this nature. This tolerance should be sufficiently large to cover uncontrollable factors that enter into the molding, but not too large as to impair the accuracy of dosage.

This paper is not intended to offer any suggestions in the manufacture of hand-molded hypodermic tablets. It merely shows what variations take place in the molding of tablets by the comparison of various yields, and what problems confront the manufacturer, endeavoring to turn out a uniform product.

ANALYTICAL AND CONTROL LABORATORY,
DIRECT SALES COMPANY, INC.,
BUFFALO, NEW YORK.

DETERMINATION OF THE REASONABLE OR PERMISSIBLE MARGIN OF ERROR IN DISPENSING. IV. PILLS.

BY MARVIN J. ANDREWS.

(*Continued from page 1122, November Journal.*)

For the purpose of making it possible to compare the results presented in Tables Nos. I to III with similar data that may have been published, but which have not been expressed in terms of the standard deviation, the per cent of deviation from the average has been calculated and is given in Tables IV, V and VI.

TABLE IV.—PERCENTAGE DEVIATION FROM THE AVERAGE WEIGHT OF PILLS PREPARED IN FILLING PRESCRIPTION NO. 1.

Batch Number.	Av. Wt. of Batch in Gm.	Number of Pills in Each Batch That Deviate from the Average Weight by— 5% or Less.	From 5% Plus to 10%.	From 10% Plus to 15%.	From 15% Plus to 20%.	Over 20%.
1	3.969	8	2			
2	3.873	10				
3	4.110	3	3	4		
4	3.532	6	3	1		
5	4.300	5	1	2	2	
6	3.725	10				
7	3.870	8	1	1		
8	3.594	2	7	1		
9	3.875	10				
10	3.650	3	2	3	2	
11	3.600	9	1			
12	3.540	7	2			1
13	3.475	6	1	2	1	
14	3.700	1	7	2		
15	3.577	4	3	3		
16	3.685	6	3	1		
17	3.680	3	5	2		
18	3.750	7	3			
19	3.770	4	2	2	2	
20	3.538	4	6			
21	3.402	4	4	2		
22	3.620	10				
23	4.483	7	2	1		
24	3.932	9			1	
25	3.573	10				
26	3.570	8	1		1	

27	3.563	8	1			1
28	3.740	9		1		
29	3.670	5	5			
30	3.770	7	3			
31	3.820	7	1	2		
32	3.730	4	3	3		
33	3.701	5	1	3	1	
34	3.280	7	3			
35	4.250	10				
36	4.100	10				
37	4.170	1	4	5		
38	3.342	10				
39	3.562	5	4	1		
40	3.492	3	2	2	2	1
41	3.620	2	5	1	2	
42	3.585	6	2	1	1	
43	3.677	6	4			
44	3.750	7	2	1		
45	4.001	5	3	1	1	
46	3.765	2	4	4		
47	3.595	3	4	2		1
48	3.680	5	4	1		
49	3.735	8	2			
50	3.940	3	5	2		
51	3.650	10				
52	3.500	6	2	2		
53	3.670	4	5	1		
54	3.591	3	7			
55	3.585	7	3			
56	3.572	4	4	2		
57	3.982	7	3			
58	3.575	7	3			
59	3.590	5	4	1		
60	3.530	6	1	1	1	1
61	3.575	10				
62	3.452	10				
63	3.439	5	4	1		
64	3.390	3	3	2	1	1
65	3.967	4	4	1	1	
66	3.590	6	2	2		
67	3.480	4	5	1		
68	3.735	7	2	1		
69	3.350	7	1	1	1	
70	3.652	5	2	2		1
71	3.350	8	1		1	
72	3.530	7	3			
73	3.395	3	3	2	2	
74	3.410	4	3	1	1	1
75	3.750	4	5	1		
76	3.900	8	1	1		
77	3.570	4	4	1	1	
78	3.685	8	2			
79	3.592	7	1	2		
80	3.550	10				
81	3.275	7	1	2		
82	3.970	3	3	4		

83	3.805	8	2			
84	3.370		7	3		
85	3.575	8	1	1		
86	3.460	5	2	2	1	
87	3.520	8		2		
88	3.750	5	3	1	1	
89	3.502	3	6	1		
90	3.540	10				
91	3.650	7	3			
92	3.490	8	2			
93	3.871	10				
94	3.565	6	2	2		
95	3.190	7	3			
96	3.580	6	4			
97	3.665	8	2			
98	3.502	5	2	2	1	
99	3.650	7	3			
100	3.530	4	2	2	2	
	Totals	610	247	105	30	8

TABLE V.—PERCENTAGE DEVIATION FROM THE AVERAGE WEIGHT OF PILLS PREPARED IN FILLING PRESCRIPTION NO. 2.

Batch Number.	Av. Wt. of Batch in Gm.	Number of Pills in Each Batch That Deviate from the Average Weight by— 5% or Less.	From 5% Plus to 10%.	From 10% Plus to 15%.	From 15% Plus to 20%.	Over 20%.
1	4.352	7	2	1		
2	4.920	5	2	2	1	
3	4.675	7	2	1		
4	5.165	7	1	1	1	
5	5.015	7	3			
6	5.425	9	1			
7	4.430	5	2	3		
8	5.060	8	2			
9	4.820	8	2			
10	4.440	8	1	1		
11	4.470	6	3	1		
12	5.037	7	2	1		
13	4.950	10				
14	5.245	10				
15	4.992	5	4	1		
16	4.710	6	2	1	1	
17	4.520	4	6			
18	5.535	7	3			
19	5.852	3	6		1	
20	5.435	3	2	4		1
21	4.800	5	4	1		
22	5.110	6	4			
23	5.115	4	5	1		
24	5.655	3	5		1	1
25	4.835	10				
26	4.300	8	2			
27	4.097	5	2	2	1	
28	5.065	3	3	2	2	
29	5.560	5	5			
30	5.168	5	3	2		

31	4.840	8	1	1		
32	4.725	5	3	2		
33	4.600	5	2	3		
34	5.290	7	3			
35	4.757	5		4	1	
36	4.450	9	1			
37	3.150	10				
38	5.300	4	6			
39	5.469	8	2			
40	3.451	4	5	1		
41	4.652	6	2	1	1	
42	4.950	8	1	1		
43	4.660	7	2	1		
44	4.520	7	3			
45	5.000	5	5			
46	4.900	1	7	2		
47	4.895	7	3			
48	4.605	5	2	2	1	
49	4.757	3	5	2		
50	5.180	1	5	3		1
51	5.120	9	1			
52	4.945	7		2	1	
53	5.000	9				1
54	4.810	7	2	1		
55	5.075	7	3			
56	4.885	8	1	1		
57	5.100	5	3	2		
58	4.895	8	2			
59	4.950	7	3			
60	5.165	8		1	1	
61	4.975	10				
62	4.425	7	3			
63	5.090	7	1	1	1	
64	4.889	8	1	1		
65	4.795	6	3	1		
66	5.277	8	2			
67	4.387	8	2			
68	4.954	10				
69	4.647	4	3	2	1	
70	4.850	8	1	1		
71	4.845	5	5			
72	5.210	3	5		1	1
73	3.880	4	1	4	1	
74	4.420	3	5	2		
75	4.509	5		5		
76	4.390	6	2	1	1	
77	4.340	5	5			
78	4.800	9		1		
79	5.175	9	1			
80	5.020	3	7			
81	4.930	7	3			
82	4.740	8	1			1
83	3.700		5	5		
84	5.120	8	2			
85	4.890	7	1	2		
86	4.000	6	2	1	1	

87	5.100	7	1	1		1
88	4.640	2	7	1		
89	4.889	10				
90	4.825	6	3	1		
91	4.500	4	2	4		
92	4.840	10				
93	5.305	10				
94	6.755	9	1			
95	4.920	6	3	1		
96	4.650	3	1	4	1	1
97	4.550	4	4	1	1	
98	4.700	5	3	2		
99	4.360	6	2	2		
100	4.350	4	3	3		
Totals		626	243	102	21	8

TABLE VI.—PERCENTAGE DEVIATION FROM THE AVERAGE WEIGHT OF PILLS PREPARED IN FILLING PRESCRIPTION NO. 3.

Batch Number.	Av. Wt. of Batch in Gm.	Number of Pills in Each Batch That Deviate from the Average Weight by— 5% or Less.	From 5% Plus to 10%.	From 10% Plus to 15%.	From 15% Plus to 20%.	Over 20%.
1	6.075	4	2	4		
2	3.865	10				
3	3.710	3	6	1		
4	7.010	7	3			
5	7.065	6	4			
6	5.015	6	1	2	1	
7	5.775	6	4			
8	5.260	7	1	1		1
9	5.460	8	1	1		
10	6.370	9	1			
11	5.075	10				
12	5.470	6	2	1	1	
13	5.097	5	3	1	1	
14	5.675	7	2		1	
15	6.750	9	1			
16	5.808	3	3	4		
17	5.042	8	2			
18	4.840	4	5	1		
19	5.300	6	3	1		
20	5.895	9		1		
21	6.246	7	3			
22	4.878	3	5	2		
23	5.604	5	4	1		
24	6.195	3	7			
25	6.552	5	2	3		
26	7.040	10				
27	3.890	6	2	1	1	
28	7.360	4	4	1	1	
29	5.450	5	2	2	1	
30	7.450	4	4	2		
31	7.380	10				
32	6.330	6	2	2		
33	6.437	8	1	1		
34	5.755	5	5			

35	6.473	6	2	1	1	
36	6.089	8	2			
37	7.120	10				
38	5.625	9	1			
39	5.110	2	8			
40	8.155	8		1		1
41	5.880	7	3			
42	5.702	4	3	2		1
43	5.230	5	5			
44	7.110	7	3			
45	5.667	2	7	1		
46	5.385	3	3	4		
47	5.150	8	1		1	
48	6.200	5	5			
49	5.210	5	4			1
50	6.100	6	4			
51	6.550	4	3	3		
52	3.300	10				
53	5.505	8	2			
54	4.900	10				
55	6.102	5	4	1		
56	5.680	7	3			
57	7.940	5	4	1		
58	8.870	7	3			
59	5.395	4	4	1	1	
60	5.360	7	3			
61	6.330	7		2		1
62	5.615	10				
63	5.620	8	2			
64	6.000	4	6			
65	5.900	8	1	1		
66	5.130	7	2	1		
67	4.350	7	2			1
68	4.790	10				
69	6.625	5	3	2		
70	4.620	10				
71	5.130	6	3	1		
72	5.670	9	1			
73	7.870	7	2	1		
74	6.445	4	3	1	2	
75	4.650	4	3	1	1	1
76	5.500	4	3	2	1	
77	5.176	8	1		1	
78	5.170	3	4	3		
79	5.670	5	5			
80	5.385	3	6	1		
81	5.960	8	2			
82	4.485	4	6			
83	5.675	6	3	1		
84	4.794	6	4			
85	5.330		5	5		
86	5.445	10				
87	4.640	4	4	2		
88	4.312	6	2	1	1	
89	4.900	5	4		1	
90	5.501	4	5	1		

91	4.834	10				
92	5.740	7	3			
93	4.005	6	2	1	1	
94	4.770	10				
95	7.908	10				
96	5.320	10				
97	5.960	6	1	1	1	1
98	4.310	5	4	1		
99	4.590	5	4			1
100	5.910	7	2	1		
	Totals	634	260	78	19	9

It will be observed on examining Tables IV, V and VI that a variation of 15 per cent from the average weight will include the majority of all the pills compounded in this series of tests. A summary of the results based on the per cent deviation from the average weight is given in Table VII.

TABLE VII.—SUMMARY OF RESULTS SHOWING THE NUMBER OF PILLS DEVIATING FROM THE AVERAGE WEIGHT AND THE PERCENTAGE OF DEVIATION.

Prescription Number.	Number of Pills Deviating from the Average Weight by— 5% or Less.	From 5% Plus to 10%.	From 10% Plus to 15%.	From 15% Plus to 20%.	20% or Over.
1	610	247	105	30	8
2	626	243	102	21	8
3	632	262	78	19	9

The foregoing results compare favorably with those reported by Dr. Robert L. Swain in a paper entitled "Prescription Accuracy by State Board of Pharmacy Examinations—A Preliminary Study" (JOUR. A. PH. A., 22 (1933), 1259). On calculating the percentage deviation based on the average weight of each batch of pills reported by Dr. Swain to be satisfactory, we find that 82.8 per cent fell within 10 per cent; 13.6 per cent fell between 10 and 15 per cent; 2.5 per cent fell between 15 and 20 per cent; while the remaining 1.07 per cent were over 20 per cent.

THE EFFECT OF TIME ON THE WEIGHT OF FRESHLY PREPARED PILLS.

In the first series of tests the pills were weighed the same day they were prepared. In this series of tests each batch of pills made for the first series of tests was weighed to determine the loss in weight on standing. These pills had been stored in ordinary pasteboard pill boxes for periods of one and two weeks.

The results of these weighings are given in Table VIII.

TABLE VIII.—AVERAGE WEIGHT OF 100 BATCHES OF PILLS AFTER STANDING FOR PERIODS OF 1 AND 2 WEEKS.

Prescription Number.	Average Weight of 100 Batches of 10 Pills Each on Day Prepared.	1 Week Later.	2 Weeks Later.	Average Loss in Weight Over a Two-Week Period.
1	3.659 Gm.	3.292 Gm.	3.204 Gm.	0.455 Gm.
2	4.795 Gm.	4.771 Gm.	4.731 Gm.	0.064 Gm.
3	5.689 Gm.	5.601 Gm.	5.501 Gm.	0.189 Gm.

CONCLUSIONS.

1. The factors largely responsible for the variation in the weight of pills made by pharmacists are (1) the nature of the excipient used, (2) the amount of care exercised in compounding, and (3) the length of time which is permitted to elapse before the pills are weighed.

The nature of the excipient used is not responsible for the variation in the weight of individual pills of the same batch, but is probably the principal cause for difference in the weight of batches of pills made by different individuals.

2. From the data obtained in the tests made it would seem that twice the average standard deviation is a reasonable margin of error for weight. This margin will cover 99 per cent of the batches of pills made in filling prescriptions Nos. 1 and 3, and 96 per cent of the batches made in filling prescription No. 2. Expressed in terms of percentage, a margin of error of 13.1 per cent variation from the average weight would cover all the above cases. From this it is concluded that a margin of 15 per cent deviation from the average weight would be reasonable and should be permitted.

(To be continued.)

A STUDY OF THE EMPTYING TIME OF THE STOMACH WITH REFERENCE TO PILLS AND TABLETS.*

BY F. S. BUKEY AND MARJORIE BREW.

The results reported in this paper have been obtained from a rather extensive study of enteric coatings. By use of the X-ray, many interesting facts were found concerning the length of time pills, tablets and capsules remain in the stomach.

Early investigators have stated that pills would remain in the stomach from one to six hours. However, the consensus of opinion was that from one to three hours was the normal emptying time. The X-ray studies indicate that six hours is about the average emptying time.

Apparently, size and shape of pills or tablets has little to do with the length of time they remain in the stomach. Pills of 7.2 mm., 5.9 mm. and 3.9 mm. in diameter, and compressed tablets of 10.5 mm. in diameter and 4.8 mm. in thickness were used. Also square tablets 10 mm. by 10 mm. and 5 mm. in thickness and rectangular tablets 12.5 mm. by 8.5 mm. by 3.5 mm. were given. The tablet and pill masses contained $BaSO_4$ in order that they might be observed by X-ray. In cases where the individuals were given nine pills, three of 7.2 mm. in diameter, three of 5.9 mm. in diameter and three of 3.9 mm. in diameter, it was not uncommon to find that the larger pills left the stomach first.

The subjects used in the study were normal and apparently in good health. The same individual was used repeatedly in order to determine individual variation. These individual variations made it almost impossible to state a general rule on

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* Section on Practical Pharmacy and Dispensing, A. PH. A., Washington meeting, 1934.