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Administration of Lycopene and Beta-Carotene Decreased Risks of Pneumonia among Children

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Abstract: This study aimed to investigate the effect of lycopene and beta-carotene on pneumonia among children. Forty infant and child aged 6 to 36 months suffer from pneumonia and admitted Bab El-Shaareya Hospital for treatment were selected for this study. The children divided into four equal groups; control group (CG), beta carotene group (BCG), lycopene group (LYG) and mixture (lycopene+beta-carotene) group (MG). All subjects were received hospital meal without any modification, while BCG received 15mg/day of beta carotene; LYG received 15 mg/day of lycopene and MG received 7.5 mg/day lycopene +7.5 mg/day beta carotene. All groups received hospital meal in addition to tested carotenoid that dissolved in orange juice. The intervention period continued for 14 consecutive days. The respiratory rate (RR) and temperature were measured daily till recovery. Also, WBCs, IgE and IgG were determined at admission and after intervention period. Results showed that RR of MG and LYG groups returned normal after 21.6±7.2 and 26.4±10.4 hours respectively at $P<0.05$, while CG recovered after 37.2±13.6 hours. Moreover, administration of lycopene decreased RR significantly ($P<0.05$) by 37.6%, while administration of beta carotene or the mixture resulted in decrement of RR by 33.4% and 28.4% respectively. Also, the administration of lycopene reduced IgE significantly ($P<0.05$) by 63.7%, followed by the mixture that reduced it by 40.7% ($P<0.05$). In conclusion the administration of lycopene alone or mixed with beta carotene had a favorable affect on recovery of pneumonia among children.

Key words: Lycopene, carotenoids, pneumonia, children, respiratory rate, immunoglobulin

Introduction

In 1993, pneumonia represented 14% of Acute Respiratory Infections (ARI) among Egyptian infants and children. Although, the mortality rate from ARI among infants and children has been fallen from 17.1/1000 in 1983 to 8.6/1000 in 1996, but in 1997 the ARI death accounts for 29.8% (Khallaf, 1997).

Improving nutrition and other risk factors will likely have the most impact on reducing severe ARI (Khan *et al*., 2004). It is well known that vitamin A maintain the health and integrity of epithelial tissues e.g. epithelial lining of the respiratory (Hadi *et al*., 2004). However, earlier studies (El Mougi *et al*., 1999) demonstrated an inverse relationship between vitamin A status and severity of ARI, particularly pneumonia. Furthermore, recent studies (Grubesic, 2004) reported that periodically providing a high dose of vitamin A capsule to children aged 6 to 60 months may be effective in decreasing the prevalence of morbidity from malnutrition and ARI.

Carotenoids (Pro-vitamin A) in vegetables and fruits represent the main source of vitamin A for 70-90% of people in developing countries (McLaren and Frigg, 2001). Carotenoids are fat-soluble compounds that occur naturally in fruit and vegetables (Gerster, 1997). Many carotenoids have been described, but 5-alfa carotene, beta carotene, beta cryptoxanthin, lutein, zeaxanthin and lycopene account for most of carotenoids found in humans (Broekmans *et al*., 2003). Carotenoids are reported to be of additional importance either as antioxidants or enhancing the immune response (Schweigert, 2001). Among carotenoids, the antioxidative properties were highest for lycopene, beta-carotene and lutein (Miller *et al*., 1996).

Several studies (Paetau *et al*., 1998; Agarwal and Rao, 1998; Gann *et al*., 1999; Arab and Steck 2000 and Sesso *et al*., 2003) reported many benefits of beta carotene and lycopene in reducing risk of LDLc, cardiovascular diseases and cancer. Other studies reported that they reduce the infectious diseases by enhancing immune response (Schweigert, 2001).

Therefore, we aimed to investigate the affect of beta-carotene and lycopene supplementation on outcome of infants and children who suffer from pneumonia.

Materials and Methods

a - Patients: The study was carried out on 40 infants and children (13 girls and 27 boys) who were suffer from

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pneumonia, their age ranged from 6 to 36 months. Infants and children who admitted the Pediatric Department at Bab El Shaareya Al Azhar University Hospital for treatment of pneumonia and meet the inclusion criteria (1) age from 6 to 36 months and (2) suffer from pneumonia (criteria for diagnosis) were enrolled in the study. Cases with chronic illness, malnutrition, very severe or severe pneumonia and recurrent wheezy chest were excluded.

b - Methods

Recognition of pneumonia: The pneumonia was diagnosed by counting the respiratory rate (RR) and chest indrawing. Infants and children who have cough and fast breathing, but without chest indrawing were consider being diseased with pneumonia. According to WHO (1990) classification of RR the pneumonia among infants and children being evident if the RR was (1) 50 or more breath/min for children aged 2 - 12 months; and (2) 40 or more breath/min for children aged more than 12 months.

The RR was counted by the inspection of the chest or abdominal movements with respiration before the child become upset by examination, the counting was for one complete minute using special counter.

Study Design: Using a repeated-measures design, subjects who suffer from pneumonia were divided into four equal groups (10 for each) as follow:

a. Control group (CG): children of this group didn't receive any supplement
b. Beta carotene group (BCG): children of this group received 15mg/day of beta carotene (obtained from MEPACO company, Anshas, Sharkeiya Governorate, Egypt)
c. Lycopene group (LYG): Children of this group received 15mg/day of lycopene (obtained from El Debeiky Company, Cairo, Egypt)
d. Mixture group (MG): children of this group received mixture of beta carotene (7.5mg/day) plus lycopene (7.5mg/day).

All studied subjects were received the standard therapy and hospital diet without any modifications. The three experimental groups received their supplementation dissolved in 100 ml of orange juice, while the control group received the same amount of juice without any supplementation. The interventions were continued for 14 consecutive days.

Ethical consideration: All mothers of selected children were informed about the study, objectives and procedures.

Data collection: Data concerning age, social status, parent's education, residency, health sanitation, parents smoking, illness and health status were obtained. The socioeconomic level was calculated according to Al Shakhs (1995).

Anthropometry: The body weight (kg) and length (cm) were measured for selected children and control group before and after interventions. The body weight and length were compared to CDC Growth Charts. 2001).

Food habits and intakes: Food habits and consumption pattern of studied subjects were recorded, also food intakes were measured using weighed food records for 7 consecutive days.

Blood samples collection: Blood samples were collected before and after dietary intervention from the cubital vein in each subject. The blood samples were taken from non-fasting subjects, placed on ice and protected from light by wrapping them in aluminum foil. All blood samples were immediately transported to the laboratory and centrifuged (3000 x g, 5 min) the serum was separated, frozen and kept till analysis.

Determination of IgE and IgG: Immunoglobulin E (IgE) and G (IgG) were determined in serum according to methods of Ziva and Minineph (1984).

Hematological indices: Hemoglobin (Hb) and RBCs were determined according to methods of Dacie and Lewis (1998), while white blood cell count were determined according to Koda-Kimble *et al.* (2001).

Follow up: All subjects were kept under close observation and RR and body temperature were measured every day till recovery. Recovery was considered when RR returned to normal range and hours expended till recovery were estimated.

Statistical analysis: All data were statistically analyzed using SPSS software and presented as mean ± SD, paired - sample t - test were used for calculating significance between values before and after interventions. Significance between different groups has been calculated by ANOVA and LSD.

Results

All selected infants and children were diagnosed as pneumonia patients.

Table 1 shows the general characteristics of studied children, as shown the majority of infected children were boys (67.5%) and their mean age were 15.4 ± 10.8 months, also, the majority of infected children were from rural areas (90.0%). However, the results show that the social level of the majority of infected children were either low (45.0%) or moderate (47.5%). Unfortunately, the majority (75%) of fathers of infected children were smokers. Regarding body weight it is clear that the

Table 1: General characteristics of studied children.

Variable	Statistics
Sex	
Girls	13 (32.5%)
Boys	27 (67.5%)
Total	40 (100%)
Age (month)	15.4 ± 10.8
Residency	
Rural	4 (10%)
Urban	36 (90%)
Total	40 (100%)
Social level	
Low	18 (45.0%)
Moderate	19 (47.5%)
High	3 (7.5%)
Total	40 (100%)
Father smoking	30 (75%)
Body weight (kg)	9.26 ± 2.7
% of standard weight*	84.2%
Body length (cm)	74.5 ± 12.9
% of standard length %*	95.4%
Blood Picture	
Hemoglobin (g/dl)	9.2 ± 1.34
RBCc (10^{12}/L)	4.16 ± 0.54
PCV (%)	27.8 ± 3.95
WBCc (10^{9}/L)	12.4 ± 4.04

* Compared with standards given by (CDC, 2001)

mean weight was 9.26 ± 2.7 kg that satisfied 84.2% from standard weight for age, on the other hand their body length satisfied 95.4% of standard length for age. Most of studied children may suffer from iron deficiency anemia where the mean Hb concentration was 9.2 ± 1.34 g/dl.

Table 2 shows the respiratory rate for studied children. It is clear that RR decreased significantly among all groups, but the highest decrement were among LYG (-37.6%) followed by BCG (-33.4%) and MG (-28.4%), whereas it decreased by -25.0% among CG. Regarding the period till RR returned to normal level, it is clear that CG expended more time (37.2 ± 13.6 hour) while the MG expended the shorter time (21.6 ± 7.2 hour) followed by LYG (26.4±10.4 hour), however, the statistical analysis showed significant differences between all studied groups at CI= 95%.

It is well known that the higher the immunoglobulins level the higher the inflammatory symptoms. The dietary intervention with mixture of lycopene and beta carotene (Table 3) resulted in significant decrement of IgG by 31.1% at $P<0.05$, while the decrement among other groups were lower and not significant. Meanwhile, the intervention with lycopene resulted in high decrement of IgE (-62.5% at $P<0.05$) followed by mixture of lycopene and beta carotene (-40.3% at $P<0.05$). On the other hand, although beta carotene reduced IgE by -30.1% but this decrement was not significant.

Discussion

As shown, the majority (about 90%) of infected children were from low or moderate socioeconomic level (Table 1) and this result agreed with that obtained by Eurico *et al.* (1991) who found that children of low socio-economic level suffer a large burden of respiratory symptoms. Ahmed, 1991), added that the problem of pneumonia is much greater in developing countries, where 5 million children under the age of 5 years die from pneumonia each year in developing countries.

The majority of fathers of studied subjects were smokers (Table 1). Holberg *et al.* (1993) reported that the presence of a smoking caregiver were significant and independent risk factor for lower respiratory tract illnesses during the first 3 years of life.

The results showed that studied children satisfied 84.2% of standard weight (Table 1), this observation agreed with El Mougi *et al.* (1999) who observed that children with pneumonia had lower body weight. However, this decrement of weight could make some health risks, where Selwyn, 1990 and De Francisco *et al.* (1993) indicated that children with low body weight-for-age had an 8-fold higher risk of dying than did heavier children.

It could be concluded from the results that respiratory rate (RR) were higher among all studied subjects before intervention (Table 2), and these results agreed with Hay *et al.* (2001), who reported that RR were raised in bronchopneumonia. The results revealed that, the return to normal respiratory rate were in the groups received single pro vitamin A (lycopene or beta carotene), these results (Table 2) emphasized that pro vitamin A play an important role in pneumonia recovery, that may be occur through maintaining the health and integrity of epithelial lining of the respiratory as mentioned by Hadi *et al.* (2004).

Also, we observed that the affect of single lycopene or beta-carotene were better than mixture, this observation were ascertained previously by Johnson *et al.* (1997) who found that ingestion of a combined dose of beta-carotene and lycopene has little effect on the absorption of beta-carotene, but improves that of lycopene in men. However, Tanumihardjo. 2002) showed that increasing consumption of fruits and vegetables with moderate and high levels of pro-vitamin A carotenoids, is important to vitamin A status and overall good health among children in the weaning age.

In this study the best effect was due to lycopene consumption and this affect could be mainly attributed to its antioxidative properties as mentioned by Takeoka *et al.* (2001) and Idamarie *et al.* (2005).

Results showed that IgE and IgG were abnormal in patients with pneumonia (Table 3) and these results agreed with Hay *et al.* (2001) who observed that about 75% of patients usually have abnormal serum immunoglobins where IgM is virtually always elevated and IgG is high in many. However, the intervention with beta-carotene decreased IgG and IgE but these decrement was little and insignificant, but some studies proved that beta-carotene affect various measures of immune function and accordingly might influence the predisposition of humans to infections (Harri *et al.*,

Table 2: Respiratory rate (breath/min) values and time expended (hour) till return to normal level (mean±SD) before and after dietary intervention.

Variable	Intervention	CG (n=10)	BCG (n=10)	LYG (n=10)	MG (n=10)
Respiratory Rate (breath/min)	Baseline	58.8±7.1^{a}	58.5±11.4^{a}	57.9±7.4^{a}	55.6±6.6^{a}
	After 14 day	44.0±5.8^{a}	37.6±3.1^{bc}	35.8±3.9^{b}	39.2±2.2^{c}
	% change	-25.0***	-33.4**	-37.6***	-28.4***
Hours from intervention till RR returned normal		37.2±13.6^{a}	28.8±10.9^{b}	26.4±10.4^{c}	21.6±7.2^{d}

CG: control group, BCG: beta carotene group, LYG: lycopene group, and MG mixture group. ** P<0.01, and *** P<0.001
Values subscribed with the same letter showed insignificant differences between these values as calculated by ANOVA and follow up test (LSD).

Table 3: Immunoglobulin (IgE and IgG) values of infected children (Mean±SD)

		CG (n=10)	BCG (n=10)	LYG (n=10)	MG (n=10)
IgG g/L	Baseline	11.3±3.0	4.3±1.8	9.0±2.1	9.1±2.6
	After 14 day	9.7±2.1	3.7±1.3	8.1±1.6	6.3±1.8
	% change	-14.2%^{NS}	-13.5%^{NS}	-9.4%^{NS}	-31.1%*
IgE U/L	Baseline	22.2±3.4	13.4±1.5	20.4±5.7	14.5±3.2
	After 14 day	19.4±2.5	9.1±2.1	7.4±1.2	8.6±2.0
	% change	-12.6% (NS)	-30.1%^{NS}	-62.5%*	-40.3%*

CG: control group, BCG: beta carotene group, LYG: lycopene group, and MG mixture group, * P<0.05, and NS: Not Significant

2004). Otherwise, Hughes (1999) found that moderate increases in dietary intake of beta-carotene can enhance cell-mediated immune responses within a relatively short period of time, but he did not measure antibodies production.

In this study the intervention with lycopene decreased IgE significantly and this results agreed with Watzl *et al.* (1999) who found that consumption of lycopenes reduces T lymphocyte and IG production. However, Takeoka *et al.* (2001), suggest that lycopene in tomatoes may also be important in conferring protective antioxidative effects.

In conclusion, the dietary intervention with single pro vitamin A (Lycopene) improve and accelerate the recovery from simple pneumonia among infants and children, hence we recommend the regular consumption of lycopene sources like tomatoes.

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