

## P1.5 An Information System to Reduce Risks of Heat Disorders in Japan

Michihiko Tonouchi<sup>1</sup>, Masaji Ono<sup>2</sup>, Koji Murayama<sup>1</sup>

<sup>1</sup> JMBSC (Japan Meteorological Business Support Center), Tokyo, Japan

<sup>2</sup> NIES (National Institute of Environmental Studies), Ibaragi, Japan

### 1. Introduction

In these 10 years, the number of patients by heat disorders has been continuously increasing. Especially in urban cities heat islands effect makes the environment worse, and it affects increase of patients especially in elderly people. In 2007, at Tokyo metropolitan city (population is around 12 million), 1,268 people had been taken to hospitals by ambulance cars and 972 people taken to hospitals in 2008. In 2007 season, the ratio of patients older than 65 years old is exceeded to 37.4 percents<sup>(1)</sup>.

MOE (the Ministry of Environment) published 'A guideline for preventing heat diseases'<sup>(2)</sup> in 2005, and the guideline has been updated with latest knowledge regarding heat diseases annually. Printed guidelines are delivered to health service sections of prefectures and the guideline in PDF version is opened on the Internet (available online at [http://www.env.go.jp/health/heat\\_stroke/manual.html](http://www.env.go.jp/health/heat_stroke/manual.html)). Additionally MOE, NIES and JMBSC have developed an experimental web site regarding heat disorders to reduce and to warn its risks to the public (available online at <http://www.nies.go.jp/health/HeatStroke/>).

### 2. Index for Heat Disorders in Japan

There are several indexes related to heat disorders, for example 'maximum temperature' or 'Heat Index' and so on, however, in humid hot cities WBGT (Wet Bulb Globe Temperature) explains patients better than other indexes (Nakai, 1990)<sup>(3)</sup>. WBGT is calculated from  $T_w$  (wet bulb temperature),  $T_g$  (globe temperature) and  $T_a$  (dry bulb temperature) by Yaglou (1957)<sup>(4)</sup>.

$$WBGT = 0.7 \cdot T_w + 0.2 \cdot T_g + 0.1 \cdot T_a \quad (\text{outside})$$

$$WBGT = 0.7 \cdot T_w + 0.3 \cdot T_g \quad (\text{inside}) \quad (1)$$

WBGT is adopted as the index to prepare for heat disorders especially for workers as ISO 7243. And in Japan, JASA (Japan Amateur Sports Association) published 'A guidebook for prevention of heat disorders for sporting activities'<sup>(5)</sup> in 1994, and in the guidebook, WBGT is introduced as an index to judge the risk of heat diseases (risk is categorized in 5 grades to help users' understanding shown in Table 1).

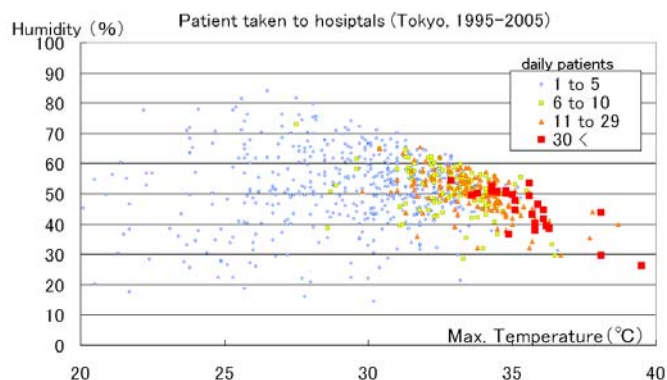


Fig. 1. Patients and average maximum temperature during Jul. and Aug in Tokyo (1995-2005).

Additionally in an instruction regarding prevention for heat diseases Labor Ministry issued in 1997, they recommend workers to use WBGT as a standard index for heat diseases risks.

**Table 1.** Risk level of heat disorders, JASA(1994)

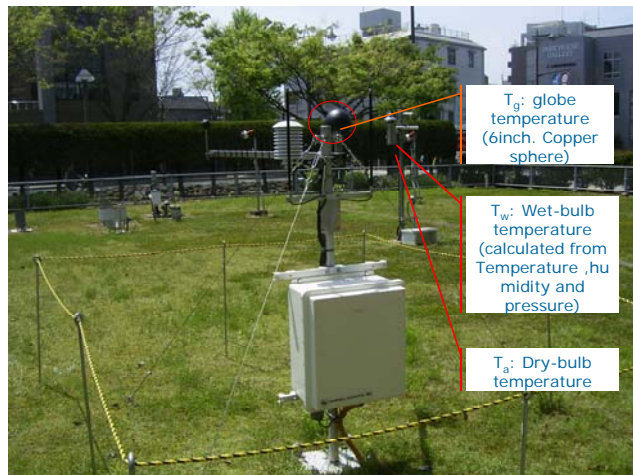
WBGT threshold (degrees C)		
31	danger	Stop exercises in principle
28	alert	Stop severe exercises
25	advisory	Take rests frequently
21	caution	Frequent hydration
	almost safe	Risk is relatively lower

### 3. WBGT Information Web Site

A web site to reduce risks of heat disorders managed by NIES is consisted from three information sites (1) Actual WBGT situation, (2) 2 days WBGT forecast and (3) Heat diseases patients prompt report managed by MOE and NIES. The site is available from June to early October.

#### (1) Actual WBGT situation

MOE sets 6 inches globe temperature sensors at 6 JMA (Japan Meteorological Agency) observatories in urban cities (Tokyo, Niigata, Nagoya, Osaka, Hiroshima and Fukuoka), and the system observes globe temperature ( $T_g$ ) and sends the data to NIES server via a mobile phone network. On the other hand, the server collects temperature ( $T_a$ ), relative humidity and pressure observed by JMA and calculated wet bulb temperature ( $T_w$ ) by an approximation formula from temperature, relative humidity and pressure, for example Iribarne J. V. (1981)<sup>(6)</sup>.



**Fig. 2.** WBGT observation equipments(Fukuoka).

On 'Actual WBGT situation' pages, actual WBGT value at 6 cities is reported 1 hourly (Fig. 3), and at the pages observed WBGT is colored in 5 colors according to JASA risk categories from blue, green, yellow, pink and red. JASA guidebook said that from 28 degree Celsius in WBGT heat disorders' patients start to increase remarkably and from 31 degree Celsius in WBGT the risk for heat disorders becomes quite danger (it means that if WBGT is in 'Pink' and 'Red' category, risk for heat disorders is high).



**Fig. 3.** Actual WBGT situation

At the upper part of the page, users can watch the trend in latest one week and people can check heat related risks easily (It is well known that (1) extreme heat, (2) continuous heat and (3) drastic heat effect increase of heat disease patients).

### (2) 2 days WBGT forecast

On '2 days forecast' pages, 3 hourly WBGT forecasts beyond 2 days for major cities in 47 prefectures is reported twice a day (around 6 a.m. and 6 p.m.), and the page is modified 3 hourly with actual observation data. WBGT value is also highlighted with 5 colors according to JASA risk categories.



Fig. 4. 2 days WBGT forecast

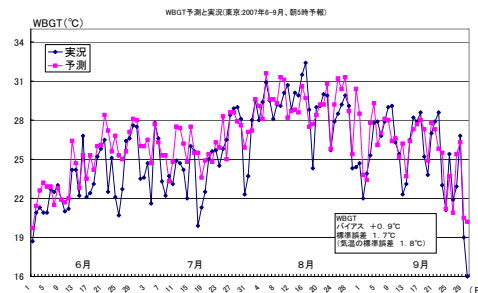


Fig. 5. WBGT forecast and observed WBGT (Tokyo, 2007)

In order to calculate WBGT forecast, we use temperature ( $T_a$ ) and wet bulb temperature ( $T_w$ ) from JMA guidance forecasts (statistical forecast based on Numerical Weather Prediction) and to estimate globe temperature ( $T_g$ ), we use temperature, humidity, wind speed and precipitation with regression formula (2) calculated from historical observed data. We tried to calculate  $T_g$  from heat valance theory, however, the accuracy from heat balance theory did not improve the accuracy much compared to regression formula,

$$T_g = T_a + 12.1 + 0.0067 \cdot S - 2.40 \cdot U^{1/2} \quad (S > 400 \text{ W/m}^2)$$

$$T_g = T_a - 0.3 + 0.0256 \cdot S - 0.18 \cdot U^{1/2} \quad (S \leq 400 \text{ W/m}^2) \quad (2)$$

here,  $T_g$  is globe temperature (degrees Celsius),  $T_a$  is dry bulb temperature (degrees Celsius),  $S$  is sun radiation ( $\text{W/m}^2$ ) and  $U$  is wind speed (m/s).

The standard deviation of maximum WBGT forecast for the day at Tokyo in 2007 summer was 1.7 degree Celsius and the bias of it was +0.9 degree Celsius. On the other hand, the standard deviation of JMA maximum temperature forecast at Tokyo was 1.8 degree Celsius, and we thought that the WBGT forecast can keep same accuracy with JMA temperature forecast. The trend of WBGT forecast and actual WBGT observed at Tokyo is shown in figure 5. In rainy season, WBGT forecast tended to be higher than actual WBGT, however, during hot weeks in August, the WBGT forecast was mostly reliable.

### (3) Prompt report of heat diseases patients

On the 'Prompt report of heat diseases patients' pages, prompt reports from ambulance centers in 21 big cities are updated once a week. The page informs of actual patients situation and warns how many patients are taken to hospitals (Fig. 6).



Fig. 6. Prompt report of heat diseases patients

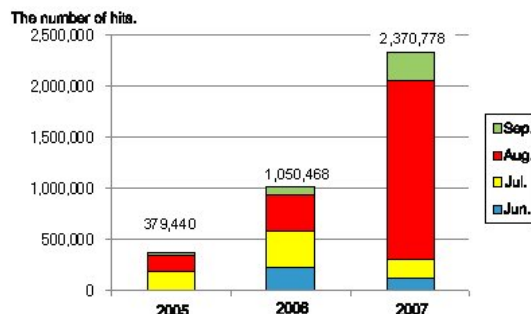


Fig. 7. The number of hits to the pages

The number of hits to those sites is shown in Fig. 7. The number of hits is continuously increasing year by year and in 2007 the number of hits exceed to nearly 2 million hits. It reveals that this web site is well known to the public and the information is used continuously as effective for prevention of heat disorders.

## 4. Conclusion

Through 3 years experiment, the web site is well known to the public. We are planning (1) improvement for more accurate forecasts, (2) development of WBGT observation and patients information network, and (3) feasibility studies for local communities regarding evacuation plans.

## REFERENCES

- (1) National Institute for Environmental Studies, 2008: Information Network for heat disorder patients in 19 cities.  
[Available online at <http://www.nies.go.jp/health/HeatStroke/spot/2007/1-4.html>]
- (2) The Ministry of Environment (in Japanese), 2007: A guideline for preventing heat diseases
- (3) Nakai S, Yorimoto A, Morimoto T (in Japanese), 1990: Environmental temperature of an athletic field in Japan and comparison between wet bulb temperature and WBGT, Japanese Journal of Physical Fitness and Sports Medicine, 39, 120-125
- (4) Yaglou, C.P. and Minard, C.D., 1957: Control of casualties at military training centers. AM.Med.Ass.Archs.Ind.Health 16,302-316.
- (5) Japan Amateur Sports Association (Kawahara T et al.), 1994: A guidebook for prevention of heat disorders for sporting activities  
[A guidebook in English version is delivered at JMBSC booth #541]
- (6) Iribarne, J. V., and W. L. Godson, 1981: Atmospheric Thermodynamics. 3<sup>rd</sup> ed., 259 pp.