

# Safety and tolerability of sauna detoxification for the protracted withdrawal symptoms of substance abuse

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## Abstract

**Objective:** Protracted drug withdrawal symptoms can last months or years after drug cessation, often precipitating a return to substance misuse. We evaluated the safety and preliminary health benefits of a unique chemical exposure regimen based on exercise, sauna and therapeutic nutrients.

**Methods:** This was a prospective evaluation of 109 individuals sequentially enrolled into a sauna detoxification component of a multi-modal, long-term residential substance abuse treatment centre.

**Results:** Data from medical charts, client self-reports and Short Form Health Survey (SF-36) responses indicated that the Hubbard sauna detoxification method was well tolerated, with a 99% completion rate, including one human immunodeficiency virus and nine hepatitis C positive clients. There were no cases of dehydration, overhydration or heat illness. Statistically significant improvements were seen in both mental and physical SF-36 scores at regimen completion, as well as in Addiction Severity Index and Global Appraisal of Individual Needs Short Screener change scores at rehabilitation program discharge, compared with enrolment.

**Conclusions:** The regimen lacked serious adverse events, had a very low discontinuation rate and high client-reported satisfaction. The SF-36 data indicated improved physical and emotional symptoms. Therefore, broader investigation of this sauna-based treatment regimen is warranted.

## Keywords

Substance abuse treatment, substance abuse withdrawal, detoxification, human, sauna, nutrient, alcohol, drug, SF-36

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## Introduction

The successful management of addiction must thoroughly address its multifaceted disruptive effects and help people to regain control of their lives. Current best practices emphasize a psychosocial approach with therapeutic adjuncts to prevent relapse. Protracted withdrawal symptoms (signs and symptoms that persist, evolve or appear well past the expected timeframe for acute withdrawal) can precipitate relapse. Such symptoms include cravings, disturbances in sleep and mood, low-level physical discomfort and reduced cognitive function that persist for 6 months to many years after achieving sobriety.<sup>1-4</sup>

Amelioration of withdrawal symptoms is important to patients and improves recovery.<sup>5</sup> Using the RAND Medical Outcomes Study Short Form Health Survey (SF-36), Raish et al.<sup>6</sup> found that well-being improves during the first 4 weeks of substance abuse treatment, a period that includes the acute withdrawal phase, but that subsequent SF-36 scores show little further improvement, levelling out at or slightly below population norms. Despite treatment, perception of well-being in addicted individuals is consistently lower than in the general population<sup>7,8</sup> and in patients with other serious chronic illnesses, such as diabetes and hypertension.<sup>9-11</sup>

There is limited research on the aetiology and mechanism(s) that might explain how symptoms can persist despite a long period of abstinence. Acknowledging that the protracted withdrawal syndrome of addiction may be similar to exposure to other types of chemicals may improve symptom management.

The US Centers for Disease Control and Prevention<sup>12</sup> recommends the recognition and treatment of chemical-related illnesses based on clinical signs or patterns. Multisystem symptoms such as headache,

fatigue, mood changes, sleep disturbances, achiness, numbness, tingling and other generalized symptoms are common signs of chronic exposure.<sup>13</sup>

Exposure to pesticides, environmental endocrine disrupters and heavy metals has striking effects on the dopamine-mediated reward, craving-related and reinforcing effects of drugs.<sup>14</sup> Through mechanisms not yet understood, both drugs<sup>15,16</sup> and environmental chemicals<sup>17</sup> cause neurochemical, behavioural and endocrine alterations, disrupt cortisol and the hypothalamic-pituitary-adrenal axis, and may prolong cravings, depression and dysphagia.<sup>18</sup>

Cecchini & Lopresti<sup>19</sup> presented pilot evidence that cocaine and benzodiazepine metabolites can be detected in the sweat and urine of previously abstinent participants undergoing sauna detoxification. The present study is the first large-scale evaluation of the utility and safety of the Hubbard sauna regimen for addressing the effects of illicit drug use.

The Hubbard detoxification protocol combines exercise, nutrient supplementation and low-temperature sauna to enhance chemical elimination and improve symptoms common to chemical exposures.<sup>20</sup> After the protocol's release in 1979, Schnare<sup>21</sup> described the regimen's safety and ability to reduce symptoms and improve mental functioning among individuals with a variety of chemical or illicit drug exposures. In nearly 40 years of application of this regimen to occupational or environmental exposures, studies have shown statistically significant reductions in human chemical pollutants, including polychlorinated biphenyls (PCBs) and dioxins,<sup>22,23</sup> and subsequent improvements in health.<sup>24,25</sup> Kilburn et al.<sup>26</sup> measured improvements in long-term memory, cognitive dysfunction and peripheral neuropathy among firefighters who completed sauna detoxification 6 months after PCB exposure

from burning transformers. Tsyb et al.<sup>27</sup> described the safety and long-term health improvements in clean-up workers after the Chernobyl disaster. Ross & Sternquist<sup>28</sup> described health improvements and reduced symptoms of chronic neurotoxicity among police officers exposed to methamphetamine during law-enforcement activities.

This paper presents the safety profile, overall client experience, client satisfaction and functional health outcomes of the Hubbard sauna detoxification regimen delivered as one component of a comprehensive residential addiction treatment program. The regimen has been studied primarily in the context of occupational and environmental exposures. This is the first large-scale safety study of the use of this regimen in aiding recovery from illicit drug and alcohol misuse.

## Methods

This was a prospective chart evaluation of a convenience sample of 109 clients consecutively enrolled in the sauna regimen known as the *New Life Detoxification Program* (NLDP); one of ten treatment modalities used in the Narconon residential drug treatment program.<sup>29</sup> This paper represents one aim of a larger outcomes study and was reviewed and approved by Chestnut Health Systems (Bloomington, IL) (IRB Approval #1078-0912).

### *Description of the setting, study group, inclusion and exclusion criteria*

The Narconon of Oklahoma facility was categorized as an ASAM (American Society of Addiction) Level-III Clinically Managed Low-Intensity Residential Service using the American Society Placement Criteria for the Treatment of Substance Abuse Disorders and accredited by the Commission on Accreditation of

Rehabilitation. Medical oversight was provided by a doctor of osteopathy with an addiction specialty and 24-hour nursing staff.

Narconon program exclusion criteria were as follows: As medication is not used as a treatment adjunct, the program does not accept individuals with a history of psychosis, extensive psychiatric treatment or suicide attempts.

Regimen exclusion criteria were as follows: Women who are pregnant or lactating; the presence of active cancer (excluding skin cancer) or current receipt of cancer treatments; individuals who are wheelchair bound; individuals with open and infectious skin lesions; individuals diagnosed with heart disease or who have cardiac medication requirements of sufficient severity to warrant concern based on physician discretion; and any medical condition that contraindicates exercise or exposure to mild heat stress based on physician discretion. Under certain circumstances, the doctor can recommend slight protocol modifications.

Alcohol, medications, drugs of abuse and viral hepatitis (a common sequela of addiction) can cause liver inflammation, as indicated by elevated liver enzymes. Only participants with liver enzymes within range or minimally elevated can begin the NLDP. Individuals with liver enzymes well above the upper limit of normal at enrolment are retested after 3 weeks of abstinence, adequate hydration and occasionally provided herbal liver support, usually OptiCleanse® (Xymogen Inc., Orlando, FL, USA) or milk thistle. If liver enzymes remain elevated, subsequent tests are performed weekly until the individual is cleared for the NLDP.

Inclusion criteria were as follows: Medical examination to assess for exclusion criteria and provide any participation recommendations and written consent to participate in the research, including release of

medical and rehabilitation-related records for review. Two clients declined to participate.

### *Summary of the New Life Detoxification Program (NLDP)*

Prior to participating in the NLDP, clients complete a non-medical withdrawal program that includes communication exercises. Following NLDP completion, clients complete additional behavioural, life skill, relapse prevention and community re-entry steps.

As described by Hubbard<sup>20</sup> and Schnare et al.,<sup>21</sup> regimen components include the following: 1. 20–30 minutes of moderate aerobic exercise (typically running on a treadmill or equivalent); 2. gradient increases of single dose, immediate-release crystalline niacin, starting at 100 mg per day and titrated higher based on niacin flushing and other responses until therapeutic doses are achieved;<sup>30–32</sup> 3. comprehensive nutritional supplementation; and 4. moderate-temperature sauna therapy totaling about 4½ hours daily with frequent breaks for cooling, hydration and electrolyte replenishment.

Trained supervisory staff ensure fidelity; observe and record the response to niacin; monitor fluid and electrolyte intake to avoid dehydration, overhydration, overheating and electrolyte deficits; and record 24-hour physical and/or emotional events. Any injury, potentially infectious symptoms, dehydration, heat events or other perceived health risks, including any that manifest outside of program hours, are referred to on-site 24-hour medical staff for evaluation.

Participation is daily. The response to niacin is patient specific and determines whether or not the dose will be increased. Program completion is typically achieved in 2–4 weeks.

The 8–10-person sauna is constructed of birch wood and equipped with flow-through venting to the outside and a floor drain. A tempered glass door permits direct assessment of sauna participants by trained supervisory staff. A stable temperature of 60–80°C is produced by granite stones surrounding a ceramic heat coil with a 15,000-W capacity, (240 V, 62.5 A) and monitored by regimen staff. Consistent with protocol specifications,<sup>20</sup> the heater emits full spectrum infrared wavelengths and matches the type of sauna conditions that have been used for thousands of years.<sup>33</sup> A non-toxic, dilute fragrance-free soap solution is used to clean the sauna daily.

All participants received client orientation that comprised a description of the regimen steps and theory. As explained above, when substances are released from bodily stores, such as fat (adipose), a person may re-experience to some degree a sensation of exposure. Clients are instructed to report all emotional and physical events on a structured Daily Report Form used for case management.

Supervisory staff set expectations for proper schedules, sleep, hydration, increased vegetable intake and other habits in accordance with the physical rigor that participation in the regimen demands. All individuals are trained in basic cleanliness protocols to prevent disease transfer; additional hygiene steps are followed for individuals who are positive for viral hepatitis or human immunodeficiency virus (HIV) antisera.

### *Outcome measures and analysis*

A structured Daily Report Form is completed for every client during each daily session. The NLDP system of ‘measurement-based care’<sup>34</sup> includes client blood pressure and weight at the start and finish of each session, exercise duration, sauna duration, niacin dose and effects, additional vitamins

and doses, quantity of water and electrolytes consumed, hours and quality of sleep, and 24-hour physical and emotional events. Following specific written guidelines, these measures guide decisions about changes to niacin and supporting nutrient doses, monitor and correct any therapy drift and monitor client progress through to completion.

Medical records data includes enrolment medical examination and drug use report, comprehensive metabolic panel and complete blood count, HIV and hepatitis anti-sera tests, plus subjective, objective, assessment and plan (SOAP) notes from any visits to medical personnel during participation in the detoxification protocol.

The SF-36<sup>35</sup> measures health-related quality of life. The respondent answers 36 questions about how they have felt in the last 4 weeks. The SF-36 has been validated as a substance abuse treatment outcomes measure and clinical tool.<sup>36</sup> It provides an 8-scale profile of functional health and well-being scores as well as psychometrically based physical and mental health summary measures, allowing for comparisons between patients with a wide range of health problems.<sup>34</sup>

A Treatment Process Questionnaire (TPQ) developed for this project assesses the client's understanding of each completed program component, their satisfaction with it and the perceived benefit to treatment goals. At completion, participants are also asked to summarize any 'success'.

The Addiction Severity Index (ASI)<sup>37</sup> and the Global Appraisal of Individual Needs Short Screener (GAIN-SS)<sup>38</sup> are completed by interview at enrolment and discharge, and will be followed up at 6 months and 1 year as part of a larger trial. The ASI is a semi-structured, 175-item interview designed to address seven potential problem areas in substance-abusing patients: medical status, employment and support, drug use, alcohol use,

legal status, family/social status and psychiatric status. The GAIN-SS measures severity of four independent dimensions of emotional/behavioural health problems as well as the recency of the problem in the past 30 days, past 90 days, during the previous year or over the lifetime.<sup>39</sup>

### **Data extraction**

Study staff extracted all physical and emotional events noted on the Daily Report Forms into Excel spreadsheets, regardless of whether they were anticipated (e.g. the flush response to niacin) or unanticipated. All visits to medical professionals, the reason for the visit and the findings were also tabulated. Because the regimen requires a 7-day/week rigorous schedule, data were also compiled for missed treatment days and categorized into medical or non-medical causes.

Clients enter SF-36 and TPQ data (including open-ended, essay-style program comments) directly into a data-protected electronic records database. Narconon staff enter ASI and GAIN-SS interview answers, program start and end dates, start and completion dates for each modality, failure to complete and client-given reason for not completing. As the records are data protected, responses on each instrument cannot be changed once entered and any changes to completion status or other information entered by Narconon staff are recorded in a change log.

Data cleaned of identifiers except a unique study ID were uploaded into SPSS version 22 (SPSS Inc., Chicago, IL, USA) for analysis. The means and standard deviations of test scores were compared before and after program participation. Statistical significance was calculated using two-tailed Student's t-tests with paired scores for pre/post comparisons or unpaired scores for comparison with published SF-36 general population norms.

## Results

### *Client demographics and drug use characteristics*

Tables 1 and 2 show the distribution of age, sex and primary drug of choice of the 109 participants. Two pregnant clients were ineligible for this component of the Narconon program and their data were therefore excluded from the results. This project reviews the remaining 107 individuals (33 women and 74 men) enrolled in the New Life Detoxification portion of the Narconon program.

### *HIV and hepatitis antisera, and liver enzymes*

Nine individuals were hepatitis C (HepC) positive and one was HIV positive. The HIV positive and all but one of the HepC positive participants had within-range liver enzyme profiles; one HepC positive participant had 174 U/L gamma-glutamyl transferase (GGT) at enrolment that normalized prior to beginning the NLDP.

At program enrolment, four individuals had aminotransferases (AST and/or ALT) elevated more than twice the normal range (109–222 U/L and 149–359 U/L, respectively) and one of these individuals also had 209 U/L GGT, all of which normalized with abstinence. An additional six individuals had a GGT range of 151–391 U/L at enrolment, which normalized with abstinence.

ASI and GAIN-SS scores are presented to provide a broader understanding of the

clientele for potential comparison with other substance abuse populations. Tables 3 and 4 show the ASI and GAIN-SS means of the 109 participants at baseline (program intake) and the same statistics for the 76 participants who completed all 10 program modalities and were discharged. The New Life Detoxification regimen is an early program step followed by a series of behavioural and life skills modalities. At the time of data analysis, 13 clients remained active in the behavioural and life skills portions of the Narconon program; 18 had discontinued treatment without completing the behavioural and life skills series.

Table 3 shows the mean ASI scores. In the ASI, composite scores are not compared with each other. In other words, a drug use score lower than the employment score does not indicate that employment is a more

**Table 2.** Primary drug of choice<sup>a</sup> (n = 109).

Opiates	58
Methamphetamine	18
Alcohol	17
THC	5
Polysubstance <sup>b</sup>	3
Cocaine/Crack	3
Amphetamine	2
Other non-opiate analgesic	3

<sup>a</sup>Of participants, 78% reported using more than one drug; listed drug is primary preferred drug of choice.

<sup>b</sup>The polysubstance case definition used was as follows: psychologically addicted to the intoxicated state without a preference for one particular substance; reporting three or more primary substances.<sup>102</sup>

THC: tetrahydrocannabinol.

**Table 1.** General demographics.

	n =	Mean age	Median age	Range	Sauna program days
All	109	28.4	25	18–59	14–48
Not medically qualified*	2	23	23	n/a	0
Male	74	29.7	27	18–59	17–48
Female	33	25.5	24	18–46	14–40

\*Participation in the New Life Detoxification Program is contraindicated with pregnancy.

**Table 3.** Addiction Severity Index (ASI) intake baseline to discharge paired-samples t-test results.

	Intake		Discharge		p = *
	Mean n = 109	SD	Mean n = 76	SD	
Alcohol use	0.21	0.293	0.00	0.023	0.000
Drug use	0.28	0.159	0.00	0.008	0.000
Psychiatric status	0.06	0.117	0.01	0.004	0.000
Legal	0.32	0.289	0.08	0.107	0.000
Employment	0.60	0.261	0.72	0.225	0.000
Family/Social	0.099	0.150	0.02	0.069	0.000
Medical status	0.17	0.279	0.02	0.085	0.000

\*Based on 2-tailed t-test.

ASI scores range between 0.000 (no relative problem) and 1.000 (most severe problem). Scales are not relative to each other.

SD: standard deviation.

**Table 4.** Global Appraisal of Individual Needs (GAIN-SS) intake baseline to program discharge (D/C) paired-samples t-test results.

GAIN-SS scale	Last 30 days			Last 90 days			Past year			Lifetime Intake
	Intake	D/C	p =	Intake	D/C	p =	Intake	D/C	p =	
Internalizing disorder	2.64	0.08	0.000	3.21	1.27	0.000	3.66	3.29	0.056	4.10
Externalizing disorder	1.83	0.11	0.000	2.64	0.79	0.000	3.36	3.23	0.626	4.35
Substance disorder	3.72	0.00	0.000	4.18	0.97	0.000	4.52	4.57	0.748	4.75
Crime/Violence	1.43	0.00	0.000	2.05	0.27	0.000	2.52	2.56	0.858	3.56
Total disorder	9.63	0.19	0.000	12.07	3.29	0.000	14.07	13.65	0.483	16.76

\*Based on 2-tailed t-test; p-values compared with intake.

**GAIN-SS interpretation:** a score of 1+ is considered moderate/high for each of the first four screeners; a score above 3 is high on the Total disorder screener. Internalizing disorder suggests a need for mental health treatment related to somatic complaints, depression, anxiety, trauma, suicide and, at extreme levels, more serious mental illness. Externalizing disorder suggests a need for mental health treatment related to attention deficits, hyperactivity, impulsivity, conduct problems and other impulse control disorders. Substance disorder evaluates the need for substance abuse, dependence and substance use disorder treatment, including the management of withdrawal, maintenance and craving reduction. Crime/Violence shows the need for help with interpersonal violence, drug-related crimes, property crimes and, in more extreme cases, interpersonal/violent crimes. Generally, the past-month count is used to measure change; the lifetime measure is used to predict risk of future relapse; higher numbers indicate greater risk of relapse.<sup>39</sup>

severe problem. It was expected that the employment composite score would increase for clients in a residential rehabilitation program. The ASI has been used extensively for treatment planning and outcome evaluation.

### Treatment length and completion rates

The length of the full Narconon residential program averaged 102 days among this

group. As shown in Table 5, the portion of time in treatment prior to commencing the NLDP was approximately 2 weeks (14 days) and the NLDP averaged 29 days. The completion rate for the NLDP was 99%.

### Client self-report experience of the sauna detoxification regimen

Table 6 shows the frequency of NLDP TPQ responses as a percentage of total

**Table 5.** New Life Detoxification Program and total program length.

	Mean	Median	Range
#Days intake to sauna: n = 107	14	13	6–42
#Days to complete sauna n = 106	29	26	14–48
#Days end of sauna to discharge n = 76 graduates*	59	56	24–182
#Days total program length n = 76 graduates	102	99	39–239

\*To date, 13 clients were still active in the behavioural and life skills portions of the Narconon program and 18 had discontinued treatment.

**Table 6.** Treatment process questions at New Life Detoxification Program (NLDP) completion.

(n = 106)

How clearly do you remember the material covered in the Narconon New Life Detoxification Program?	
Very clearly	85.2%
Somewhat clearly	14.8%
Not very clearly	0.0%
Not clearly at all	0.0%
How helpful did you find the material in the NLDP Orientation?	
Very helpful	81.7%
Somewhat helpful	17.4%
Not very helpful	0.9%
Not helpful at all	0.0%
How satisfied are you with your experience with the NLDP?	
Very satisfied	95.7%
Somewhat satisfied	4.3%
Somewhat dissatisfied	0.0%
Very dissatisfied	0.0%
Statements on completion of the regimen (unstructured, open-ended essays)	
Improved energy	68%
Can think clearly; clarity, acuity	51%
Drug/chemical free	54%
Emotionally stable	45%
Improved fitness, sight/smell/ other senses or fewer physical symptoms	31%
Positive outlook, ability to fix situation	31%
Now sleeps well	28%
No cravings	26%
Happy	25%
Back to myself	22%
Other general health & well-being	20%

responses. The final question is an open-ended, essay-type question asking participants to state their program perceptions. Participants returned answers averaging 94 words (range 14–250 words).

Every participant noted positive improvements: 68% reported improved energy levels, 51% said they could now 'think clearly', 54% stated that they were drug and chemical free (although all the participants understood that this was an aim of the regimen), 28% stated they could now sleep well despite irregular sleep patterns at the start of the regimen, 26% remarked that they no longer craved drugs or alcohol. Responses included a diverse array of physical changes, from healed track marks to mitigated pain, improved vision or hearing and a positive outlook or certainty regarding repairing social situations and living a drug-free life.

### *Change in health-related quality of life with sauna detoxification*

The SF-36 scoring mechanism produces an 8-scale profile of functional ability and physical and mental well-being in the last 4 weeks. Table 7 and Figure 1 show SF-36 change scores at program enrolment (intake), prior to the start of the NLDP and at completion of the NLDP, as well as the discharge scores for those who had completed the full program as of this



**Table 7.** Mean SF-36 health-related quality of life scores. Comparison of baseline (intake), changes during the New Life Detoxification Program (NLDP), full program discharge, and published population norms using RAND methodology.

	Intake n = 107		Pre-sauna n = 107		Post-sauna n = 106		Discharge n = 76		RAND norm n = 2471	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Physical functioning	84.46	21.78	91.19	15.13	95.37	14.61	97.76	6.95	70.61	27.42
Role limitations due to:										
Physical health	56.53	42.87	75.37	38.06	96.03	15.41	99.01	8.60	52.97	40.78
Emotional problems	50.45	44.24	73.13	38.59	97.51	11.85	100	0.00	65.78	40.71
Energy/fatigue	45.50	20.96	57.84	21.02	76.31	14.66	86.97	11.75	52.15	22.39
Emotional well-being	52.43	20.40	65.91	20.54	86.36	10.58	94	7.23	70.38	21.97
Social functioning	54.39	25.98	70.34	22.28	93.46	11.69	99.01	4.45	78.77	25.43
Pain	63.29	26.02	70.71	26.16	89.49	14.17	94.57	11.96	70.77	25.48
General health	58.29	20.99	72.31	18.82	87.66	11.72	92.7	10.53	56.99	21.11
Health change	50.23	26.44	74.25	25.36	94.63	11.91	96.71	11.06	59.14	23.12

Comparison of intake/pre-sauna scores  $p < 0.001$  for all scales except Physical functioning ( $p = .027$ ), Role limitations due to physical health ( $p = 0.003$ ) and Pain ( $p = 0.067$ ) (2-tailed t-test).

Comparison of pre/post scores  $p < 0.001$  for all scales except Physical functioning ( $p = .072$ ) (2-tailed t-test).

Comparison of post-sauna scores with discharge scores  $p < 0.001$  except Physical functioning ( $p = 0.188$ ), Role limitations due to physical health ( $p = 0.129$ ), Role limitations due to emotional health ( $p = 0.069$ ), Pain ( $p = 0.012$ ), General health ( $p = 0.003$ ) and Health change ( $p = 0.231$ ).

Comparison of post-detoxification mean scores with RAND norms yields  $p < 0.001$  based on 2-tailed Z-test.

SD: standard deviation.

analysis. Pre- and post-NLDP scores and full program discharge scores were compared with baseline scores and with SF-36 US adult population norms.

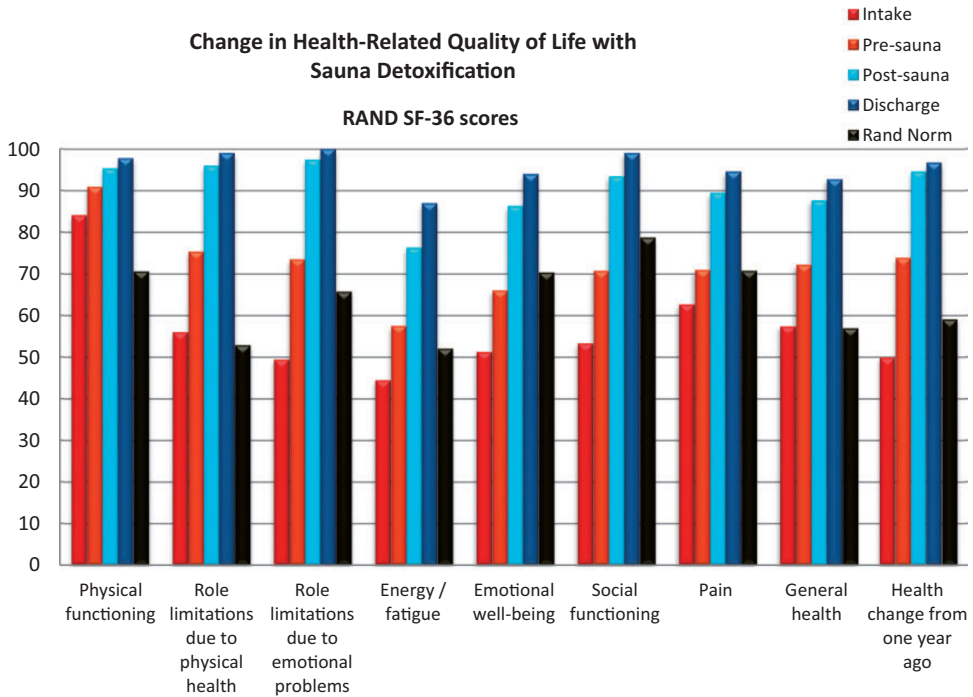
The SF-36 yields scores from 0–100 for eight scales. Higher scores indicate better self-assessed health and well-being: Physical Functioning (PF), Role Limitations due to Physical Health (RP), Role Limitations due to Emotional Problems (RE), Energy/Fatigue (EF), Emotional Well-being (EW), Social Functioning (SF), Bodily Pain (BP) and General Health (GH), plus one question about perceived health change in the last year.

For five of the scales (PF, RP, RE, SF and BP), a score of 100 indicates the absence of limitations or disability. On three scales (EF, EW and GH), a score of 100 indicates a positive state of well-being.

As a guide, a change of 4 points is clinically significant<sup>35</sup>.

At enrolment, program participants reported greater PF scores than RAND population norms and similar PF and GH scores, but greater impairment on all other scales. During the 2-week acute withdrawal phase, all scale scores improved from baseline:  $p < 0.001$  for all scales except PF ( $p = .027$ ), RP ( $p = 0.003$ ) and BP ( $p = 0.067$ ) and scores on all scales except EW and SF approached or exceeded population norms.

During the 2–5-week NLDP sauna regimen, all scale scores continued to increase such that post-detoxification scores greatly exceeded population norms for four scales (PF, RP, RE and SF), approaching or equal to 100 ( $p < 0.001$ ). Change scores on each scale were greater than improvements measured during the withdrawal phase.



**Figure 1.** Change in health-related quality of life with sauna detoxification. Short Form Health Survey scores.

*Anticipated and unanticipated discomforts and medical events during sauna detoxification*

The US Food & Drug Administration defines an adverse event as ‘any undesirable experience associated with the use of a medical product in a patient’ and provides a list of what problems are considered serious.<sup>40</sup>

Table 8 shows the frequency of different reported events and whether or not the event led to a medical consultation, missed treatment day(s) or program discontinuation. The most frequent reason for physician visits was body aches. Although this may be regimen-related, it is also a result of the osteopathic physician–participant relationship and the convenience of osteopathic manipulations.

Common reasons for missing treatment days were insufficient sleep (10% of clients), unrelated medical appointments (10%, usually off-site; see footnote to Table 8) and digestive discomfort (7%). Per protocol, patients who achieve less than 6.5 hours of sleep have their next day’s treatment shortened to a minimum of 2.5 hours. Clients who have had insufficient sleep to tolerate even a shorter session instead receive hands-on assistance to remedy the sleeplessness. As the NLDP regimen is delivered 7 days a week, some clients have legal, dental and other appointments that cannot be rescheduled and cause missed days.

Of the 107 eligible individuals, only one did not complete the regimen. Non-completion was owing to excessive program

**Table 8.** New Life Detoxification Program protocol unanticipated events and safety.

n = 107 clients (individuals commonly experience multiple sensations)					
	Number who experienced transient event	Event caused missed Tx day	Medical consultation; did not miss Tx day	Medical consultation; missed Tx day	Event caused discontinued Tx
Niacin flush, itchy skin	107	0	0	0	0
Emotional, irritable, despondent	80	4	0	0	0
Re-experience of drug sensations	74	3 <sup>a</sup>	0	0	0
Fatigue, lethargy	55	0	0	0	0
Sleeplessness, vivid dreams	44	11 <sup>b</sup>	0	0	0
Body aches	44	5 <sup>c</sup>	13 <sup>c</sup>	5 <sup>c</sup>	0
Headache	33	1	2	0	0
Stomach cramps, nausea, diarrhoea	33	8	1 <sup>d</sup>	5	0
Drug cravings	24	0	0	0	0
Skin rash	23	1	3	1	0
Cough, congestion, sore throat	19	3	1	3	0
Unrelated doctor's or other appointment	15	11 <sup>e</sup>	4 <sup>f</sup>	4 <sup>f</sup>	1 <sup>g</sup>
Flu-like symptoms; no fever	7	2	2	1	0
Asthma/allergies	6	0	6	0	0
Colour or particulate discharge	4 <sup>h</sup>	0	0	0	0
Flu-like symptoms with mild fever	0	0	0	0	0

<sup>a</sup>Two individuals were 'dope sick' (with nausea) and one experienced an 'alcohol hangover'; each had insufficient sleep to participate in the next day's session (see note b).

<sup>b</sup>Per protocol, patients who have less than 6.5 hours of sleep have their next day's treatment shortened to a minimum of 2½ hours. If an individual has not had sufficient sleep to tolerate even this abbreviated treatment, then that individual entirely skips that day.

<sup>c</sup>Physician performs wellness checks and osteopathic manipulative therapies for pain management; these are often requested. Notable events include one sprained ankle from the running portion of the regimen, two backaches that created insufficient sleep (one from a pre-existing motorcycle accident, one because the individual elected to skip that day against advice), and one shoulder ache from a pre-existing injury.

<sup>d</sup>Gastric symptoms from pre-existing hiatal hernia returned during the regimen. Patient had a medical consultation and then 2 days later missed 1 day when acute symptoms worsened to flu-like symptoms without a fever. Dietary adjustment over a period of 7 days while continuing the regimen resolved all symptoms.

<sup>e</sup>Two individuals missed 2–3 days owing to court appearance or probation meeting requirements; two individuals took a day off to visit with family and another missed because of a religious observance. Five individuals scheduled unrelated medical appointments (see note f).

<sup>f</sup>Appointments included review of pre-existing high cholesterol test, wellness check, responding to patient questions, request reduced medication dosage. Missed days: three routine dental appointments and one complicated tooth extraction followed by 17 missed days before resumption of regimen was possible.

<sup>g</sup>One individual repeatedly violated facility regulations and detracted from other participants' programs. This individual was referred to a higher level of care after starting this regimen. Additionally, one client returned a positive pregnancy test 2 days after starting the regimen and was discontinued, as this regimen is contraindicated with pregnancy.

<sup>h</sup>Three individuals noted coloured sweat; two who worked in oil fields described black soot mid-program, a third noted 'grey resin similar to crack resin'. The fourth individual monitored the movement and subsequent expulsion of a piece of glass that had been embedded in his forehead for 8 years.

Tx: treatment.

rule violations resulting in referral to a higher level of residential care.

## Discussion

### *Why might a chemical exposure regimen benefit the substance-abusing population?*

*Drugs add to the complex toxic chemical milieu that affects health and behaviour.* In terms of chemical exposures, the concept of detoxification, more accurately 'biotransformation', refers to the metabolic processes by which the toxic qualities of a substance are reduced and then eliminated by the body, potentially resulting in diminished symptoms. In substance abuse treatment, reductions in acute (primarily physical) symptoms, such as sweating, nausea, rapid heart rate and intense drug craving, determine when withdrawal may be considered clinically complete; this typically occurs in a few weeks. However, a constellation of symptoms, including cravings, disturbances in sleep and mood, anxiety, low-level cravings and reduced cognitive function, can last months or years.<sup>1-4</sup>

Like environmental metals and chemicals,<sup>41</sup> recreational drugs such as tetrahydrocannabinol, opiates and cocaine share the capacity to be stored in body tissues.<sup>19</sup> Metabolic clearance as detected in blood, urine and oral fluid ceases after a few days for most illicit drugs but may persist up to 4 weeks for cannabis and cocaine users.<sup>42</sup> However, there is limited data regarding the sequestration to tissues and long-term storage effects.<sup>19</sup> Further, many drugs of abuse are also contaminated (either during their manufacture or intentionally) with chemicals such as additives, metals<sup>43</sup> irritants and neurotoxins,<sup>44-46</sup> which have the potential to cause serious health issues.<sup>47,48</sup>

Chemical compounds that are fat soluble or have certain ionic structures readily penetrate the blood-brain barrier, myelin, axonal membranes and synaptic terminals.

This applies to most medications and illicit drugs, as well as most pesticides and many persistent organic pollutants. In addition to their temporary effects, compounds with these properties have the potential to alter the normal activity of the nervous system in long-term, neurotoxic fashion. Whether or not the striking changes in architecture and function<sup>49-53</sup> are caused by residual drug or chemical stores, underlying cellular changes, or both, is as yet unclear, despite popularly held beliefs about the safety of low-level use.

*Illicit substances and toxic chemicals share biotransformation pathways.* Biotransformation of both drugs and toxic chemicals involves members of the large cytochrome P450 family (CYP), paraoxonase (PON1; involved in the biotransformation of organophosphate pesticides), glutathione S-transferase and numerous other genes and enzymes.<sup>54-57</sup>

Both chemically sensitive and addicted individuals have polymorphisms in the genomic neighbourhoods that regulate the biochemical breakdown and elimination of neurotoxic substances such as drugs, metals and pesticides.<sup>58</sup> For example, the well-characterized aldehyde dehydrogenase (ALDH2) gene alteration increases sensitivity responses such as flushing and hangovers<sup>59,60</sup> as well as sensitivity to certain environmental chemicals.<sup>60</sup> Reduced ALDH2 enzyme activity elevates acetaldehyde, thereby increasing the risk of cellular damage<sup>61</sup> and various cancers,<sup>62,63</sup> probably via folate and alcohol metabolic pathways.<sup>64</sup>

Molecular science research on addiction susceptibility has identified polymorphisms potentially related to risk phenotypes representing both environmental events (e.g. flushing and other enzymatic pathways) and psychosocial forces (e.g. impulsivity, reward pathways and disinhibition).<sup>65,66</sup> Cuyàs et al.<sup>67</sup> have shown that CYP2D6

polymorphisms alter 3,4-methylenedioxy-methamphetamine (MDMA; 'Ecstasy') biotransformation, which impairs cognitive function and causes other health effects. Using a mouse model, Cheng et al.<sup>68</sup> have shown that enhanced expression of the CYP2D6 detoxification enzyme results in a heightened ability to adapt to serotonin-mediated anxiety pathways.

*Both drugs and toxic chemicals influence dopamine reward pathways.* Exposure to pesticides, environmental endocrine disruptors and heavy metals has striking effects on the dopamine-mediated reward, craving and reinforcing effects of drugs.<sup>14</sup> Many of these effects are caused by chemicals that bio-accumulate. The most studied oestrogen mimetic of this type is bisphenol A (BPA). BPA exposure during development heightens adult sensitivity to the reward effects of opiates.<sup>69,70</sup> Animal studies show that oestrogen-like chemicals modulate the dopamine-associated behavioural and reward effects of illicit drugs, cocaine and amphetamines.<sup>71,72</sup> Even heavy metal exposure appears to both predispose to later addiction and increase relapse risk.<sup>73</sup>

*The reactive oxygen species: the nitric oxide–peroxynitrite cycle.* The above mechanisms are thought to require the presence of a causative compound. However, the inducible nitric oxide synthase (iNOS) pathway may explain persistent cravings, inflammation and even disease after environmental exposure has ceased.

Comprising a family of omnipresent cellular messengers, three NOS isoforms produce nitric oxide (NO), the physiologic function of which varies widely depending on cell type. In a variety of cell types, including brain astrocytes, N-methyl-D-aspartate (NMDA) receptor-mediated iNOS activity elevates NO and its downstream product peroxynitrite (ONOO<sup>-</sup>), leading to progressive hypersensitivity of

local NMDA receptors<sup>74,75</sup> and cellular damage by inhibiting the mitochondrial respiratory chain, which leads to energy failure and ultimately cell death.<sup>76,77</sup> iNOS has been shown to interact with both xenobiotics and a range of drug compounds<sup>75,78</sup> and is implicated in both the cravings and tolerance associated with a variety of abused substances.<sup>79,80</sup>

### *How might the Hubbard regimen produce improvements in well-being and health?*

*Nutritional elements of the regimen.* Smoking, drinking and both licit and illicit environmental chemicals increase oxidative stress and other inflammatory markers.<sup>81</sup> The regimen improves the general diet and provides a broad range of micronutrients that correct nutrient status and support healing.

Although participants are not asked to follow a specific dietary regimen, they are instructed to consume vegetables daily and consumption is tracked on the Daily Report Form. Ingestion of fruits and vegetables provides general protection from the effects of chemical toxins.<sup>82</sup> Increased vegetable consumption provides nutrients such as  $\alpha$ -lipoic acid, which can upregulate ALDH2,<sup>83</sup> and isothiocyanates, which act through a variety of mechanisms, including epigenetic induction.<sup>84</sup>

In addition to general dietary improvements, some dietary oils, vitamins and minerals help remediate the reaction products of drug and alcohol degradation, particularly those leading to liver damage (acetaldehyde, nicotinamide adenine dinucleotide with hydrogen and reactive oxygen species) and hepatic encephalopathy.<sup>85</sup>

*Crystalline niacin (vitamin B3).* A comprehensive review of niacin mechanisms is beyond the scope of this paper; however, a few key activities warrant discussion.

### *Improved Phase II xenobiotic biotransformation.*

Niacin coenzymes, particularly in the form of nicotinamide adenine dinucleotide, are required for more than 500 enzymatic reactions, including biochemical pathways that modify foreign compounds during their biotransformation and elimination.<sup>86,87</sup> Niacin coenzymes may increase the rate of phase II biotransformation, especially in the liver, a process by which free radicals activated during phase I are rapidly conjugated with glutathione or other compounds and rendered less toxic.<sup>88</sup>

*Release of fat-stored compounds into the bloodstream.* Although the regimen does not involve fasting, early research demonstrated that fat-stored chemicals are released into the bloodstream when fatty acids are released during fasting.<sup>89,90</sup> Although crystalline niacin initially inhibits adipose free fatty acid release, lipolysis begins approximately 2 hours after ingestion and is maintained for at least 4 hours.<sup>91,92</sup> Several recent studies have replicated the 2–6-hour niacin-mediated release of free fatty acids and explored niacin's beneficial utility in cardiovascular disease by correcting serum lipid profiles by reducing concentrations of very low-density lipoprotein triglyceride and low-density lipoprotein cholesterol and increasing high-density lipoprotein cholesterol.<sup>93–95</sup>

*Sauna and exercise influence physiological states.* Many studies show the benefits of exercise in promoting deep circulation in the tissues and mobilizing lipid from storage depots.<sup>96–99</sup> Both processes aid tissue oxygenation, nutrient status and healing.

Kukkonen-Harjula<sup>100</sup> has suggested that sauna induces subtle endocrine changes, including raised noradrenaline and beta-endorphin levels and activation of the renin–angiotensin–aldosterone system. Although these changes usually normalize

post-treatment, they may partially explain the physical relief described by participants.

Interestingly, sauna therapy and exercise both lower NO levels by upregulating tetrahydrobiopterin (BH<sub>4</sub>) production in vascular tissues as well as through a heat-shock protein-mediated (Hsp90) pathway that slows BH<sub>4</sub> degradation. Increased availability of BH<sub>4</sub> leads to lower NO levels.<sup>101</sup>

### *Limitations*

This was an uncontrolled, pre–post, intervention safety study of a convenience sample participating in the NLDP sauna regimen as one component of a multimodal residential substance abuse treatment program that emphasizes behavioural change and life skills. The reported outcome changes should be interpreted with caution. Pre–post-sauna detoxification improvements in health and well-being may be a result of the regimen; however, without a comparison group, it is impossible to know how much change might have occurred over the same length of time from continued sobriety, strong expectations or placebo effect. Intensive daily contact, exercise and improved nutrition may account for improvements regardless of actual elimination of residual drug metabolites, which was not demonstrated or quantified in this study. ASI and GAIN-SS scores were not obtained immediately before or after the NLDP, only at enrolment and discharge for the full program, of which the NLDP is an early component. Future work will measure the observed health changes more precisely.

Future controlled studies should address these limitations and examine the mechanisms of action underlying the measured improvements. These could include validated measurement tools to capture changes in cognitive function, craving and symptoms associated with protracted withdrawal, as

well as forensic-quality testing for drug metabolite release.

## Conclusions

To our knowledge, this is the first large study of a sauna-based chemical detoxification program provided as part of a substance abuse treatment program. Most of the anticipated and unanticipated events experienced during this regimen were transient discomforts. There were no serious medical complications and the program was tolerated well even by individuals with hepatic stresses, if they were given enough abstinence time to permit the liver to begin to heal. The level of client orientation appeared appropriate and sets expectations for managing the anticipated non-harmful flush associated with immediate-release niacin, as well as the discomforts that clients associate with past drug use or chemical exposures.

Completion of the NLDP was accompanied by measurably improved functional health and well-being in both physical and emotional domains. On some SF-36 scales, these improvements were greater than improvements measured during the prior 2 weeks, on average, of acute withdrawal; a phase completed when nursing staff authorize medical release after physical withdrawal symptoms subside. As continued low motivation, physical pain and discomfort, cognitive fogging, emotional difficulties, low-level cravings and disturbances in sleep are among the key triggers for drug relapse after treatment, additional improvements in these areas may be important for stable recovery.

Participants expressed high levels of satisfaction with the regimen, noting improved energy, mental clarity, emotional stability, reduced cravings, greater well-being and a positive life outlook.

Owing to the prevalence of recurrent addiction cycles and the associated

enormous cost and social consequences, the safety and beneficial health effects of the sauna-based Hubbard detoxification protocol demonstrated here suggest the need for additional studies. Important issues that remain unresolved include additional measurements of physical and mental health changes and investigation of whether these are improved through toxic elimination, nutrient and systems restoration or both.

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