 10 subjects excreted the total recoverable dose within 96 hours. For the 10 subjects, the mean percentage of marker excreted in 24 hours was 22.4%, in 48 hours 54.3%, and within 96 hours 76.1%. While the time of appearance and disappearance of the marker may be very similar on two different occasions, the time to reach the maximum quantity may vary widely. Figure 1 illustrates this and presents the excretion of Cr^{51} in two different subjects. In one subject the time to reach the peak was 73 hours and in the other 117 hours. There was therefore an important difference in the handling of the marker which would not have been demonstrated using older methods of study.

COMMENT

This method permits quantitative measurement of several parameters of gastrointestinal transit. It has the advantage of being physiological, and as far as is known, neither chromic oxide nor sodium chromate have any action on the alimentary tract (Whitby and Lang, 1960; Roche, Perez-Gimenez, Layrisse, and Di Prisco, 1957). More important, it permits the measurement of the rate of passage of the maximum bulk of the marker which cannot be done using current methods such as barium or carmine which give information only about the rate of passage of the head and tail of the column.

Alvarez and Freedlander (1924) gave coloured glass beads to the subjects to estimate transit and showed that normal subjects passed 15% in 24 hours, 50% in 48 hours, and 75% in 96 hours. In so far as a comparison can be made, our results agree with those of Alvarez.

Another important use of an unabsorbable marker is in absorption studies, and recently Wiggins and Dawson (1961) have used polyethylene glycol and phenol red as a marker in studies of fat absorption. Radioactive chromium is advanced as a simple and quantitative alternative to the chemical substances at present available as markers in gastro-intestinal study.

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REFERENCES

- Alvarez, W. C., and Freedlander, B. L. (1924). The rate of progress of food residues through the bowel. *J. Amer. med. Ass.*, **83**, 576-580.
- Cameron, A. D. (1960). Gastro-intestinal blood loss measured by radioactive chromium. *Gut*, **1**, 177-182.
- Mulinos, M. G. (1935). The value of selective drugs in the treatment of constipation. *Rev. Gastroent.*, **2**, 292-301.
- Roche, M., Perez-Gimenez, M. E., Layrisse, M., and Di Prisco, E. (1957). Study of urinary and fecal excretion of radioactive chromium Cr^{51} in man. Its use in the measurement of intestinal blood loss associated with hookworm infection. *J. clin. Invest.*, **36**, 1183-1192.
- Whitby, L. G., and Lang, D. (1960). Experience with the chromic oxide method of fecal marking in metabolic balance investigations on humans. *Ibid.*, **39**, 854-863.
- Wiggins, H. S., and Dawson, A. M. (1961). An evaluation of unabsorbable markers in the study of fat absorption. *Gut*, **2**, 373-376.