

## **Problematic Substance Use Identified in the TBI Model Systems National Dataset**

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This technical report is intended as a resource to researchers in traumatic brain injury (TBI) who are studying substance use disorders or would like to include a measure of this construct in the data they are collecting. While the measurement portions of this review are based on the TBI Model Systems methodology, that method is in turn based on the most widely used surveys of substance use in the general population—the National Household Survey on Drug Abuse (Substance Abuse and Mental Health Services Administration, 1998) and the Behavioral Risk Factors Surveillance System (Centers for Disease Control and Prevention, 1998). Thus, this information should be useful to researchers regardless their involvement in the TBI Model Systems.

This report is organized into three sections:

- Research on Traumatic Brain Injury and Substance Abuse;
- Defining Problematic Use of Alcohol and Other Drugs; and
- Measurement of Substance Use in the TBI Model System.

The first two sections provide background information that is useful for considering measurement issues presented in the third.

### **Research on Traumatic Brain Injury and Substance Use Disorders**

Substance use disorders (abuse and dependence) are more prevalent among persons with disabilities than society in general (Center for Substance Abuse Treatment, 1998); yet, research and treatment specific to this segment of the population has been minimal (National Association on Alcohol Drugs and Disability, 1998). Among disability groups with unique issues of substance use are those individuals who have experienced TBI. There has always been acknowledgment of the relationship between intoxication and injury (Jernigan, 1991; Dikmen, Machamer, Donovan, Winn & Temkin, 1995; Corrigan, 1995), but only more recently has attention been given to the mediating effects of substance use disorders on rehabilitation outcomes following TBI (Corrigan, 1995; Dikmen et al., 1995; Kreutzer, Witol, Sander, et al., 1996; Corrigan, Bogner & Lamb-Hart, 1999). Clinicians and researchers have repeatedly observed that cognitive and emotional impairments caused by brain injury present unique problems when addressing co-existing substance use problems (Langley, 1991; Center for Substance Abuse Treatment, 1998; Corrigan et al., 1999).

Young adult males are among the highest risk groups for TBI, with most injuries occurring as the result of moving vehicle crashes (Thurman, 1998). Alcohol is a major contributor to the occurrence of these injuries. Equally troubling is the proportion of adolescents and adults hospitalized for TBI who have pre-injury substance use disorders. Among patients receiving acute medical rehabilitation, as many as two-thirds have evidence of premorbid substance use disorders (Corrigan, 1995). A longitudinal study at Ohio State University found 58% of a consecutive sample of 350 patients admitted to the Brain Injury Unit had prior histories of substance use disorders using DSM-III-R criteria.

There is growing evidence that persons with TBI and substance use disorders have significantly worse problems than persons with TBI alone. Among patients with the most severe brain injuries, alcohol or other drug consumption declines in the immediate post-injury period; however, many people tend to return to pre-injury levels of use by two years post-injury (Corrigan, Rust & Lamb-Hart, 1995; Kreutzer, Witol & Marwitz, 1996; Corrigan, Smith-Knapp & Granger, 1998). Between 10% and 20% of persons who abstained or were light drinkers pre-injury, become high volume users after (Kreutzer, Witol, Sander, et al., 1996; Corrigan, et al., 1995). Persons with TBI and substance abuse problems are less likely to be working (Kreutzer, Witol, Sander, et al., 1996; Bogner, Corrigan, Spafford & Lamb-Hart, 1997; Corrigan, Bogner, Mysiw, Clinchot & Fugate, 1997), and have lower life satisfaction (Bogner et al., 1997).

A measure of problem substance use derived from variables in the TBI Model Systems National Dataset (described below) indicates that approximately half (48%) of subjects show problem use before their injuries. A premorbid history of problem use was significantly ( $p < .01$ ) more frequent in males (53% vs. 33%), those with a high school education or less (51% vs. 42%), those unemployed at injury (68% vs. 44%), those with a history of prior TBI (59% vs. 47%), those with an arrest record pre- and post-injury (72% vs. 32% and 67% vs. 45%, respectively), and those intoxicated due to alcohol at time of injury (76% for  $BAL \geq .08$ , vs. 41% and 33% for those  $< .08$  and not tested, respectively).

Clinical experience suggests that persons with TBI face several challenges when seeking treatment from chemical dependency treatment providers. Cognitive impairments may affect a person's learning style, making participation in didactic training and group interventions more difficult. Misinterpretation of memory problems as resistance to treatment can undermine a treatment relationship. Damage to the frontal lobes affects executive skills and promotes socially inappropriate behavior. Environmental cues may not be perceived, creating consternation for fellow clients and staff. It is easy to interpret these behaviors as intentionally disruptive, particularly when the individual with a brain injury shows no visible signs of disability (Center for Substance Abuse Treatment, 1998).

### **Defining Problematic Use of Alcohol and Other Drugs**

Listed below are summaries of criteria from the Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-IV; 1994) for establishing a diagnosis of either substance dependence or substance abuse. DSM-IV criteria are the most widely used clinical criteria in North America, and closely parallel the World Health Organization's (1990)

delineation of these disorders in the International Classification of Disease, 10<sup>th</sup> edition. (In a departure from the DSM-IV, rather than include the category "abuse," the ICD-10 includes the concept of "harmful use." This category was created so that health problems related to alcohol and other drug use would not be underreported.) The DSM-IV summaries, below, are followed by recommendations from the National Institute on Alcoholism and Alcohol Abuse regarding low risk levels of alcohol consumption.

### Substance Dependence (DSM-IV)

A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by three (or more) of the following, occurring at any time within the same 12-month period:

1. Tolerance, as defined by either:
  - a. need for markedly increased amounts of the substance in order to achieve intoxication or desired effect; or
  - b. markedly diminished effect with continued use of the same amount;
2. Withdrawal, as manifested by either:
  - a. characteristic withdrawal syndrome for the substance; or
  - b. the same (or closely related) substance is taken to relieve or avoid withdrawal symptoms;
3. Substance is often taken in larger amounts or over a longer period than intended;
4. There is a persistent desire or unsuccessful efforts to cut down or control substance use;
5. A great deal of time is spent in activities necessary to obtain the substance, use it, or recover from its effects;
6. Important social, occupational, or recreational activities are given up or reduced because of substance use;
7. Continued substance use despite knowledge of having a persistent or recurrent psychological or physical problem that is likely to have been caused or exacerbated by the substance.

The DSM-IV includes specification of whether a positive diagnosis is with/without physiologic dependence based on the presence or absence of the first two criteria.

If dependence was previously diagnosed and no criteria for abuse or dependence have been present for at least 1 month, additional specifications include: early vs. sustained (> 1 year) remission, partial or full remission, on agonist therapy, or in a controlled environment.

### Substance Abuse (DSM-IV)

A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12-month period:

1. recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home;
2. recurrent substance use in situation in which it is physically hazardous;
3. recurrent substance-related legal problems;

4. continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.
- Symptoms must have never met criteria for substance dependence for the class of substance.

#### Unhealthy Use (Dietary Guidelines for Americans, 1990)

Excessive levels of alcohol use for adults are shown below. Note that a standard drink is 12 grams of pure alcohol, which is equal to one 12-ounce bottle of beer or wine cooler, one 5-ounce glass of wine, or 1.5 ounces of distilled spirits.

- Men  $\leq$  65 years old--more than two drinks per day  
    >65 years old--more than one drink per day
- Women--more than one drink per day
- Abstain from alcohol when pregnant or considering pregnancy, when taking a medication that interacts with alcohol; *if a contraindicated medical condition is present (e.g., ulcer, liver disease)* [italics added], or if alcohol dependent.
- If at risk for heart disease, consider potential benefits and risks of alcohol use: light to moderate drinking is associated with lower rates of coronary heart disease in certain populations (e.g., men over 45, postmenopausal women). Infrequent or nondrinkers are not advised to begin a regimen of light to moderate drinking to reduce the risk of coronary heart disease because vulnerability to alcohol-related problems cannot always be predicted. Similar protective effects can likely be achieved through proper diet and exercise.

Any use of illicit drugs, including alcohol by children is not recommended.

The guidelines for low risk use indicate that most consumption of substances is not recommended based on health issues alone (i.e., regardless the psychosocial consequences), and only a relatively limited amount of alcohol consumption can be considered healthy for adults *who do not have medical problems that would be exacerbated by alcohol*. Though at least two studies have reported additive effects of alcohol and TBI on impairment to brain structure (Bigler et al., 1996) and function (Baguley et al., 1997), there is not yet adequate research in TBI to delineate when any alcohol is counter-indicated. Our clinical experience suggests that the effects of alcohol and other drugs are different for people after a brain injury. The potential risks of use, medical and psychosocial, have lead us to conclude that the only healthy advice we can give is to not drink alcohol or use illegal drugs after TBI.

#### **Measurement of Substance Use in the TBI Model System**

The TBI Model Systems National Dataset assesses alcohol and other drug use to determine premorbid status, as well as use at each annual follow-up. In Form I, premorbid history of use is elicited from the best available source of information during the subject's rehabilitation hospitalization. In Form II, annual follow-up questions of both the individual and a family member/significant other inquire about alcohol and other drug use. Except for minor changes in wording reflecting the timing of the questions, the items used in Forms I and II are identical.

### History of the Substance Use Variables

Prior to October 1999, the TBI Model Systems substance use questions consisted of: (a) one item that inquired whether illicit drugs had been used and which ones; (b) four questions about alcohol consumption from Cahalan and Cisin's Quantity-Frequency-Variability Index (QFVI; 1968); and (c) four questions comprising the CAGE questionnaire (Ewing, 1984). As of 10/1/1999, the CAGE questions were discontinued and changes were made to the alcohol consumption questions to allow comparison of TBI Model Systems data to those from on-going national surveys. This latter change was necessitated in part by the most recent norms for the QFVI being based on 30-year old survey data that was no longer considered reflective of population-based estimates. In contrast, the National Household Survey on Drug Abuse (Substance Abuse and Mental Health Services Administration, 1998) is conducted by the US Department of Health and Human Services every two years using national sampling criteria. The Behavioral Risk Factor Surveillance System (Centers for Disease Control and Prevention, 1998) is conducted annually by the Centers for Disease Control and Prevention in collaboration with each state's health department. The new alcohol consumption items allowed TBI Model Systems data to be compared with these national surveys.

As of 11/1/02, substance use is assessed by asking the following questions:

#### *VARIABLE 292a1* DRUG USE -- FOR PERSON WITH BRAIN INJURY

292a1. During the last 12 months (or during the time since your injury -- if year 1 follow-up) did you use any illicit or non-prescription drugs?

- 1 No
- 2 Yes
- 7 This variable not due this year
- 9 Unknown

292a1 a-f) If yes for #1, please indicate the drugs used:

- 1 No drug use
  - 2 Crack/cocaine
  - 3 Pot/Marijuana
  - 4 LSD/Hallucinogens
  - 5 Heroin/Opiates
  - 6 Speed/Stimulants
  - 7 This variable not collected this year
  - 8 N/A, no other drug use
  - 0 Variable not in existence when data collected on this case
  - 9 Unknown
- List other drugs: \_\_\_\_\_

#### *VARIABLE 292a2* ALCOHOL USE -- FOR PERSON WITH BRAIN INJURY

- 1) During the past month, have you had at least one drink of any alcoholic beverage such as beer, wine, wine coolers, or liquor?

- 2) During the past month, how many days per week or per month did you drink any alcoholic beverages, on the average?
- 3) A drink is 1 can or bottle of beer, 1 glass of wine, 1 can or bottle of wine cooler, 1 cocktail, or 1 shot of liquor. On the days when you drank, about how many drinks did you drink on the average?
- 4) Considering all types of alcoholic beverages, how many times during the past month did you have five or more drinks on an occasion?

A project is underway to provide comparisons between alcohol and other drug use in the TBI Model Systems sample and the general population (“A Comparison between the TBI Model Systems Cohort and National Estimates of Substance Use,” Corrigan, Bogner, Whiteneck, Hammond, Sander and Kreutzer). Problem use in the TBI Model Systems cohort, as defined by use of illicit drugs or unhealthy alcohol consumption, is described below.

### Defining Problem Use in the TBI Model Systems

One impetus for the present report is to provide suggestions for using model systems data when a variable reflecting substance use is desired. We suggest the variable “problem substance use” be utilized, as it is intended to reflect potentially risky levels of alcohol or other drug use. This variable is not intended to reflect a clinical diagnosis of a substance use disorder as items included in the National Dataset are not adequate to make these diagnostic distinctions (see “Defining Problematic Use of Alcohol and Other Drugs”).

The criteria we propose for establishing “problem substance use” assume that any use of illicit drugs is potentially risky; and that heavy use of alcohol, either in a single drinking session (bingeing) or regularly during the past month, is potentially risky. The criteria for heavy use are taken from recommendations by the Centers for Disease Control and Prevention (1998) and the Substance Abuse and Mental Health Service Administration (1998).

Using the current TBI Model Systems alcohol use variable (292a2), first calculate drinks per week by either multiplying days per week times number of drinks; or days per month divided by 4, times number of drinks. Then apply the following categorization:

- Abstaining — none (a "no" on question 1)
- Infrequent or light — "yes" to question 1 and < 3 drinks per week
- Moderate — for men, 3-14 drinks per week; for women, 3-7 drinks per week
- Heavy — for men, >14 drinks per week; for women, > 7 drinks per week

Also define a variable “binge” as having at least 1 day in the past month when the person consumed 5 or more drinks (per question 4 in item 292a2).

"Problem Use" is defined as:

- any use of illicit drugs (292a1); OR
- positive for BINGE drinking; OR
- “Heavy” consumption (as defined above).

### Comparability of the “Old” and “New” Problem Use Variables

As described above, the alcohol use item (but not other drug use) changed significantly in October 1999. Prior to that time, the alcohol use item consisted of four questions about alcohol consumption from Cahalan and Cisin’s Quantity-Frequency-Variability Index (QFVI; 1968); and four questions comprising the CAGE questionnaire (Ewing, 1984). Recently, we sought to determine whether a measure of problem use extracted from the previous items would be comparable to a measure of problem use derived from the new variables.

The definition of “Problem Use” for the Model Systems data collected prior to October 1999 was based on previously published definitions of substance use in the National Dataset (Kreutzer, Witol, Sander et al., 1996). Using the old variables we started by calculating categories of the Quantity-Frequency-Variability Index questions (old 292a2) as described below:

- Q1. During the year before your injury, how often did you have one or more drinks containing alcohol?
- Q2. When you drank alcohol, how often did you have 6 or more drinks?
- Q3. When you drank alcohol, how often did you have just 4 or 5 drinks?
- Q4. When you drank alcohol, how often did you have just 1 to 3 drinks?

#### Responses for Q1:

- |                            |   |
|----------------------------|---|
| 1 Three or more times/day  | 7 Two or three times/month                    |
| 2 Two times/day            | 8 About once/month                            |
| 3 Once/day                 | 9 Less than once/month but at least once/year |
| 4 Nearly every day         | 10 Less than once/year                        |
| 5 Three or four times/week | 11 Not at all                                 |
| 6 Once or twice/week       | 00 Variable not in existence                  |
|                            | 99 Unknown                                    |

#### Responses for Q2 through Q4:

- |                           |                             |
|---------------------------|-----------------------------|
| 1 Nearly every time       | 5 Never                     |
| 2 More than half the time | 0 Variable not in existence |
| 3 Less than half the time | 9 Unknown                   |
| 4 Once in a while         |                             |

We created the variable “QFVI” (Quantity Frequency Variability Index) as follows:

- if (Q1=1 or 2 or 3 or 4 or 5) QFVI = 1
- if (Q1=6 and Q2=1 or 2) QFVI = 1
- if (Q1=6 and Q2=3, 4 or 5) QFVI = 2
- if (Q1=7) QFVI = 2
- if (Q1=8 and Q2 or Q3 =1 or 2) QFVI = 2
- if (Q1=8 and Q2 or Q3=3, 4 or 5) QFVI = 3
- if (Q1=9) QFVI = 4
- if (Q1=10 or 11) QFVI = 5
- missing value QFVI = 9

value labels were QFVI 9 = 'unknown'; 1 = 'heavy'; 2 = 'moderate'; 3 = 'light'; 4 = 'infrequent'; 5 = 'abstinent'.

From the old 292a3 we made a variable called “CAGE” that was the number of the four questions that were answered 2 = yes.

"Old Problem Use" was defined as:

- any use of illicit drugs (292a1); OR
- Heavy (=1) PQFVI; OR
- Answering Q2 (6 or more drinks) as a 1,2, 3 or 4; OR
- CAGE is greater than or equal to 2.

Table 1 below compares “old” and “new” criteria for problem alcohol, other drug, and substance use. (The variable “substance use” was created by a positive for either alcohol or other drug use.) It should be noted that the composition of the TBI Model System centers changed dramatically in 1998, which created the potential that the subject pool in the National Dataset changed after the alcohol use variable changed. Of course, the data also may not be comparable due to historical changes in substance use occurring in the population at large. Indeed, the “other drug use” variable did not change when the alcohol items were changed, but there were still differences in the rates and relationships before and after October 1999. Thus, it appears possible that either population changes in substance use or a change in the Model System cohort affected the nature and rates of problem use.

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insert Table 1 about here

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While there appeared to be significantly less problem alcohol use in the new versus old data, the other drug use item (which did not change) showed less prevalence, as well. Indeed, if the proportion of decline in other drug use is applied to the old rate of problem substance use, the expected rate would be 43.7%. The actual rate was 43.5%.

In terms of associations with variables known to correlate with problem substance use, only two variables showed a different relationship with “old” or “new” data than that evident for “combined.” Using a value of  $p < .01$ , prior history of TBI was significantly associated with problem alcohol use for the combined and the old data, but only showed a trend in that direction for the new data. The number of arrests at 1 year was significantly associated with problem alcohol use for the combined and the new data, but not for the old data. There were three variables that showed different relationships (using the  $p < .01$  criterion) for other drug use—education, employment at 1 year, and arrests at 1 year. Differences in “problem substance use” were caused by the differences in alcohol or other drugs.

Based on these analyses, we concluded that despite an apparent change in the subject pool and/or using behavior before and after changing the alcohol use variables, the problem substance use variable described above can be used with both eras of the TBI Model Systems National Dataset.

**Table 1. Relationships between “Old” and “New” Problem Use Variables**

FREQUENCIES	“Old” Data		“New” Data		Combined	
	n	% positive	n	% positive	n	% positive
Problem Alcohol Use	966	52.2	1197	34.7	2163	42.5
Problem Other Drug Use	1246	31.3	1323	26.2	2569	28.7
Problem Substance Use	1262	52.2	1333	43.5	2595	47.8
ASSOCIATIONS	Chi-square	p-value	Chi-square	p-value	Chi-square	p-value
<b>Problem Alcohol Use</b>						
Gender	42.174	<.001	32.922	<.001	71.355	<.001
Education	6.233	0.044	1.600	0.449	5.698	0.058
Employed at Injury	1.906	0.167	1.684	0.194	1.414	0.234
Unemployed at injury	12.963	<.001	12.453	<.001	37.146	<.001
Prior history of TBI	7.420	0.007	4.287	0.038	13.262	<.001
Prior history of arrest	152.958	<.001	110.751	<.001	251.197	<.001
BAC <.08	150.544	<.001	241.193	<.001	391.236	<.001
Employed at 1 year	1.240	0.265	0.341	0.559	0.108	0.742
Arrest at 1 year	0.986	0.321	17.349	<.001	11.836	<.001
Life Satisfaction at 1 year	3.07*	0.003	3.17*	0.001	4.32*	<.001
<b>Problem Other Drug Use</b>						
Gender	19.578	<.001	14.022	<.001	33.584	<.001
Education	30.379	<.001	5.815	0.055	33.282	<.001
Employed at Injury	1.384	0.239	3.593	0.058	5.589	0.018
Unemployed at injury	51.850	<.001	36.192	<.001	94.273	<.001
Prior history of TBI	2.843	0.092	1.609	0.205	4.719	0.030
Prior history of arrest	164.741	<.001	143.353	<.001	307.607	<.001
BAC <.08	47.678	<.001	36.860	<.001	87.234	<.001
Employed at 1 year	18.936	<.001	3.505	0.061	20.550	<.001
Arrest at 1 year	4.097	0.043	10.961	<.001	13.252	<.001
Life Satisfaction at 1 year	4.05*	<.001	4.36*	<.001	5.95*	<.001
<b>Problem Substance Use</b>						
Gender	42.319	<.001	32.127	<.001	73.908	<.001
Education	19.965	<.001	2.989	0.224	18.582	<.001
Employed at Injury	0.067	0.765	0.000	0.986	0.031	0.861
Unemployed at injury	38.821	<.001	28.027	<.001	74.854	<.001
Prior history of TBI	4.533	0.033	4.638	0.031	9.788	0.002
Prior history of arrest	198.555	<.001	203.842	<.001	400.197	<.001
BAC <.08	119.244	<.001	165.685	<.001	283.910	<.001
Employed at 1 year	6.958	0.008	0.569	0.451	5.878	0.015
Arrest at 1 year	2.971	0.085	20.577	<.001	17.604	<.001
Life Satisfaction at 1 year	2.81*	0.005	4.24*	<.001	5.00*	<.001

\* T statistic from Wilcoxon Rank-Sum Test

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