PHILLIPS' (W. F. R.)

METEOROLOGICAL CONDITIONS OF SUNSTROKE.

BY

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SUNSTROKE, insolation, heatstroke, and other more or less etiologically significant names are used to denote certain morbid phenomena which are generally understood to be produced or excited by heat, either natural or artificial. The word sunstroke is the one most frequently met with in both medical and popular literature, and for this reason will be generally adopted in this paper.

In order to avoid any misconception that might arise from the use of the term sunstroke as it is generally defined, it is necessary to state that throughout this paper it is used in a restricted sense, and has reference only to sunstroke as seen in temperate climates and to those cases that are apparently excited by abnormal meteorological conditions. Those cases that are due to artificial heat, such as the heated atmosphere of boiler-rooms and the like, although pathologically identical with those produced by general atmospheric conditions, cannot properly be considered as coming within the purview of this paper; but in dealing with very extensive collections of statistics it will not be found practicable to exclude all such cases from those dependent upon the general condition of the weather. It seems also necessary to acknowledge that the line of demarcation cannot be sharply drawn between sunstrokes of purely meteorological causation and those of partly or purely artificial origin. Undoubtedly many cases of sunstroke have their inception in local sur-

roundings, but become manifest as such after removal from the primary excitant—*e. g.*, a man working in a hot furnace-room may, after leaving it apparently well, be overcome under atmospheric conditions but slightly abnormal. Cases of this and of other sorts, which will doubtless immediately suggest themselves to you, render the study of the meteorological aspect of sunstroke very difficult and perplexing.

It seems that, in order to reach any trustworthy opinion as to the meteorological conditions influencing or producing sunstroke, it is necessary to assume some arbitrary basis or standard as to what shall constitute the presumption that the weather was the principal etiologic factor in originating the case in question.

In arriving at the conclusions to which it is the purpose of this paper to invite your attention, the author has assumed, as the necessary presumptive evidence of meteorological influence, the coincidence of the following conditions, viz.: that (*a*) the weather must be noticeably abnormal in some particular, (*b*) the number of sunstrokes must be sufficiently great to attract public attention, (*c*) the sunstrokes must not be confined to any particular class, trade, or occupation, or to the occupants of any one shop, office, or other structure, and (*d*) they must not be confined to a particular spot, but must occur throughout the locality subjected to the abnormal weather. Although it may not be strictly correct to use the term epidemic in connection with sunstroke, yet when the conditions just enumerated are complied with the writer will, in order to facilitate reference, speak of such compliance as constituting an epidemic of sunstroke. If this explanation regarding the use of the term epidemic be kept in mind, no confusion or misunderstanding will occur.

It will, perhaps, not be out of place to close this introduction by a brief statement of the generally accepted doctrine concerning the meteorological causation of sunstroke. The following appear to be the chief points of agreement among modern writers:

The sole efficient cause of sunstroke is heat, either as the

result of direct exposure to the sun's rays or to a high atmospheric temperature in the shade.

The particular degree of atmospheric temperature that may be considered one of great danger is difficult to fix because of the great tolerance of heat by persons in perfect health.

The action of heat is much influenced by the hygrometric condition of the atmosphere. A dry, hot air, it is claimed, is better tolerated than a moist one at a lower temperature, because it favors perspiration, and thereby keeps the body cool, while damp air diminishes evaporation and the refrigerating processes of the body.

Impure air is an important factor, as are also personal hygienic conditions and surroundings.

The injurious effects of heat are primarily exerted upon the nervous system.

In opposition to the importance of high relative humidity has been placed the rare occurrence of sunstroke at sea, the cases recorded having been stated to have occurred generally at night and between decks where the ventilation was extremely bad.

The special purpose of this paper is to call attention to certain facts discovered in the course of an investigation of the sunstroke epidemic of August, 1896, and to certain conclusions that seemed warranted by the facts disclosed. This investigation was made by the direction of the chief of the Weather Bureau, and the facts ascertained thereby were published in a paper contributed to the *Monthly Weather Review* for November, 1896, of which the following is a synopsis:

During the first part of August, 1896, there prevailed over a large part of the United States an exceptionally severe and prolonged period of hot weather, and during the same period there occurred a great many cases of sunstroke. This hot weather and the coincident sunstrokes were particularly severe in the Middle Atlantic and Central States. In response to a circular sent out by the Weather Bureau, information was obtained of 2038 deaths from sunstroke; 1817 of these were reported by the health officials of the localities in which they

occurred, and the remainder were obtained from what seemed fairly trustworthy sources. The cities of Boston, New York, Brooklyn, Philadelphia, Baltimore, and Washington furnished a total of 1461, and St. Louis and Chicago a total of 310 deaths. In addition to the number of deaths from sunstroke, there were obtained from a number of hospitals and physicians more or less complete histories of 841 cases of sunstroke. A comparison of the meteorological and sunstroke statistics showed that: (*a*) The number of sunstrokes was greatest from August 9th to August 12th. (*b*) The daily mean temperatures were highest during the same period, and were from 10° to 13° above the normal for the month of August. (*c*) The absolute humidity was at its maximum during these four days. (*d*) The relative humidity was above the normal in the Central States and below the normal in the Middle Atlantic States. The other recorded meteorologic conditions—*i. e.*, pressure, wind, rain, and state of weather—did not show any features that could be regarded as significant.

These facts seemed to warrant the following conclusions: (*a*) That the number of sunstrokes follows more closely the excess of the temperature above the normal than it does that of any other meteorologic condition. (See Tables A and C, and diagram.) (*b*) That the number of sunstrokes does not appear to sustain any specific relation to the relative humidity, the maximum having occurred in one region with a relative humidity above the average, and in the other region with a relative humidity decidedly below the average. (See Tables A, B, and D, and diagram.) (*c*) That, although the absolute humidity was greatest during the maximum of sunstrokes, yet it does not appear that its variations influenced the number of cases. (See Table E.)

The only conclusion enunciated that above conflicts strongly with accepted ideas is that regarding the influence of relative humidity of the atmosphere.

Inasmuch as the course of the temperature was the meteorologic condition that appeared most intimately associated with the increase and decrease in the number of sunstrokes, the

attempt was made to determine what degree of atmospheric temperature was necessary or likely to give origin to sunstroke. It was noticed that sunstrokes were reported in Boston when the average temperature of the day reached 82°, or 13° above the August normal. On the other hand, it was observed that the normal August temperature for New Orleans was 82°, and that, too, without any sunstrokes. Therefore, it was evident that sunstrokes were not excited by the same degree of temperature in every locality; and, for reasons not necessary to enumerate, it was assumed that each particular locality had for its native or acclimated inhabitants a special local sunstroke temperature or range of temperature. The next step, therefore, was to ascertain, if possible, whether this particular local temperature, or climatic sunstroke temperature, as it may be called, was capable of expression as a climatological function. With this object in view, a careful examination of the temperatures prevalent during the sunstroke period appeared to show that there was empirical evidence for adopting as a provisional index to the sunstroke temperature of each climate its normal daily maximum temperature. Applying this provisional standard to the cases of sunstroke as reported in the cities of New York, Boston, Philadelphia, and Washington, the following results were obtained:

In New York City 96 per cent. of the cases occurred with daily mean temperatures equal or nearly equal to the normal maximum temperature for August, the period in question. In Boston and Philadelphia 91 per cent., and in Washington 77 per cent. of the cases occurred under like conditions of temperature. In the light of these results, the following working hypothesis was proposed:

Sunstroke becomes imminent during the summer months when the mean temperature of any one day or of several consecutive days becomes equal or nearly equal to the normal maximum temperature for the period.

In order that the Association may judge as to the validity of the foregoing conclusions and hypothesis, the statistics

upon which they were based are submitted in the appended tables.

Inasmuch as the foregoing facts and conclusions seem resolvable into the generally accepted proposition that heat is the sole efficient cause of sunstroke, the chief point of interest centres in determining what degree of atmospheric temperature is likely to produce in a given community an epidemic of sunstroke. I think we may safely assume that while humidity, relative and absolute, wind, and atmospheric pressure may, under special conditions, be very important to a particular individual, they are as causative factors of sunstroke as a widespread event or epidemic obscured, and sink into insignificance in comparison with the overwhelming effect of high atmospheric temperature or intense direct insolation.

Taking this view of the subject, I have endeavored to find, by using such statistics for other years as were accessible, how far the hypothesis stated could be depended upon as a criterion of impending danger from sunstroke, with the result that it appears to be a fairly good index for the eastern and central parts of the United States. But it is to be remembered that, although it embodies certain plausible climatological considerations, it was evolved simply as an empiricism based upon quite a large number of events, and that it does not rest upon a satisfactory knowledge of all the factors involved.

As a matter of possible interest, it may be stated that the fatality among the 841 cases previously referred to as reported by hospitals and physicians was 16.6 per cent., 140 cases having terminated fatally. It may also be interesting to state what appeared to be the influence of alcoholic beverages in determining both the incidence and fatality of the affection. Of the 841 cases the history of 465 as to the use of alcoholic drinks is given as follows:

Using to excess	140	cases, or 30	per cent.
" moderately	230	" 50	"
" not at all	95	" 20	"
Total	465	" 100	"
History unknown	376		
Total	841		

and of the 140 deaths that occurred the history of 70 is given as follows:

Using to excess	41	deaths, or	60	per cent.
" moderately	22	"	30	"
" not at all.	7	"	10	"
Total	70	"	100	"
History unknown	70			
Total	140			

TABLE A.—THE DAILY NUMBER OF CASES OF SUNSTROKE ADMITTED TO CERTAIN HOSPITALS OR TREATED IN THE PRACTICE OF CERTAIN PHYSICIANS FROM AUGUST 1 TO 20, 1896, INCLUSIVE, TOGETHER WITH THE RESULTING MORTALITY.

Places.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total cases.	No. of deaths.	Authority (hospital or physician).
Manchester, N. H.	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	1	Elliott Hospital.
Albany, N. Y.	...	...	...	...	...	...	...	1	...	4	5	5	...	...	...	...	...	...	...	...	15	3	Albany Hospital,
Rochester, N. Y.	...	...	...	...	...	...	...	2	...	...	...	...	...	1	2	...	...	...	...	...	5	...	Homœopathic Hospital.
Boston, Mass.	...	...	...	...	...	...	...	...	...	4	8	18	2	...	...	1	...	...	...	...	32	8	Boston City Hospital.
New Haven, Conn.	...	...	...	...	...	...	...	...	...	2	2	4	7	3	2	...	...	...	...	...	20	2	New Haven Hospital.
New York, N. Y.	...	...	...	2	3	9	5	12	15	49	78	106	64	9	5	...	...	...	...	...	357	62	Hudson Street, Roosevelt, and New York hospitals.
Brooklyn, N. Y.	...	...	...	...	...	2	4	8	5	11	26	32	11	2	2	...	...	...	...	...	103	22	St. John's, St. Mary's, and Brooklyn hospitals.
New Brunswick, N. J.	...	...	...	...	...	1	...	...	1	...	3	...	...	...	...	...	...	...	...	...	5	2	Drs. Williamson and Smith.
Philadelphia, Pa.	...	...	...	...	1	9	11	13	8	22	30	34	21	13	2	...	...	...	...	...	164	16	St. Agnes', Episc., Med.-Chir., and Hahn'n hosps.
Washington, D. C.	...	...	...	...	1	1	2	3	2	5	1	3	2	...	1	1	...	...	...	...	22	7	United States Government Hospital for Insane, Garfield, Providence, and Freedman hospitals.
Middle Atlantic States	...	...	...	2	5	22	22	39	31	97	154	202	107	28	14	2	...	...	...	...			
Pittsburg, Pa.	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	2	2	S. S. Hospitals.
Cincinnati, Ohio	...	...	3	2	2	4	2	8	4	9	7	...	1	2	3	...	...	...	1	...	48	5	U.S. Marine Hosp., St. Mary's, and Cincinnati hosps.
Columbus, Ohio	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	2	...	St. Francis' Hospital.
Cleveland, Ohio	...	...	...	...	...	...	...	...	4	4	1	...	...	...	...	...	...	...	...	...	9	2	St. Alexis', St. John's, and Huron Street hospitals.
Detroit, Mich.	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	2	...	United States Marine Hospital.
Holland, Mich.	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	Dr. Henry Kremeis.
Chicago, Ill.	...	..	...	2	1	1	1	6	3	1	1	...	...	2	1	...	...	...	...	...	19	4	St. Luke's, Mercy, and Michael Reese hospitals.
Springfield, Ill.	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	2	...	City Physician, Wabash Emp. Hospital.
Louisville, Ky	...	...	2	1	...	3	1	...	2	...	...	...	...	...	...	...	...	...	...	...	9	...	City Hospital.
Cairo, Ill.	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1	...	Dr. W. F. Grimsted.
Hannibal, Mo.	...	...	...	1	...	...	3	...	...	...	...	1	...	...	...	...	...	...	...	...	5	1	Drs. R. H. Godin, S. Q. Smith, P. L. Kabler.
Columbia, Mo.	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	1	1	...	Dr. W. A. Norris.
Kansas City, Mo.	...	...	...	...	...	1	...	...	2	...	...	...	...	1	...	...	...	...	...	...	4	1	Drs. W. S. Wheeler, L. A. Berger, C. L. Hall.
Des Moines, Iowa	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	Dr. F. L. Wells.
St. Paul, Minn.	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	2	1	City and County Hospital.
Central States	...	...	6	7	4	9	8	16	17	15	11	2	1	6	5	...	...	...	1	1			
Raleigh, N. C.	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	Rex Hospital.
Charleston, S. C.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	City Hospital.
Mobile, Ala.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	Dr. J. A. Abrahams.
Dallas Tex.	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	3	...	Parkland Hospital,
Palestine, Tex.	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	Dr. J. M. Colley.
Grand total	1	...	6	10	9	31	30	56	48	112	166	204	108	34	19	2	...	1	1	3	841	140	

TABLE B.—THE DAILY NUMBER OF DEATHS FROM SUNSTROKR OCCURRING IN CERTAIN REGIONS BETWEEN AUGUST 1 AND 20, 1896, INCLUSIVE.

Places.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Authority.
Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, Maryland, District of Columbia, and Virginia,	...	...	...	...	4	11	11	28	107	204	274	264	108	37	5	4	...	2	1	1	Newspaper clippings, health officers' reports, special reports, physicians, and others. (The information from which this table is compiled is far from complete.)
Ohio, Kentucky, Tennessee, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, and Oklahoma.	...	1	...	5	5	14	16	13	50	100	58	14	3	1	...	2	1	...	...	1	
Total	...	1	...	5	9	25	27	41	157	304	332	278	111	38	5	6	1	2	1	2	

TABLE C.—THE MEAN TEMPERATURE OF EACH DAY AT CERTAIN SELECTED STATIONS DURING THE SUNSTROKE EPIDEMIC OF AUGUST 3 TO 18, 1896, INCLUSIVE.

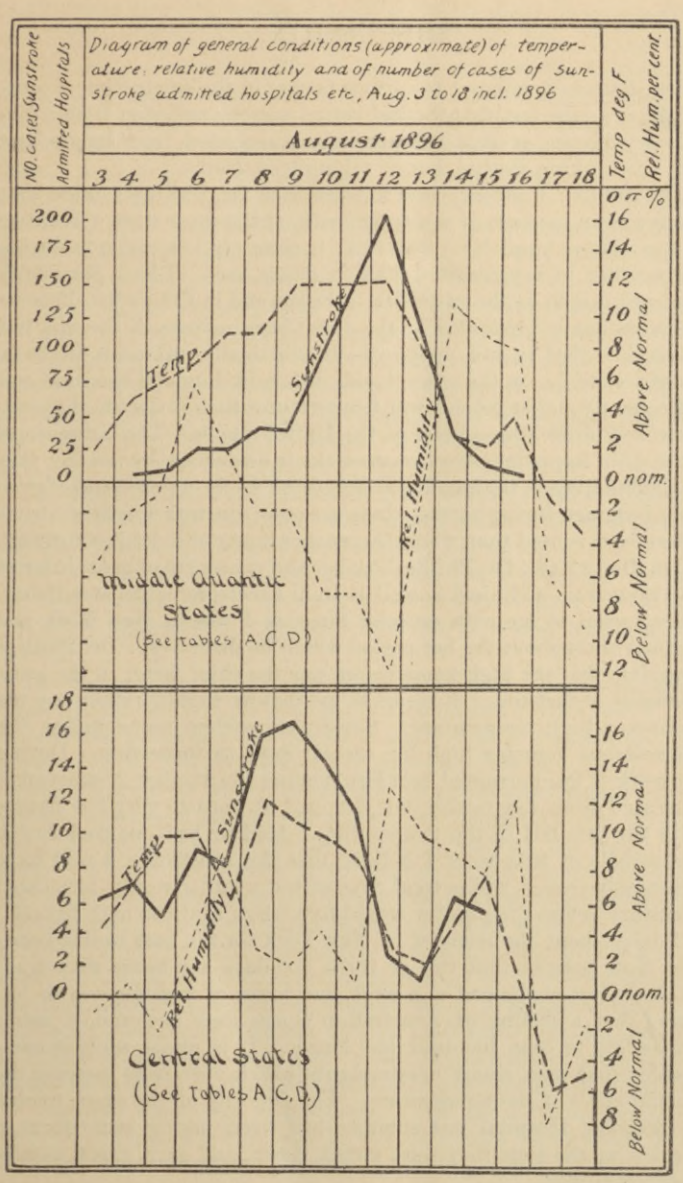
Places.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Normal.	Normal Maximum.
Albany, N. Y.	72°	78°	82°	83°	82°	82°	82°	84°	83°	82°	77°	76°	75°	74°	69°	64°	71°	80°
Boston, Mass.	71	78	72	65	77	75	82	86	82	82	76	71	67	74	72	68	70	78
New Haven, Conn.	71	77	80	72	77	81	82	84	83	84	82	74	72	73	69	64	70	78
New York, N. Y.	74	77	80	82	80	82	82	84	85	84	81	75	74	73	68	65	73	80
Philadelphia, Pa	77	79	82	86	84	86	87	84	87	87	85	77	79	78	74	71	74	82
Washington, D. C.	78	80	83	88	87	84	87	84	84	86	82	78	77	79	73	71	75	84
Chicago, Ill.	77	82	84	79	77	87	83	86	81	73	72	78	76	72	68	65	71	78
St. Louis, Mo.	82	86	88	90	91	91	90	84	86	82	79	81	86	77	72	72	77	86
Cincinnati, Ohio	78	78	81	85	76	84	85	84	82	78	80	78	82	76	68	70	75	84
Charleston, S. C.	84	80	83	82	82	85	87	86	84	82	84	82	80	84	86	80	81	87
Jacksonville, Fla.	86	84	82	83	84	84	86	86	86	84	85	83	84	84	84	86	82	90
New Orleans, La.	82	86	86	84	84	81	78	82	82	86	84	82	80	82	85	87	82	88

TABLE D.—THE DEPARTURE OF THE DAILY RELATIVE HUMIDITY FROM THE NORMAL AT CERTAIN STATIONS FROM AUGUST 3 TO 18, 1896, INCLUSIVE.

Places.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Normal.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Albany	0	+3	− 7	− 5	+ 9	+8	+4	− 4	− 3	− 5	+ 1	− 2	− 6	+ 8	−20	+ 5	76
Boston	− 2	−9	+ 3	+19	+ 9	−3	−1	− 5	−12	− 5	+ 1	+16	+14	+ 7	−15	−11	75
New Haven	− 1	−1	− 8	+15	+13	−3	−1	− 1	− 7	− 7	− 5	+15	+ 9	+ 1	− 9	−11	79
New York	0	+2	− 9	+12	+ 7	+4	+4	−10	− 4	−10	− 7	+17	+15	+12	+ 2	+10	74
Philadelphia	− 9	0	− 2	+ 2	+ 1	−3	−2	−12	−14	−20	− 6	+ 6	+ 8	+10	−30	−16	72
Washington	− 9	0	+ 4	− 8	− 7	−8	−7	− 8	− 6	−13	+12	+ 4	0	+ 2	−12	−18	76
Chicago	− 3	−3	− 6	+12	+14	+1	+5	+ 7	− 1	+18	+16	+12	+ 6	+ 8	−14	− 8	68
St. Louis	+ 1	+4	− 1	− 9	− 3	−1	−7	+ 3	+ 3	+18	+ 9	+ 9	+11	+22	+19	+23	67
Cincinnati	− 1	+3	+ 1	+ 7	+15	+9	+7	+ 3	0	+ 4	+ 6	+ 5	+ 5	+ 7	−10	−10	65
Charleston	+ 4	+6	+ 2	0	− 1	+1	−5	− 3	− 1	+ 2	− 1	+ 1	0	− 1	+ 1	+ 4	82
Jacksonville	−13	+7	+ 3	− 1	− 3	−6	−8	−11	− 4	− 8	+ 3	− 5	− 1	− 3	− 7	− 3	81
New Orleans	− 2	+5	−11	− 5	− 1	0	+1	+ 3	− 9	−13	− 3	0	+ 3	0	− 7	− 6	79

TABLE E.—THE DAILY ABSOLUTE HUMIDITY (GRAINS PER CUB. FT.) AT CERTAIN STATIONS FROM AUGUST 3 TO 13, 1896, INCLUSIVE.

Places.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Normal.
Boston	6.6	7.0	6.6	6.1	8.5	7.5	8.8	8.0	8.0	8.5	7.0	7.0	6.4	6.6	5.0	4.4	5.6
New York	6.6	7.5	7.7	8.5	8.5	8.5	9.4	8.0	8.8	8.0	7.5	8.0	7.5	8.0	5.6	5.2	6.1
Philadelphia	6.2	7.5	8.0	9.1	8.5	8.5	9.1	8.2	8.0	7.2	8.0	8.0	7.5	8.0	3.8	4.2	6.1
Washington	7.0	8.0	9.1	8.5	8.2	8.5	10.0	7.5	8.5	8.5	8.0	8.0	8.0	8.5	5.6	4.7	6.6
Chicago	6.4	7.2	7.5	8.0	8.5	8.5	9.4	8.8	8.0	7.5	7.2	7.5	6.8	6.1	4.9	4.1	5.4
St. Louis	7.5	8.8	9.1	8.5	9.1	9.4	8.5	8.5	9.1	8.5	8.0	8.2	8.5	8.5	7.5	7.5	6.1
Cincinnati	6.6	7.2	7.5	8.0	8.0	8.5	8.8	8.5	7.5	7.0	7.7	7.5	7.5	7.0	4.1	4.4	5.7
Charleston	8.8	9.6	9.6	9.1	9.4	9.6	9.1	9.6	9.6	9.6	9.1	9.6	9.1	9.4	9.4	9.1	8.8
Jacksonville	8.5	9.1	9.1	9.1	8.8	8.5	8.5	8.2	8.5	8.5	9.4	8.8	9.1	8.8	8.5	9.1	8.5
New Orleans	9.1	8.8	8.5	8.5	9.1	8.0	8.5	8.8	8.0	7.5	9.1	8.5	9.1	8.8	9.1	9.1	8.5


No. cases Sunstroke Admitted Hospitals
Diagram of general conditions (approximate) of temperature, relative humidity and of number of cases of sunstroke admitted hospitals etc., Aug. 3 to 18 incl. 1896
August 1896
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Temp deg F
Rel. Hum. per cent.
200 175 150 125 100 75 50 25 0
0 2 4 6 8 10 12 14 16
Above Normal
0 nom.
2 4 6 8 10 12
Below Normal
Temp
Sunstroke
Rel. Humidity
Middle Atlantic States
(See tables A, C, D)
18 16 14 12 10 8 6 4 2 0
16 14 12 10 8 6 4 2
Above Normal
0 nom.
2 4 6 8
Below Normal
Temp
Sunstroke
Rel. Humidity
Central States
(See tables A, C, D)

DISCUSSION.

Dr. Babcock referred to various factors in the production of sunstroke, *e. g.*, the fact that the individual may be suffering from a circulatory disease, or that he cannot be dissociated from habits, not only of drinking alcohol, but of taking iced drinks.

Dr. Solly: I am surprised to learn from Dr. Phillips's table that there was an increase of sunstroke, with, at the same time, a decrease in the relative humidity. Sunstroke is certainly less common during hot weather in dry climates than in damp ones. I have personally observed this to be the case both in Egypt and in Colorado. Persons are occasionally prostrated by the direct burning rays of the sun, but sunstroke—that is, sun apoplexy—is practically unknown in these countries, while, on the other hand, in humid England it occurs not infrequently and at much lower temperatures than it does in the comparatively drier atmospheres of the United States. The influence of alcoholism in predisposing to sunstroke is evidenced by the fact that in England, where the laborers always drink freely of some form of alcoholic beverage during harvest, there are more sunstrokes in the districts where beer is used than where the weaker liquor of cider is consumed.

Dr. Brannan: Dr. Phillips's paper and charts are of great interest and value from a clinical as well as from a meteorological standpoint. They appeal to me with especial force, as I was in New York last summer throughout the hot period which he describes. Dr. Phillips considers that the high temperature was the chief factor in the great mortality of that time; it seems to me that we should rather say the *continuous* high temperature. Sunstrokes seldom occur unless the thermometer remains high for several days in succession. During the week of uninterrupted heat last summer the number of sunstrokes increased from day to day, but dropped at once to very low figures with the first fall in the temperature. Had we had one cool day in the middle of that week I believe that the sunstrokes would have practically ceased, and several days of hot weather would have been necessary before the number would have risen again to high figures.

I have spent the summer in New York for the past twelve years, and have noticed that two or three hot days are borne with tranquillity; but at the end of a week our power of resistance is so lessened that a feeling of desperation comes over one, and it seems impossible to bear the heat any longer. It is under such circumstances that men resort to stimulants, which operate to increase the hurtful effect of the temperature. The majority of the cases treated in Bellevue Hospital last summer had been taking some form of alcohol at the time they were struck down, and such cases usually resulted fatally.

DR. PHILLIPS: In reference to what Dr. Brannan said regarding continuous high temperature, I agree entirely with him. In speaking of the matter I meant to intimate that the atmospheric temperature must be high and continue high for some considerable period—two or more days at least—and I am very glad that he has called attention to this point, in order that it may be brought out prominently. The human body is so constituted that it can stand a very high degree of atmospheric temperature, provided the temperature be not of too long duration. Experimenters have endured for a few minutes, without appreciable ill effect, temperatures of about 260° F. Of course, if during this hot spell the temperature had dropped to nearly normal for even a day we should probably have had considerably fewer sunstrokes.

I have no doubt that many of the cases of sunstroke are the result of indulgence to excess in alcoholic drinks, and during very hot weather I think the use of alcohol as a beverage in any form is to be condemned, and this appears to be the opinion of all physicians that have observed or studied the subject of insolation.

Now, concerning the question of atmospheric humidity:

By absolute humidity is meant the real amount of water existing as vapor in a unit volume of air. This amount is, in English measures, usually stated as grains of water per cubic foot of air.

By relative humidity is meant the ratio that the amount of vapor actually present bears to the amount required to saturate the space at the given temperature. Relative humidity is usually stated as percentage.

The amount of vapor required to saturate a given space will depend upon the temperature. For example, a cubic foot of air at 50° F. will require for saturation 4.09 grains of vapor, and if we raise the temperature to 98° F. it will take 18.69 grains to effect saturation. Thus a cubic foot of air at 50° F. saturated with moisture would have a *relative humidity* of 100 per cent.; but if its temperature was raised to 98° F. it would have a *relative humidity* of only 22 per cent. Conversely, a cubic foot of air at 98° F., the *relative humidity* of which was 22 per cent., if cooled to 50° F., would have a *relative humidity* of 100 per cent. In both illustrations the actual weight of vapor or *absolute humidity* remains unchanged. Absolute humidity is a statement of a physical condition independent of any other conditions; whereas relative humidity is a statement of a relation that, to be rationally understood, requires that we shall know both the temperature and the absolute humidity. Relative humidity is not a meteorologic element; it is simply a questionable convenience, so far at least as medical climatology is concerned. The use of these two terms, relative and absolute humidity, is very apt to lead to confusion in the minds of those who meet them for the first time, and it seems to me that a new term might be introduced to describe one of these condi-

tions—that is, a term that would not likely be confused with the other.

In New York the absolute humidity on August 9th was 9.5 grains of moisture to the cubic foot; on the 12th it was only 9 grains. For some reason that I do not understand, it declined before the temperature. I did not illustrate the absolute humidity on the chart, but if we were to draw a line to indicate it it would about parallel the line that indicates the temperature, however, commencing to fall a little before that line does.

Concerning the influence of atmospheric humidity upon heat loss, the subject is yet one for us to determine. Moist air has greater capacity for heat than dry air at the same temperature; but how does this affect our comfort? If it imparts more heat to us, conversely it must abstract more heat from us. It is true that we feel heat or cold more acutely when the atmosphere is relatively damp; but may this not be caused by the effect of moisture upon cutaneous sensations in general rather than any real action of moisture as a thermolytic factor? A dry skin is not as appreciative to tactile sensations as a moist one. Of course, we can assume extreme cases of an atmosphere saturated with moisture at a temperature of the human body, and then there is no question of the effect of the humidity; but in nature we will not meet in this country with any instance approximating such a state of affairs. In the hottest weather the humidity will never be such that it will interfere with the evaporation of all the perspiration excreted under normal conditions of exercise and rest.

In regard to Dr. Babcock's remarks, I did not refer to iced drinks, because that aspect of the subject was not included in my statistical information. Of course, a great many people suffer from sunstroke because of weak circulatory systems or other diseased conditions rendering them unable to resist the occasional excessive high temperatures of our summers. Any habit or practice that tends to impair health would doubtless, in excessively hot weather, contribute to the incidence of sunstroke in the individual indulging therein.

During the hot weather of August there was one feature of the temperature with which I have since been struck, and which may be of considerable importance in the causation of sunstroke epidemics, that is, that during the prevalence of the epidemic the night temperatures did not fall below 75° F. I think this high night temperature had a particularly bad effect; if we could only have gotten a little relief for but a few hours of the night, perhaps we would have stood the high temperature of the day very much better and for a much longer time. This point has been emphasized in my estimation by the following facts:

Among the statistics that were gathered were accounts of about seventeen cases of sunstroke in Arizona and California (these facts

were furnished by the health officials of the different communities and are authentic). Most of the cases occurred in July, 1896, during which month the Pacific and Rocky Mountain States suffered severely from a prolonged spell of hot weather. In Arizona and California temperatures of 108° and 110° F. were recorded during the day, and frequently the night temperatures did not fall below 75° F. It was upon these occasions that most of the above cases occurred. Therefore, I think in order to produce a sunstroke epidemic it is necessary that the night temperatures be high as well as the day temperatures. These considerations suggest, so far as the etiology of sunstroke is involved, the probable importance of diurnal temperature range, and the climatologic conditions that favor the same and which, perhaps, account for the relative infrequency of sunstroke in such climates as Colorado and Egypt, where, owing to the relative dryness of their atmospheres, there are very few clouds to interfere with terrestrial radiation, and as a consequence the temperature always falls very much after sunset. As an indirect agent in the climatologic distribution of sunstroke, humidity and its relation to temperature may thus be of great significance.

As Dr. Solly has remarked, there are two perhaps distinct causes of sunstroke—one, the effect of intense direct insolation, and the other the effect of high atmospheric temperature. I think the former variety rare, and the latter the more common in the temperate zones. What I have called sunstroke in this paper might with more propriety be denominated heatstroke, but I have used the former term because it is the more common.