This magazine is published to promote sound thought upon and concerning industrial medicine and traumatic surgery. To that end it will contain articles, news items, reports, digests, and other presentations, together with editors' comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited.

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Benzol Poisoning

—Method for Its Control in a Light Chemical Plant—

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THERE is no need to emphasize the seriousness of chronic benzol poisoning to anyone who has become acquainted even with the bare rudiments of its nature. In any plant where benzol is handled, the necessity for some system of control can generally be conveyed to the management by the proper educational approach, but there may not be complete unanimity, even among industrial hygienists and industrial physicians, concerning the best "method" of control. Analysis of air samples collected in the plant is one valuable control procedure; the determination of the organic-inorganic sulfate ratio in the urine of exposed workmen is a useful supplement to it. Both of these measures are well adapted to reveal exposure to benzol, but neither gives any idea of whether the exposure has produced damage to the blood-forming tissue in the bone marrow. In a complete benzol-control program, therefore, these chemical procedures must be supplemented by periodic medical examinations, and, in such examinations, the periodic blood-count appears as the most important single feature.

There may be some who believe that with adequate engineering—with all benzol handled in closed systems or in well-ventilated locations—no health hazard can exist. These persons, if there be any, would then consider periodic medical examinations superfluous. However, in the case reported by Hunter,' fatal poisoning was attributed to an unbelievably small exposure to benzol, and the recording of this case in the literature has unmistakable medicolegal implications, whether one is prepared to agree with the diagnosis or not.

As to the efficacy of engineering safeguards, it can never be absolute—not as long as there are pumps that spring leaks, or pipes that burst, or workmen who spill things on tht floor, or fans that break down, or painters who have discovered benzol is an excellent dish cleaner. easily obtainable by the pailful from the "friend" over in "the plant." As long as there are any of these factors operating, good engineering is not enough: there must also be medical supervision and constant vigilance by a safety organization. It is the rule to assume that anywhere benzol is handled, benzol will be absorbed. Where benzol is absorbed, sooner or later there will be a workman who is susceptible to the poison. The only way to detect this early is to make periodic blood counts, and to have them interpreted by a physician who understands benzol poisoning.

To recognize an abnormal blood count, it is necessary to have a very definite idea of what constitutes a normal one. Like so many other factors met with in biology;, this one has a certain vagueness that may irritate the worker in more esact sciences. Textbooks on clinical pathology usually give tables which express in round numbers the "normal" values for blood counts. but such figures are practically meaningless because they give no idea of the range or the limits of normal.

One of the most complete and easily understood methods for indicating the exact range of any biological characteristic is the frequency-distribution curve, which usually takes the familiar bell shape shown in Fig. I. The quantities measured along the X-axis can be any characteristic one wishes; the Y-axis is used

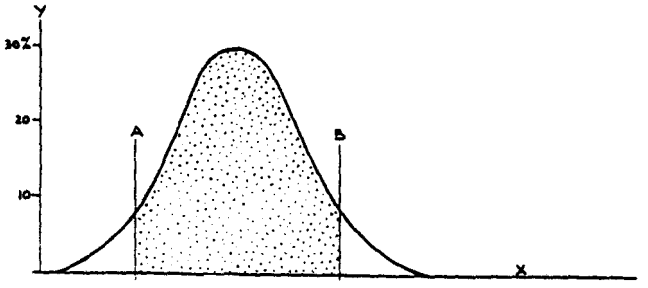

Fig. 1.

to indicate the percentage of persons in the group who possess any given value of the characteristic which is under investigation. One can choose any arbitrary limits, such as the lines A and B, on either side of the peak of percentages. and can call these the limits of normal. The shaded area between these limits. lying under the curve. will then indicate how big a part of the group under investigation may be called "normal." The small unshaded areas remaining under the curve represent that part of the group which is arbitrarily called "abnormal." The choice of the limits A and E is arbitrary: it can only be made after study of the curve. and it will be influenced by a number of practical consideration-.

To apply thi: method to blood counts. a frequency-

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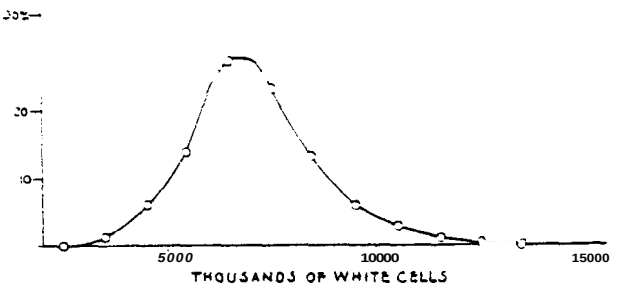

Fig. 2.

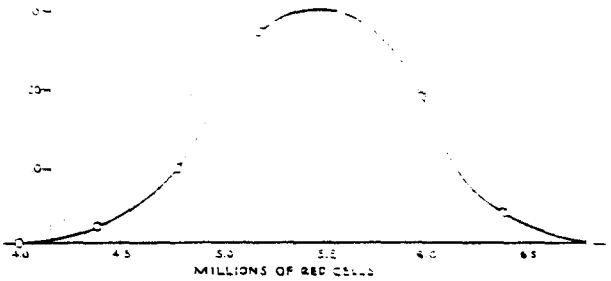

fig. 3.

distribution curve may be constructed for the particular factory population to be studied. Blood counts should be made on **a** large number of employees apparently in good health and not exposed to any known bone-marrow poisons. Fig. 2 shows **a** frequency distribution curve for values of the white cell count found by Osgood[2] in normal adults. It will be noted that this curve varies from the typical bell shape, especially in its right hand branch. This merely indicates that white counts higher than 7000 are more common than those below 7000.

A similar curve for values of the red cell count in the same group is shown in Fig. **3.**

By plotting curves like these for the normal members of any factory population. **a** proper notion of what constitutes a "normal" blood count can he approached. and one is then prepared to pass judgment on the blood counts of those exposed to benzol.

In the Xbbott Laboratories chemical manufacturing division, there is **a** group of 100 to ***200*** men who may, at one time or another, come in contact with benzol. Periodic blood counts have been made on these men regularly for the past three years. One man's record for that period is shown in Table I. Such a record is **of** great value when any question concerning the status of the particular individual comes up, and this sheet is therefore kept with the man's individual chart. However, records of this kind can give only a completely confused idea of what is happening in the plant as a whole. For this reason, it was necessary to devise some simple means of coding these blood counts so that they could be recorded on **a** single master chart.

After some thought, it was decided to set arbitrary values for a blood count that would be indisputar "normal."

These were as follows :

1. White cell count above 6.000.
2. Red cell count above **4.50** million.
3. Hemoglobin above 12.0 pm. 100 cc.
4. ***So*** immature or abnormal red **or** white cells.

Next, values were set for ***a*** blood count thnt wou. indisputably show a depression of the bone-marrow These were :

1. White cell count below 5.000, *or*
2. Red cell count below **3** million. *or*
3. Polymorphonuclear cells below 30%, *or*
4. Any immature or abnormal red or white cells.

Values in between these two limits were to be liste as "suspicious." On the master chart. ■ section which is shown in Fig. 4, the names of all men expose to benzol were listed in alphabetical order in the lef hsnd column. Across the top were printed the month of the year. Each blood count was recorded as a sing mark. red for an abnormal count, blue for a suspicious count, and black for **a** normal count. The mark wa placed under the name of the month in which the coun was made. and the space for each month was left wid enough so that the position of the work from right t left could indicate almost the esact date of the blo count. By telescoping the space. blood counts for pr- vious years could be recorded in separate columns t the left. It will be apparent **at** once that **a** number facts can be gathered by the simple inspection of su **a** chart. By scanning the line opposite any man's nam from left to right, one can check whether he has ha his periodic counts at regular intervals or not. If he shows an abnormal count, the character of preceding countscan be known immediately by the color of the marks used to designat them. Finally, the approximate date when the nex count is due can **be** determined; this last feature is of great help to the nurs whose duty it is to call the men in at the proper times By scanning any month from **top** to bottom, one can determine whether there **is** an **unusual** large number **of** abnorma or suspicious **blood** counts this is **a** reflection **of** co ditions in the plant as a whole **during** that month and **will** point the way more rigid inspection stronger enforcement safety rules, or better e gineering. The amount

TABLE I
BLOOD COUNT REPORT

NAME: John Doe DATE EMPLOYED: 2-12-34

FORMER OCCUPATION : Chemist, steel plant

Date	White Count	Differential White Count						Red cells x 10^6	Hemoglobin Gm. 100 cc.
		Neutrophils		Eosino	Baso	Lympho	Mono		
		Young	Mature						
10- 4-39	7,350	4	44	6	0	35	10	5.41	16.0
1-22-40	5,400	10	31	1	0	44	13	6.26	13.9
2-12-40	7,900	1	47	1	3	35	8	6.02	15.0
5-31-40	5,950	1	64	3	0	26	6	4.72	15.0
8-28-40	6,150	5	35	6	0	47	7	4.99	14.0
10-31-40	5,950	1	19	4	1	37	7	5.26	15.5
12-19-40	7,100	7	40	5	2	36	7	4.78	14.5
2- 3-41	10,850	18	40	3	3	27	5	4.96	14.5
3-27-41	8,150	2	69	3	1	21	4	4.89	14.0
7- 2-41	6,600	0	55	2	0	40	3	4.80	15.0
10-21-41	6,700	3	50	1	1	43	2	4.60	17.0
1-15-42	6,100	6	52	2	2	30	8	5.27	17.4
4-14-42	8,050	0	57	3	0	38	2	4.86	14.0
7- 9-12	6,700	0	63	4	1	30	2	4.58	15.5
10- 8-12	8,650	3	54	1	0	34	8	4.82	15.4
1-28-43	7,250	0	75	0	0	23	2	4.69	16.0

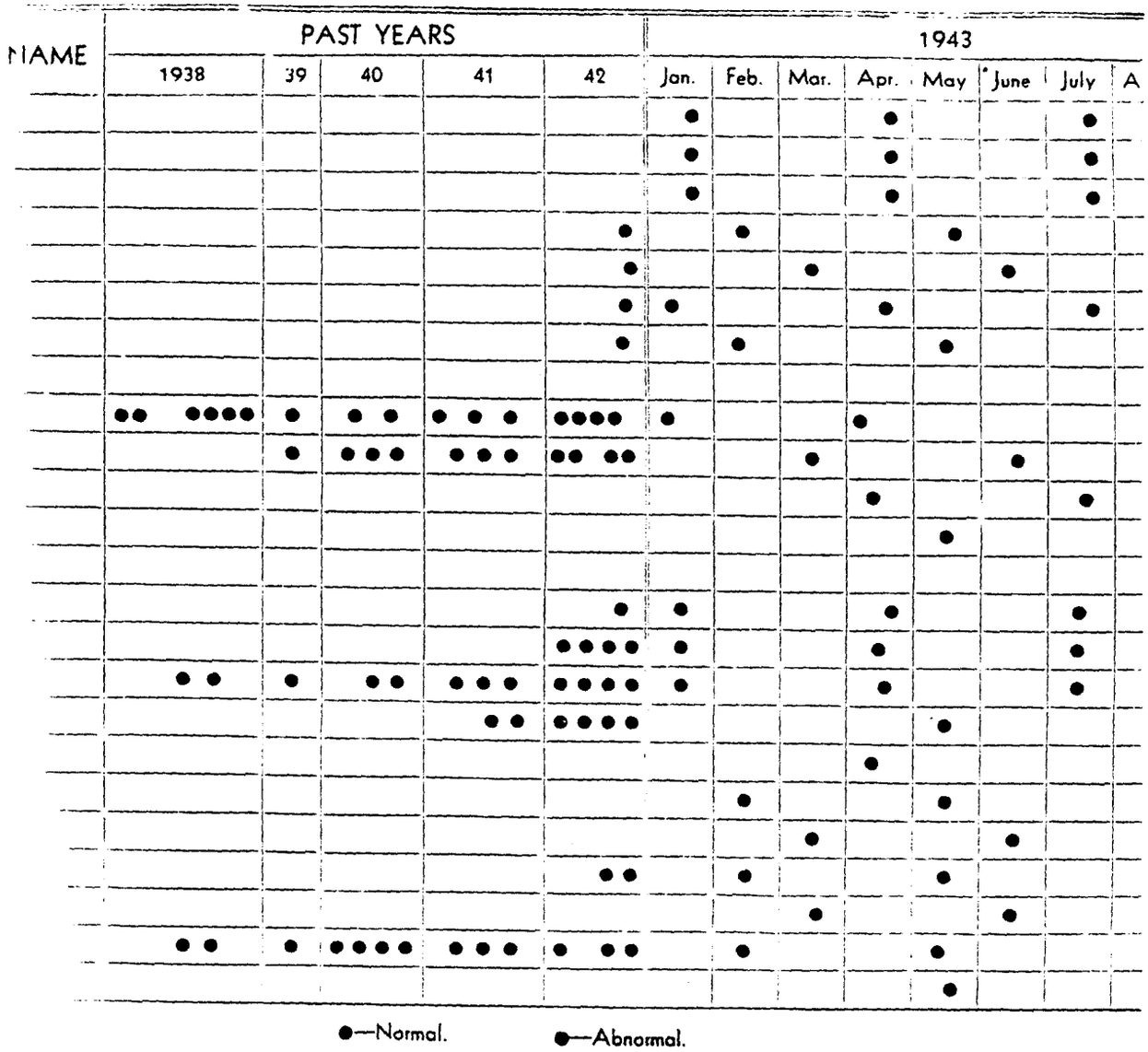

Fig. 4.

r blue showing on the chart at the end of the will be a fairly good measure of the success or of the benzol-control program.

se who advocate periodic blood counts for workxposed to benzol differ slightly in their recomions concerning the time interval which should between routine counts. The consensus is sometween one and two months. At Xbbott Laboraie routine interval is three months. but this nly to men who continue to show normal blood Any man showing a suspicious count must blood examined again in two months. and show abnormal counts are examined again or two weeks. If the count is abnormal after ount. the man is called in for an interview. mediately removed from all contact with benafter. his blood count is repeated weekly ies norma.. The few men who have shown abnormal counts have not been allowed to their former work even after they recovered. the three years this system has been in operimately 1300 blood counts have been made master chart. Five cases of incipient failure were detected. and all of these normal status after they were removed with the poison. The transfer of these whom were highly skilled and valuable workers, to other departments stimulated their superior officers to find and remedy a number of benzol hazards which they had formerly considered unimportant, and in this way general working conditions were improved so that there has not been a single red mark on the master chart for the past year.

Summary

THE necessity for a program of periodic examinations. with emphasis on blood counts. is asserted to exist in any industry where benzol is handled no matter what other safeguards surround the process.

2. To simplify the recording of these blood counts. and to obtain an over-all estimate of the benzol control program. a system is proposed for classifying blood counts as "normal." "suspicious" or "abnormal." and for recording them on a single sheet by single marks of three different colors.

3. Application of this system to a light chemical manufacturing plant where benzol is extensively used has detected five cases of incipient benzol poisoning early enough to permit complete recovery.

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2. OSGOOD, E. E., [illegible]: Normal Hematologic Standards, *Arch. Int. Med.*, 56:484, 1935.