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EVALUATION OF A DETOXIFICATION REGIMEN FOR FAT STORED XENOBIOTICS

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ABSTRACT

A detoxification regimen has been found to be safe for use by individuals exposed to recreational (abused) and medical drugs, patent medicines, occupational and environmental chemicals Patients with high blood pressure had a mean reduction of 30.8 mm systolic, 23.3 mm diastolic. Cholesterol level mean reduction was 19.5 mg/100ml, while triglycerides did not change. Medical complications associated with the program were rare, occuring in less than three percent of the subjects. The program resulted in improvements in psychological test scores. The mean increase in Wechsler Adult Intelligence Scale IQ was 6.7 points. High Minnesota Multiphasic Personality Inventory profiles decreased on the third scale (10.7), the fourth scale (8.0), the fifth scale (4.5) and the sixth scale (8.0). The decrease in the fourth scale suggests hope for sociopaths, a group with fourth scale scores not improved by National Institute for Mental Health or Narcotic Addict Rehabilitation Act inpatient programs.

INTRODUCTION

Over four million distinct chemical compounds have been reported in the literature since 1965, with 6,000 new compounds added to the list each week. Of these, as many as 70,000 are currently in commercial production. (1) Human exposure to these chemicals is both direct and indirect. More than 3,000 chemicals are deliberately added to food (2) and over 700 have been identified in drinking water (3). Along with pharmaceuticals and recreational street drugs, the direct exposure to humans is considerable. In addition, the biomagnification of chemicals discharged into the environment has resulted in human accumulation, generally due to the partitioning of these xenobiotics from water into lipids.(4-6) Additional partitioning from one form of lipid to another leads to accumulation of these chemicals in lipid deposits throughout the body, (7) but especially in adipose tissue. (5) Over 400 chemicals have been identified in human tissues, with some 48 found in adipose, 40 in milk, 73 in the liver, and over 250 in blood plasma. (8) The characters of chemicals found in adipose tissue are diverse, but tend to reflect biologically persistent or often used materials such as DDT, PCB, dioxin, nalkanes, PCP and THC.(9-13)

Chemicals stored in adipose and other tissues pose a continuing physiological and psychological threat to human health. Dioxin has been associated with ischemic vascular disease (14) and with other physiological as well as psychological effects as long as ten years after initial exposure. (15) Oncological studies have shown a significant association between PCB and DDE levels in fat and increased cancer incidence. (16-17) In addition, PCB exposures have resulted in increased plasma triglycerides, even in the absence of overt symptoms of PCB intoxification. (18) PCB's in monkeys not only resulted in increased blood lipids, but negatively affected the ability to maintain pregnancy. (19) Further, they have been related to personality and cognitive functioning of persons unexpectedly exposed. (20) Phencyclidine (PCP, Angel Dust, etc.), also shown to be stored in adipose, has been demonstrated to have long-lasting behavioral effects as well. (12)

Concern over the potential health effects associated with lipid and other tissue stored xenobiotics has resulted in public upset of remarkable proportions, leading to federal responses such as the clean up efforts in Love Canal, NY, or the major medical follow up of veterans exposed to defoliant Agent Orange. (21) With exposure to chemicals significant, long-term health effects likely, and public concern continuing, the need for detoxification of xenobiotics takes on increasing importance.

Approaches to detoxification generally exploit pathways which lead to excretion of chemicals and their metabolites in urine and feces, or extrarenal excretion in sweat or sebum. Lipid mobilization serves as the basis for promotion of xenobiotic metabolism through the action of detoxifying chemicals such as ascorbic acid, niacin,

and phenobarbital. (22-25) Typically, lipid mobilization is not enhanced prior to use of bioactive chemicals, however techniques have been studied which accomplish increased mobilization, especially through starvation (5,26-27) or exercise. (28-29) A fecal associated route exists which is not dependent upon bioactive chemicals and partitions xenobiotics through the intestine wall into non-absorbable materials such as paraffin. (30)

The second major class of pathways is extrarenal excretion via sweat or sebum. One of these pathways (it is unclear which) has been identified as a route for loss of n-alkanes, (11) paraffinic hydrocarbons, (31) methadone, (32) amphetamines (33) and antiepileptics, (34-35) among others.

The purpose of this paper is to present clinically observed physiological and psychological changes in subjects who underwent a comprehensive extrarenal excretion regimen intended to remove lipophilics and other xenobiotics from the body. This study was developed to evaluate clinical manifestations associated with the regimen, and is preliminary to a study of its efficacy.

METHODOLOGY

Test Subjects One hundred and three individuals who enrolled in the detoxification program volunteered for additional testing concomitant with the program. California guidelines for human experimentation were used. Individuals were accepted on a first application received basis for a period of four weeks. Initial interviews were used to collect demographic data and obtain informed consent.

In addition to the experimental group, a control group of nineteen individuals was accepted on a first application basis. Initial interviews were used to collect demographic data and administer intelligence and psychological tests. They received no special instructions on diet, exercise, vitamins or any activities and were simply tested and retested three weeks later to determine any variance on repeat intelligence testing over this short time period.

Detoxification Regimen The detoxification regimen (36-38) consists of seven components: (a) Physical exercise, preferably runnin aerobically, for 20-30 minutes immediately prior to sauna exposure. ?b) Forced sweating by sauna at 140-180 OF (46-68 OC) for two and one half to five hours daily, immediately following the physical exercise. The exposure was as close to five hours as could be comfortably taken. The sauna was done in one period each day, with short breaks for cooling shower or additional exercise permitted. (c) A nutritional supplement centered around gradually increasing doses of niacin kept in strict proportion with other vitamins and minerals, including vitamins A, D, C, E, B Complex, Bl and multi-minerals containing calcium, magnesium, iron, zinc, manganese, copper, potassium, and iodine. (d) Water, salt and potassium taken as needed to avert dehydration or salt depletion due to the concentrated sweating. (e) Polyunsaturated (allblend) oil, from 28 tablespoons daily based on individual tolerance. (f) Calcium and magnesium supplements. (g) A regular daily schedule with balanced meals and adequate sleep. No medications, drugs or alcohol were permitted during the period of the regimen (two exceptions as noted). Participants were directed to follow their usual diet and not make any major changes in food consumption.

This regimen was followed daily for about three weeks, and until the individual subjectively realized the point at which his body was "free from impurities". (36) The individual filled out a progress report daily. These reports were reviewed daily by the program director to ensure standardness in application of the regimen. The program director directed increases in nutritional supplements, evaluated subjective changes reported, and directed individuals to their medical professional when any medical problems or questions arose. A medical history and physical examination was required before the program was begun, and individuals with heart disease or anemia were not permitted to continue with the regimen. Each of these program components are standard to use of the regimen and were not, therefore, added for the purpose of the investigation.

Physiological Tests and Observations Prior to commencement of the regimen, laboratory analysis of blood cholesterol and triglycerides was conducted. Two individuals with incompletely diagnosed heart disease, one individual with an undiagnosed neuromuscular disorder, and two people with adrenogenital syndrome were excluded from the study. Two patients on high blood pressure medicine (Catapres 0.2 mg b.i.d; Aldomet 250 mg t.i.d, Inderal 40 mg b.i.d.) were continued unchanged.

Upon completion of the regimen, physical examinations and blood tests were repeated. Participants were also requested to write a summary of any changes or events that occurred during the program.

Psychologic Tests and Observations The Wechsler Adult Intelligence Scale (WAIS) and the Minnesota tiultiphasic Personality Inventory (MMPI) were administered to individuals in the experimental and control group before and after the regimen.

Statistical Evaluation Results of both physiological and psychological tests were reviewed for distributional normality prior to further analysis. The results on all tests indicated degrees of skewness and kurtosis which would be expected to confound multivariate analysis in samples as small as were used. Since significance probabilities of the Student T and variance tests change when non-n6rmal data are examined, a nonparametric method was used to ensure that significance levels would be constant, no matter what type of distribution the data assumed. (39) The Wilcoxon signed rank test was used to determine the significance of differences between measurements.

RESULTS

In general, the regimen was tolerated very well, with only minor complications. Medical problems observed included one case of pneumonia which responded quickly to treatment, one case of external otitis, and one case of diarrhea with consequent swollen hemorrhoids, possibly as a result of excessive vitamine C.

The extended periods of time in the sauna were tolerated very well. Individuals with heat intolerance adapted quickly to the sauna temperatures, and over a few days were able to comfortably stay for thirty minutes to an hour at a time with no clinically observed adverse effects. The average length of the regimen was about thirty-one days, with time spent on the program varying from 11 to 89 days. The average niacin dose reached 3285 mg/day with a range of 800 to 6800 mg/day.

Physiological measures indicate a generally beneficial result from the regimen. Table I presents the post regimen means and mean changes of specific measures. As expected, weight did not change appreciably. However, there were dramatic changes in blood pressure, especially for individuals whose preregimen levels were greater than either 140 mm systolic or 90 mm diastolic. These high blood pressure reductions averaged 30.8 mm systolic and 23.3 mm diastolic.

POST REGIMEN PHYSIOLOGIC MEASURES

	MEAN	SD	MEAN CHANGE
REGIMEN LENGTH (DAYS)	30.5	16,2	
FINAL NIACIN DOSE (MG/DAY)	3285	1445.6	
WEIGHT (LBS)	157	30.7	+ 0.7
BLOOD PRESSURE (MM HG)			
SYSTOLIC	117	18.7	- 3.3
DIASTOLIC	71	10.4	- 6.7***
HIGH BLOOD PRESSURE CASES			
SYSTOLIC	141	30.8	- 30.8'
DIASTOLIC	77	11.7	- 23.3"
CHOLESTEROL (MG/100 ML)	170	33.3	- 19.5...

TRIGLICERIDES (MG/10C ML)	101	74:g (PRE) 61 (POST)	+0.6

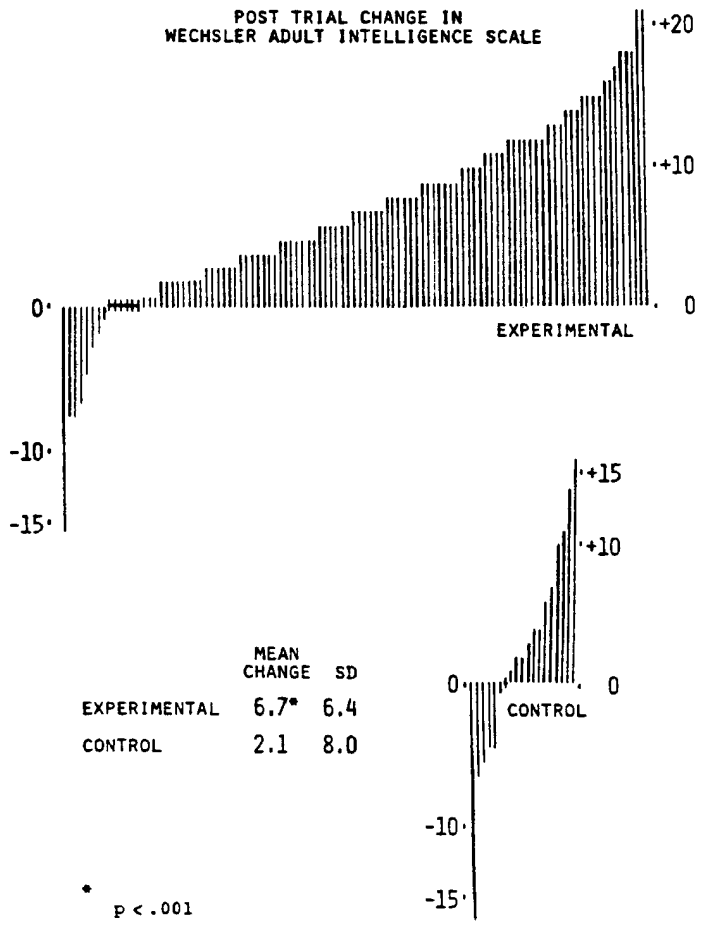
*p < .05
**p < .01
*** p < .001

TABLE I

Cholesterol and triglyceride levels also changed, although in different ways. On average, there was an 11 percent reduction in cholesterol levels, with most of this change reflected in individuals with high pre-regimen levels. Triglycerides did not change on average, however the variance from the mean changed, reflecting a moderating influence of the program. Both low and high levels moved toward the mean.

Psychological measures also showed active movement. With respect to the WAIS, no statistical difference could be demonstrated between the test and control groups before the trial; however there was a significant difference afterward (Table II). Six people tested lower on full scale IQ, post trial, fourteen people tested the same or less than a four point increase and eighty-three improved their full scale IQ by four or more points. A full third of the individuals improved their scales by at least 10 points. The average change was a 6.7 point increase.

The second psychological measure tested was the WPI. On average, changes were small, although several were statistically significant (Table 111). Of perhaps greater interest was the change of high score individuals. Table IV presents the post trial change in MMPI scores for individuals whose initial scores were more than two standard deviations from the norm (T scores greater than 70). The most frequently observed high scale configuration within the initial high scale subgroup was the



43 pattern followed by the 49 pattern. These two patterns accounted for 38 percent of the high score configurations, with the rest of the patterns spread among seventeen other configurations. This pattern frequency has been recognized in several studies on drug users, groups similar in character to the individuals who underwent the program(40-45).

Four of the scales had significant decreases: the third scale (Hy); developed to aid in the identification of patients using the neurotic defenses of the conversion form of hysteria; the fourth scale (Pd), developed to measure the personality characteristics of the amoral and asocial subgroup of persons with psychopathic personality disorders; the fifth scale (Mf), developed to identify features related to sexual inversion disorders, and usually used to modify the interpretation of other scales; and finally the sixth scale (Pa); developed to evaluate the clinical pattern of paranoia, also used to modify other scales. The changes in the third and fourth scales of these high score patients were large, nearly a full standard deviation for the fourth (Pd) scale, and over a full standard deviation for the third (Hy).

POST TRIAL CHANGE IN

MINNESOTA MULTIPHASIC PERSONALITY INVENTORY

MMPI Scales	Mean Change in IN T Scores	SD
1	-3.9**	7.92
2	-2.2	9.93
3	-2.2**	8.29
4	-2.7**	7.98
5	-1.5	6.53
6	+0.5	8.11
7	-2.7***	6.02
8	-1.7*	6.45
9	+0.2	10.43
	N = 69	
*p <.05	**p < .01	***p < .001

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TABLE III

POST TRIAL CHANGE IN HIGH MMPI INITIAL SCORES

MMPI Scales	N	Mean Change in T Scores	SD
1	0	-15.5	9.19
2	7	-13.0	17.88
3	7	-10.7*	7.95
4	16	-8.0**	5.40
5	15	-4.5*	6.51
6	4	-8.0*	4.00
7	2	-17.0	7.07
8	0	-	-
9	2	-4.5	6.36
*p < .05		**p < .01	

TABLE IV

It has been previously found that any interruption in the maintainance of a heroin habit seems effective in eliciting some degree of personality change, particularly as evidenced on the lst (Hs) and 3rd (Hy) scales. (46) Tables III AND IV suggest that the regimen was also effective in eliciting this change in two other groups, the former drug user, and those who were only exposed to medicinal or prescription drugs.

Of particular interest is the reduction in the 4th (Pd) scale. Sutker found that elevations on the 4th scale dominate the addict profile, and are particularly characteristic of the heroin addict, whether addicated or abstinent. However neither the inpatient Narcotic Addict Rehabilitation Act (NARA) program administered through the Department of Psychiatry and Neurology at the Tulane University School of Medicine, a six week program; nor the inpatient program administered by the National Institute for Mental Health (NIMH) Clinical Research Center at Fort Worth, a six month program, could elicite a decrease in scores on the 4th scale. (47)

While the reduction in 4th scale scores in Table III represents all participants in the regimen and Table IV represents all high scores, the @ubset of individuals with opiate and hallucinogen histories are shown **in** Table V and demonstrate even greater decreases in 4th scale scores. These regimen related Pd scale reductions suggest that former drug users may not be condemned to terminal sociopathy.

PD SCALE CHANGE IN INDIVIDUALS WITH DRUG HISTORIES

INITIAL PD SCORE	FORMER DRUG HISTORY: OPIATES ONLY		HALLUCINOGENS ONLY		OPIATES AND HALLUCINOGENS		TOTAL	
	Δx[1]	- 0 +[2]	Δx	- 0 +	Δx	- 0 +	Δx	- 0 +
59 or less	+7.0	0 0 2	-0.7	1 1 1	+3.3	3 2 4	+3.3	4 3 8
6 0 - 6 9	-8.0	I I 0	-3.0	3 1 0	-3.8*	4 2 0	-4.2**	8 4 0
70 or more	---		-8.9**	7 0 0	-9.3*	4 0 0	-9.0**	11 0 0

1. Mean change in post-trial score.
2. Frequency 0 f i ndividuals with negative (-), positive (+) or no (0) change in score.

*p <.05
**p <.Ol

TABLE V

In addition to the measured psychologic and physiologic changes, there were several changes in medical conditions noted during the regimen (Table VI). The authors observed improvement in a wide range of unrelated medical conditions from seborrhea to irritable bowel. In total, eighteen conditions found reported to have improved while twelve others generally showed no change.

Two specific cases are of particular interest. One participant is a paraplegic who has been wheelchair bound for 17 years. Initial work up at onset was inconclusive, but symptoms were felt to be most consistent with transverse myelitis. On physical examination prior to starting the regimen the patient had some plantar flexion of right ankle and mild flexion at the hips. During the program increased sensation was noted in the legs and gradual increase in voluntary control. On post trial physical examination the patient had middorsiflexion of the hips. There was also muscle growth in both gastrocnemia. Six months after finishing the program the patient continued to have mild increases in the voluntary control of her lower legs. Currently, although wheelchair bound, transfers are easier and continued muscle growth is evident on physical examination.

MEDICAL CONDITIONS REPORTED DURING DETOXIFI CATION REGIMEN

CONDITION	NUMBER OF PATIENTS	CASES WITH IMPROVEMENT	CASES W ITH NO CHANGE
MYOPIA	31	24	7
BURS I TIS/FIBROMYOSITIS	11	11	-
IRRITABLE BOWEL	9	8	1
DERMATITIS	8	7	1
ACNE	8	7	1

DYSMENORRHEA	7	5	2
TENSION HEADACHES	7	6	1
HYPOGLYCEMIA	5	5	-
FLUID RETENTION	5	4	1
THYROMEGALY	4	3	1
MIGRAINE HEADACHES	4	3	1
ALLERGIC RHINITIS	4	3	1
SEBORRHEA	3	3	-
HYPERTENSION	2	2	-
PYORRHEA	2	2	-
PARAPLEGIA	1	1	-
PEYRO IES DISEASE	1	1	-
GRAVE S DISEASE WITH EXOPHTALMUS	1	1	-
FIBROCYSTIC BREAST DISEASE	7	1	6
HEMORRHOIDS	5	1	4
URINARY INCONTINENCE	3	-	3
VERRUCOSE VERRUCA	3	1	2
CONDYLOMA ACCUMINATA	2	-	2
PSORIASIS	2	-	2
STRABISMUS	2	1	1
ALOPECIA	2	-	2
PROSTATOSIS	2	-	2
BELL'S PALSY	1	-	1
I MPOTENCE	1	-	1
CEREBRAL PALSY	1	-	1

Table VI

A second patient with weekly migraine headaches controlled partially by low dose propranol was able to stop medication and has only mild headaches since finishing the regimen.

Not shown in Table VI are numerous observations of improved abilities which are not usually considered medical improvements. These included ability to think more clearly, feeling more aware, feeling lighter, improved smell or taste, and feeling more energetic.

A variety of incidents were reported during the regimen, some of which may be suggestive that chemicals stored in tissues were being released. There were reports of brief full blown 'LSD trips' with hallucination. Participants who had ether exposures prior to the trial (several had used cocaine and had engaged in 'free basing') were reported to smell like ether in the sauna. Old injuries would flare up with swelling or redness along surgical scars and then resolve over a few days. The flushing, which followed ingestion of niacin, frequently would occur along lines of bathing suits or old sunburns. This would diminish over a few days then recur in a different pattern. It was not unusual to have a person re-experience the physical condition associated with taking a certain drug or anesthetic. For instance, one patient complained of onset of mild right lower quadrant pain, nausea, light headedness, and reddening of an old appendix scar. This recurred the next two days at lessening severity and then was gone in three days.

CONCLUSIONS

The detoxification regimen reported on in this paper, was developed for the purpose of handling the restimulative effects of drugs and toxic residuals. (36) This paper serves to examine two aspects of the regimen: are there observable positive or negative health effects as a result of the program; and does it hold out the promise of a useful detoxification regimen for the countless individuals exposed to xenobiotics, especially those highly exposed?

Theoretical Basis for the Regimen The regimen, as described above, acknowledges the potential for storage of xenobiotics in human tissues, especially lipids. It is designed to promote excretion of foreign chemicals through lipid mobilization and increased circulation followed by sauna induced sweating. This process is enhanced through good nutrition, adequate sleep, a regular schedule and a vitamin, mineral and oil supplement.

Many investigators have demonstrated the presence of foreign chemicals in human tissues, and the mechanism for the uptake is undergoing active investigation. The role of fatty acids (48) and the preferential association these chemicals with triglycerides rather than lipophilicity itself (7) begins to explain the relationship between water-lipid partitioning or resistance of these chemicals to enzymatic degradation, resulting in biological magnification. (4) The degree of storage has been documented by investigators referenced earlier, and other work supports those gross measures of lipids contamination by establishing the lack of relationship between plasma levels of PCP, for example, and the ingestion of that chemical. (49) Furthermore, chemicals such as dioxin thought to be excreted or metabolized within short periods of time (10) have been found to persist in adipose tissue at significant levels. (50)

Several mechanisms have been demonstrated to mobilize lipids, and such mobilization has been found to be accompanied by mobilization of xenobiotics as well. Starvation has been found to cause mobilization of stored residues. (25,51) However, these residues are not necessarily excreted. It has been found that residues move from fat to muscles during starvation, and return to fat upon refeeding. (27,51)

Physical exercise has also been shown to increase lipid metabolism. (28, 53) However, mobilization of lipids through exercise is not immediate, lagging the commencement of exercise by about 15 minutes. This short suppression of mobilization is due to elevated blood lactate levels. (54) The significance of this finding in relation to the detoxification regimen is that at about the time lipids begin to mobilize, freeing xenobiotics as well, the body commences increased excretion via the sweat, thereby providing a pathway out of the body, in competition with storage in lipids in muscle tissue.

The sweat excretion route for xenobiotics has been suggested for over a decade. (55-56) Such excretion is not exclusively an ionic transfer, with non-ionic diffusion appearing to be important. (32,57) A variety of chemicals have been identified in sweat, including n-alkanes, paraffinic hydrocarbons, methadone, amphetamines, antiepileptics and morphine, as referenced earlier. The effectiveness of this pathway is significant, with as much material excreted through the sweat as through the urine. (58)

A second dermal route of excretion exists. The lipophilicity of many chemicals can be exploited by increasing sebaceous gland discharge. The same high temperatures which accelerate sweating have been found to increase the excretion rate of sebum as well. (59) Dietary hydrocarbons have been found to be excreted in this manner. (31) The efficiency of dermal excretion, a subject deserving further study, has been sufficiently demonstrated to support the construction of the regimen studied.

Potential Health Effects Two types of health effects generated concern during review of the regimen; the potential effects of the tissue stored chemicals upon release, and the potential effects of the exercise, heat and vitamin program.

The effects expected from stored xenobiotics are usually chemical specific. However, there appears to be a common factor: chronic effect. For example, PCB has been shown to alter lipid metabolism at levels of exposure and bioaccumulation insufficient to produce overt symptoms.(18) Other similar biochemical alterations have been observed in individuals up to two years after PCB exposure. (60)

Dioxin has been shown to cause similarly chronic effects up to 10 years after exposure. (15,61) It seems reasonable that such chronic effects would subside if the chemicals were cleared from the body.

Somewhat more egregious is the potential for cancer promotion. Investigators have found a relationship between adipose stored xenobiotics and cancer. (16-17) While mobilization of these chemicals may not be desirable, others feel that the risk is small and where a detoxification or excretion pathway exists mobilization should be encouraged. (5)

Aspects of the detoxification regimen raised some questions about safety. The use of large quantities of niacin was followed by reactions and flushes which appear to mimic radiation burns like sunburn. These somatic conditions appeared in decreasing intensity over the course of a few days.

The side effects of niacin have been discussed at length. (62-64) It is unclear why these phenomenon appear, but it is clear that simple vasodilation is an inadequate theory for these flushes. (65) It has been suggested that the reported side effects of niacin may actually be the creation of other vitamin and mineral imbalances, (36) a theory which can not be refuted on the basis of this study, as negative side effects were not noted when correct proportions were administered. The importance of vitamin and mineral balance during detoxification of xenobiotics has been recognized before, (66) and is an aspect which deserves further study.

The high degree of sweating may also cause minerals depletion. The instructions for the program specifically recognize this potential problem, and no cases of minerals deficiency were noted during the study. The importance of this aspect may be smaller than expected, in any case. Studies of individuals who perform heavy exercise and sweat profusely on repeated days do not appear to incur tissue hypokalemia.(67)

Vitamins also have positive effects during detoxification. Niacin has been shown to reduce dyspnea in paraquat poisoned rats. (24) Niacin administration has also been found to lower cholesterol levels, (64) and is the probable cause for lowered cholesterol levels in program participants. Vitamin C affords protection against enzyme activity alterations and histological changes caused by PCB toxicity. (23)

With respect to health, the program appears to be safe as long as it is done under the care of a physician. The exercise and sauna are tolerated very well as long as they are begun slowly and increased gradually. As with any major physical exercise program, however, general physical condition and physical health needs to be monitored. The regimen is inadvisable for any person with coronary artery disease or any other major physical disabilities unless directly done under the supervision of a physician familiar with exercise physiology who is willing to work out a specific exercise, sauna, and vitamin program for the patient.

Areas for Future Study There are two specific areas which would be appropriate for study as a result of this work. First, the efficacy of the program should be determined, and is under study by the authorsat this writing. There are populations such as chemical workers who can be expected to have high levels of xenobiotic contamination. There are new simple bioassays utilizing human adipose tissue and sebum which have been successfully used on study groups. Analysis of sweat is becoming routine. Together they provide an excellent opportunity to study a detoxification regimen which might very well extend the lives of highly exposed individuals.

A second area for study is the potential for improved psychological status of groups exposed to environmental chemical threats. One example would be individuals exposed to the defoliant Agent Orange. These individuals have complained of nonspecific problems not unlike those which resolved in the study group after application of the detoxification program. While it is unlikely that Agent Orange, or dioxin caused these nonspecific complaints, it may be that the widespread use of drugs and alcohol among combatants is the more subtle source of continuing problems. The detoxification regimen may have large positive effects on such a population, especially since the experimental group had significant drug use and realized dramatic improvements in both IQ and personality traits.

REFERENCES

1. Council for Environmental Quality, Environmental Quality, U.S. GPO, Washington, D.C., 197

2. Ribicoff, A, Chemicals and the future of man. Hearings of the Committee on Government Operations, U.S. Senate, Washington, D.C. 1971.

3. National Research Council.Drinking Water and Health, Volume 3. Washington, D.C., National Academy Press, 1980.

4. Metcalf R, Sanborn J, Lu P, Nye D, Laboratory model ecosystem studies of the degradation and fate of radiolabeled tri-, tetra-, and pentachlorobiphenyl compared with DDE. Arch Env Contam Tox, 3:151-164. 1975.

5. Lambert G, Brodeur J. Influence of starvation and hepatic microsomal enzyme induction of the mobilization of DDT residues in rats. Tox App Pharm. 36:111-120. 1976.

6. Bjerk F, Brevik E. Organochlorine compounds in aquatic environments. Arch Environ Contam Toxicol. 9:743-750, 1980.

7. Sandermann H. Triglyceride/phospholipid partitioning and persistence of environmental chemicals. Chemosphere. 8:499-508, 1979.

8. Environmental Protection Agency. Chemicals identified in human biological media, a data base. US EPA. Washington, D.C. EPA 560/13-80-036B, PB81-161-176, 1980.

9. Jensen G, Clausen J. Organochlorine compounds in adipose tissue of greenlanders and southern danes.J Toxicol Environ Health. 5:617-629, 1979.

10. US Air Force Occupational and Environmental Health Laboratory. The toxicology, environmental fate and human risk of herbicide organge and its associated dioxin. Brooks AFB, Texas. OEHL TR-78-92, 1978.

11. Schlunegger U. Distribution patterns of n-alkanes in human liver, urine and sweat. Biochim Biophys. Acta. 260:339-344, 1972.

12. Misra A, Pontani R, Bartolomeo. Persistence of phencyclidine (PCP) and metabolites in brain and adipose tissue and implications for longlasting behavioural effects. Res Comm Chem Pathol Pharmacol. 24:431-445, 1979.

13. Hofmann F. Handbook on drug and alcohol abuse. New York, Oxford University Press. 1975.

14. Walker A, Martin J. Lipid profiles in dioxin exposed workers. Lancet. Feb 24:446, 1979.

15. Pazderova-Vejlupkova J, Lukas E, Nemcova M, Pickova J, Jirasek L. The Development and prognosis of chronic intoxication by tetrachlorodibenzo-p-dioxin in men. Arch Environ Health. 36:5-11, 1981.

16. Wassermann M, Nogueira D, Cucos S, et al. Organochlorine compounds in neoplastic and adjacent apparently normal gastric mucosa. Bull Environ Contam Toxicol. 20: 544-553, 1978.

17. Unger M, Olsen J. Organochlorine compounds in the adipose tissue of deceased people with and without cancer.
Environ Res. 23:257-263, 1980.

18. Baker E, Landrigan P, Glueck C, et al. Metabolic conse quences of exposure to polychlorinated biphenyls (PCB) in sewage sludge. Am J Epidemiol. 112:553-563, 1980.

19. Barsotti D. Reproductive dysfunction in rhesus monkeys exposed to low levels of polychlorinated biphenyls aroclor 1248. Food Cosmet Toxicol. 14:99-103, 1976.

20. Brown G, Nixon R. Exposure to polybrominated biphenyls. J Am Med Asso. 242:523-527, 1979.

21. Holden D. UCLA designing big agent orange study. Science. *21 2:* 905, 1 981 .

22. Libby A, Stone J. The hypoascorbemia-kwashiorkor approach to drug addiction: a pilot study. J Orthomolecular Psych. 6(4), 1977.

23. Chakraborty D, Bhattacharyya A, Chatterjee J, et al. Biochemical studies on poly-chlorinated biphenyl toxicity in rats: manipulation by vitamin C. Int J Vitam Nutr Res. 48:22-31, 1978.

24. Brown 0, Heitkamp M, Song C. Niacin reduces paraquat toxicity in rats. Science. 212:1510-1511, 1981.

25. Century B. A role of the dietary lipid in the ability of phenobarbital to stimulate drug detoxification. J Pharm Exp Ther. 185:185-194, 1973.

26. Clark D, Prouty R. Experimental feeding of DDE and PCB to female big brown bats. J Toxicol Environ Health. 2:917-928, 1977.

27. defreitas A, Norstrom R. Turnover and metabolism of polychlorinated biphenyls in relation to their chemical structure and the movement of lipids in the pigeon. Canad J Physiol. 52:1080-1094, 1974.

28. Wirth A, Schlierf G, Schettler G. Physical activity and lipid metabolism. Klin Wochenschr. 57:1105-1201, 1979.

29. Essen B. Intramuscular substrate utilization during prolonged exercise. Ann NY Acad Sci. 301:30-44, 1977.

30. Richter E, Lay J, Klein W, Korte F. Paraffin stimulated excretion of carbon-14 labeled 2,4,6,2',4' pentachlorobiphenyl by rats. Toxicol Appl Pharmacol. 50:17-24, 1979.

31. O'Neill H, Gershbein L, Scholz R. Identification of pristane in human sebum and related lipid sources. Biochem Biophys Res Comm. 35:946-952, 1969.

32. Henderson G, Wilson B. Excretion of methadone and metabolites in human sweat. Res Comm Chem Path Pharm. 5:1-8, 1973.

33. Vree T. Excretion of amphetamines in human sweat. Arch Int Phamacodyn. 199:311-317, 1972.

34. Parnas J. Excretion of antiepileptic drugs in sweat. Acta Neurol Scandinav. 58:157-204, 1978.

35. Stowe C, Plaa G. Extrarenal excretion of drugs and chemicals. Am Rev Pharmacol. 8:337-356, 1968.

36. Hubbard L. The purification rundown replaces the sweat program. HCO Bulletin. Dec 4, 1979.

37. Hubbard L. Research data on nutritional vitamin increases on the purification rundown. HCO Bulletin. Feb 14, 1980.

38. Hubbard L. Purification rundown case data. HCO Bulletin. May 21, 1980.

39. Snedecor G, Cochran W. Statistical Methods. Ames, Iowa, Iowa State University Press. 1974.

40. Sheppard C, Ricca E, Fracchia J, Merlis S. Indications of psychopathology in male narcotic abusers, their effects and relation to treatment effectiveness. J Psychology. 81:351-360, 1972.

41. Robbins P. Depression and drug addiction. Psychiat Quarterly. 48:374-386, 1974.

42. Lombardi D, O'Brien B, Isele F. Differential responses of addicts and non-addicts on the MMPI. J Projective Techniques. 32:479-482, 1968.

43. Hampton P, Vogel D. Personality characteristics of servicemen returned from Viet Nam identified as heroin abusers. Amer J Psychiat. 130:1030-1032, 1973.

44. Haertzen D, Hooks N. Changes in personality and subjective experience associated with the chronic administration and withdrawal of opiates. J Nervous and mental disease. 148:606-614, 1969.

45. Gilbert J, Lombardi D. Personality characteristics of young male narcotic addicts. J Consult Psychol. 31:536-538, 1967.

46. Sutker P. Personality differences and sociopathy in heroin addicts and nonaddict prisoners. J Abnormal Psych. 78:247-251, 1971.

47. Sutker P. MMPI indices of personality change following short-term and long-term hospitalization of heroin addicts. Psychol Reports. 34:495-500, 1974.

48. Leighty E. Decreased retention of fatty acid conjugated DDT metabolites in rats given injections of heparin, bile salts or lecithin. Res Comm Chem Path Pharm. 31:69, 1981.

49. Bailey D, Shaw R, Cuba J. Phencyclidine abuse: Plasma levels and clinical findings in casual users and in phencyclidine-related deaths. J Anal Toxicol. 2:233-237, 1978.

50. Van Miller R, Marlar R, Allen J. Tissue distribution and excretion of tritiated tetrachlorodibenzo-p-dioxin in non-human primates and rats. Fd Cosmet Toxicol. 14:31-34, 1976.

51. Anderson D, Hickey J. Dynamics of storage of organochlorine pollutants in herring gulls. Environ Pollut. 10(3):183-200, 1976.

52. Findlay G, defreitas A. DDT movement from adipocyte to muscle cell during lipid utilization. Nature. 229:63-65, 1971.

53. Swartz R, Sidel F. Effects of heat and exercise on the elimination of pralidoxime in man. Clin Pharm Therap. 14(l):83-89, 1973.

54. Masoro E. Physiological Chemistry of lipids in mammals. Philadelphia, WB Saunders. 1968.

55. Johnson H, Maibach H. Drug excretion in human eccrine sweat. J Invest DerTn. 56(3):182-188, 1971.

56. Heath G, Stowe C. A preliminary survey of the secretion of certain drugs in equine sweat. Cornell Veterinarian. 62:406-411, 1972.

57. Thayse J, Schwartz I. The permeability of human sweat glands to a series of sulfonamide compounds. J Exp Med. 98:261-268, 1953.

58. Ishiyama 1, Nagai T, Komuro E, Momose T, Akimori N. The significance of drug analysis of sweat in respect to rapid screening for drug abuse. Z Rechtsmed. 82:251-256, 1979.

59. Williams M, Cunliffe W, Williamson B, Forster R, Cotterill J, Edwards J. The effect of local temperature changes on sebum excretion rate and forehead surface lipid composition. Br J Derm. 88:257-262, 1973.

60. Shigematsu N, Ishimaru S, Saito R, et al. Respiratory involvement in polychlorinated biphenyls poisoning. Environ Res. 16:92-100, 1978.

61. Crow K. Lipid profiles in dioxinexposed workers.
Lancet. 982:May 5, 1979.

62. Mosher L. Nicotinic acid side effects and toxicity: A review. Ainer J Psychiat. 126(9):1290-1296, 1970.

63. Hoffer A. Safety, side effects and relative lack of toxicity of nicotinic acid and niacinamide. Schizophrenia. 2:78, 1969.

64. Newbold H. Niacin and the schizophrenic patient. Amer J Psychiat. 127(4):535-536, 1970.

65. Lipid-lowering drugs. Med Letter. 22:16, 1980.

66. Combs G, Scott M. Polychlorinated biphenyl stimulated selenium deficiency in the chick. Poult Sci. 54(4):11521158, 1975.

67. Costil D. Sweating: its composition and effects on body fluids. Ann NY Acad Sci. 301:160-174, 1977.