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A Recovery Based Intervention to Improve Retention in an Activity Centric Health and Fitness Program. An "outside-in" Approach

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Introduction

One hundred eight million people were estimated to be on a diet in the United States in 2014 at any given time, with each of those making 4 to 5 attempts to lose weight each year - translating to approximately 2.5 billion dollars spent failing weight loss programs [1-3]. A variety of mechanisms have been studied and marketed in attempts to increase the length of time users will follow their diet and/or exercise programs, with largely disappointing results [2,4-6].

Temporal evaluation of clinical interventions to manage obesity have identified several points of potential exploitation. First, inverse correlates of success in this space have been defined, including - relevant to this proposal - degrees of calorie restriction or program structure [7,8]. Attempts to mediate these variables has also resulted in at least partial success, the most illustrative example being the Weight Watchers® program. Weight Watchers has enjoyed positive results based on the principles of less stringent dietary choices and dynamic scheduling *with regard to intake* [3,9]. Second, the neurophysiological response to diet and exercise responsible for so many repeat failures has been detailed [10-14]. These hormonal axes have been bypassed successfully via bariatric surgery, with subsequent real weight loss maintenance and disease control [15-17]. Third, the Obesity Medicine community has embraced an activity mediated transformative approach to health living - clearly stating that "exercise alters food preferences toward healthy foods . . . and healthy muscle trains the fat to burn more calories," and that lessons learned through the study of exercise biology point toward molecular modification through activity as the new frontier of healthy living [18,19]. Fourth, "something is better than nothing" [20-22]. Much of attrition is related to incomplete adherence and an "all or nothing" mentality from the user. Dieters realize they cannot maintain the entirety of a schedule and usually decide to quit the process altogether. Fifth, successful transformation is linked to exercise recovery [18,19,23-26].

Based on the principles delineated above (defined physiological responses to diet that limit progress, proven success using dynamic approaches with less stringent calorie requirements, activity mediated induction of long-term preference change, "something is better than nothing," and recovery importance), We propose a unique, dynamic, individualized, activity centric, adjustable program for weight loss and conversion to healthy living.

Nature of the Proposed Program

Overcoming the restrictive nature of commercial programs that result in diet failures

This is the epicenter of the proposal. There are no presently available all-inclusive diet and fitness (or even fitness alone) programs for patients or the public that address the clear relationship of structure with attrition [7,27,28]. As mentioned above, programs that do target this relationship on the diet/intake side of this equation have proven themselves effective over time [3]. Other facets of wellness that employ a dynamic structuring have also enjoyed consistent, objective, positive results. The most powerful example of these can be found in the phenomenon of Alcoholics Anonymous (AA). The AA system has been working for almost 80 years, had millions and millions of members, consistently reported success rates, has no leadership, and enjoys a worldwide presence [29,30]. It doesn't involve medication, doesn't cost money, doesn't implement a schedule, has no forced accountability (it's anonymous), and requires nothing of its members.

They AA program capitalizes on the inverse relationship between structure and success with regard to user effort - and by doing so integrate into the peaks and valleys of member's lives. They "stay with them" so to speak, as their lives oscillate, rather than superimposing a generalized schedule on to thousands of individuals with different emotions and domestic demands - which inevitably leads to failure.

This proposed program likewise adjusts to the individual user's biofeedback. So well-known are the changes that occur in between workouts that elite athletes and fitness professionals in the know purposefully capture this process as part of their training [23]. New set-points are established. Red blood cells are replenished, more efficient heart rates and blood pressures are established, stress hormones are decreased, calcium is put into bones, muscles change their structure, metabolic rates are increased, circulating fat and glucose are decreased, immune systems are strengthened, and overall wellbeing is improved. Each user will undergo the process of exercise recovery at a different rate, depending on their body habitus, basal metabolic rate, genetics, and exercise history [24-26].

Participants interested in a novel approach should be trained to recognize the body's feedback and to adjust their program accordingly. For example, an individual's personalized diet and fitness schedule may look like that in figure 1 on any given day. In this example, the user has progressed to Level 2 (upper right hand

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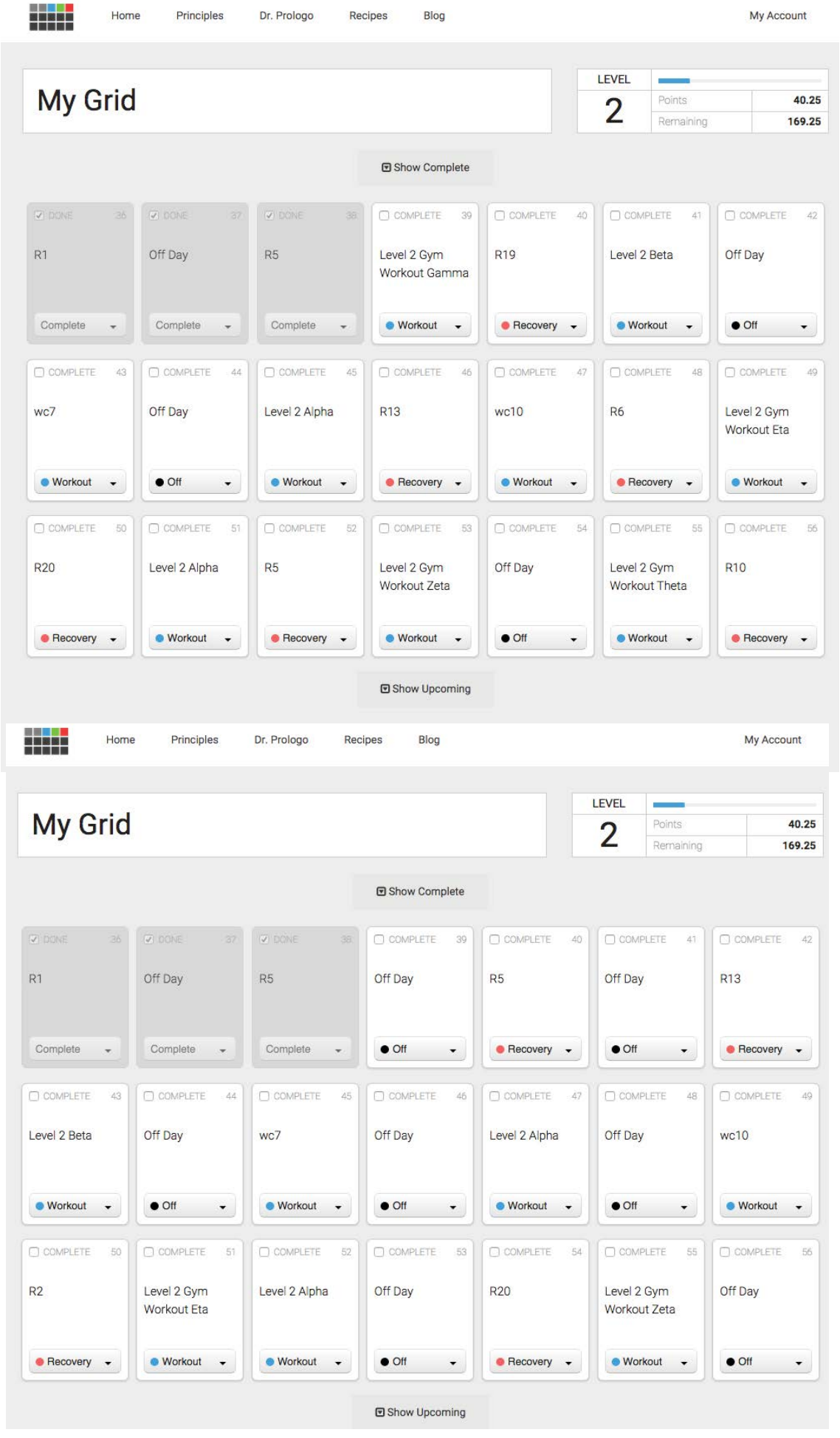

Figure 1A and 1B: Sample grids from the program demonstrating the functionality of a proposed program founded on dynamic scheduling

corner), and has 169.25 more points to earn in order to complete this level. The greyed out boxes represent completed days and the current day calls for "Level 2 Gym Workout Gamma." The innovation lies in the drop down option. The user has the option to change the current day to a different workout, recovery day, or off day - all of which are worth variable points depending on a multitude of factors included in the background algorithm (such as number of off days in a given span of time, involvement of the recovery intervention, and so on). When the user selects an alternate option, the program recalibrates according to a predetermined number of needed points to complete the level, which has been determined based on weighted calculations of the users initial input data. (Appendix 1) Each user will have an individualized goal - and their personal grid will recalibrate according to this goal when they switch a day, thereby truly "keeping them on track," in the face of dynamic scheduling. In this particular example (based on the programmers input), the user has switched to an off day and the program has rescheduled the workouts and recoveries in order to keep him/her on track toward the level 2 completion (notice remaining points and accumulated points are unchanged - the person has not lost ground by rescheduling). This response is in contradistinction to the negative feedback and negative connotation that accompanies "missing a day" of a predetermined rigid program schedule - an event that often leads to termination of the program as a whole, and restart some other day.

Restructuring the neurophysiological response to diet and exercise

The body's response to diet and exercise has been well documented. These signals are real, survival based, and nearly impossible to overcome [14,15,31,32]. Bariatric surgery works because it changes the levels of these molecules [15-17,33]. The central theme underpinning this point is that the brain can be changed to respond differently to input - to respond differently to diet and exercise [34-36]. The key is resetting this system and reversing the signals such that new neural circuitry is recruited to send retrograde messages to the brain that result in restructuring. This process leads to new antegrade signaling in the face of these stressors [37-39].

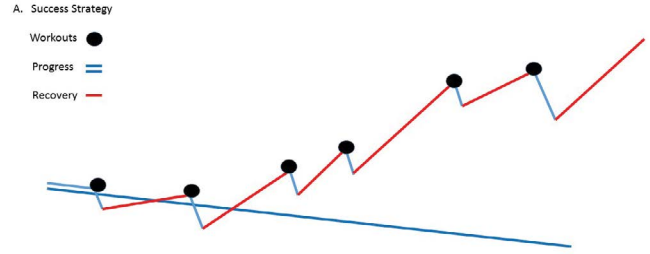

Figure 2A: To be successful, users must time their workouts at the end of recovery, in order to allow time for the application of stress through exercise to induce change.

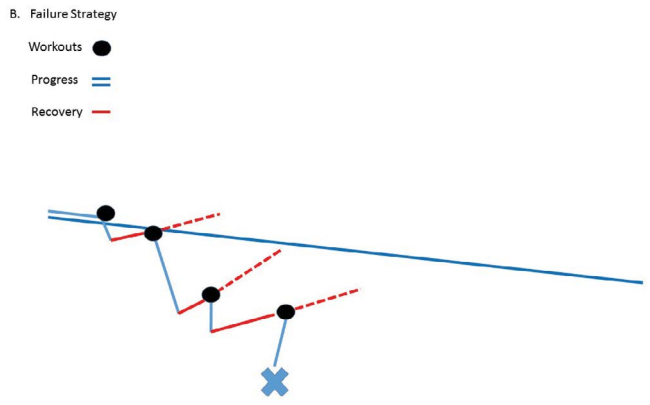

Figure 2B: Traditional programs schedule workouts in a static grid, without considering individual recovery time, so the workouts come too soon, before recovery is complete - leading to a downward spiral, and cyclic failures.

The dynamic nature of the program, in combination with intentional exercise and select recovery interventions - results in a new period between workouts that allows for adaptation (Figure 2). By attending to the inter-exercise adaption, users create new patterns through neuroplasticity, thereby leading to new responses in this setting. Each "off" day allows for restructuring, and each "recovery" day contains evidence based, lifestyle interventions to accelerate the process of adaptation.

Accelerating transformative change according to Obesity Medicine principles through intentional exercise and recovery

The specific descriptions for users to follow each day are prescribed with the intent of inducing change. Specifically, the exercise regimen is not intended to burn calories so that the user can "lose weight," but rather to induce adaptation and change internally, so that the signaling pattern can be changed through retrograde signaling.

The exercise regimen is divide into "Levels" in order to communicate to the user that he or she is progressing. Clearly the concept of progression toward a goal has proven effective toward behavior modification in the setting of obesity management [7]. Moreover, the levels are progressively more involved and difficult - thereby allowing the user to maintain their progress over time. (Figure 3)

The recovery interventions should be selected based on scientific evidence of disease control effect, exercise recovery, and appetite control. Briefly, we propose three categories:

Sleep: The benefits of sleep, as it relates to exercise, weight loss, and fitness, can be divided broadly into two categories: recovery and the homeostasis of energy metabolism in humans. The first, recovery, is mediated through direct stimulation of protein transcription, through the production of antioxidant molecules, and through adjustment of immunological mediator profiles [40-46].

That is, exercise results in a disruption of our molecular structure, a disruption that the body seeks to correct. The new structure will have

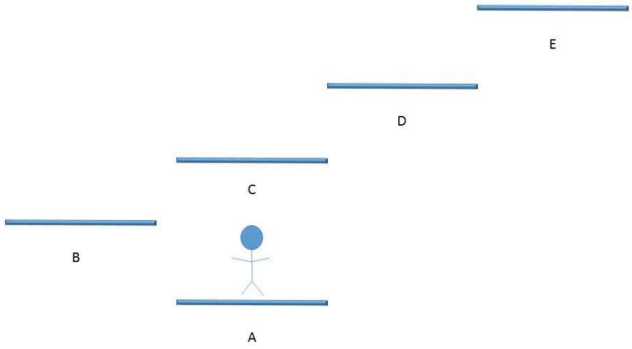

Figure 3A: The program is arranged in levels, so that the user may benefit from both progression toward define goals and positive feedback.

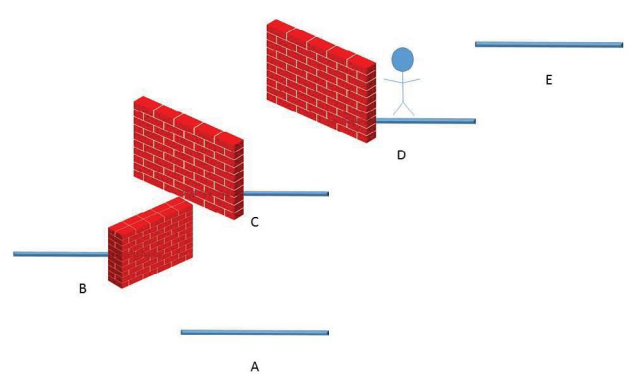

Figure 3B: The schedule is arranged around changing biofeedback in order to stabilize each quantum of progress made by the user

the capacity to endure a greater amount of exercise, thereby ultimately tipping the caloric balance. These specific anabolic processes are mediated by growth hormone, (GH) via hepatic production of insulin growth like factors (IGFs). Downstream adjustments translate to increased metabolism, less injury, and improved exercise capacity [47-50].

Growth hormone reaches its peaks during sleep. When the body is sleep deprived, it switches to survival mode and foregoes optimization. In order to optimize physical exercise induced adaptation, subjects must access this reorganization strategy, mediated by GH during sleep.

Similarly, the autonomic "fight or flight" response is attenuated when adequately rested, and parasympathetic output maximized, which optimizes rebuilding and adaptation. Otherwise, this response exists at a low level which is counterproductive to the exercise cause. In this situation, hormones and proteins, appropriately named "stress proteins," or "the stress response" circulate in relatively higher levels, resulting in increased storage of fat and toxicity to recovering muscles [43,51-53]. Finally, in the absence of adequate sleep following exercise, the body exhibits a pro-inflammatory response, consisting of pro-inflammatory cytokines and characteristic immune cell presence [54-56], which causes direct damage to muscles, in addition to hindering recovery. Conversely, sleep is associated with decreased levels of all of these mediators and uninterrupted reorganization of our underlying structure following exercise. (Figure 4)

Secondly, sleep is intricately related to the energy cycle and homeostasis. As is well known, the body's responses and adaptations are often rooted in evolution and survival. Humans originally needed to sleep, eat, and reproduce in order for the species to survive. As a result a bi-directional hormonal system evolved such that satiety resulted in sleep. Sleep is required for humans to "protect brain cells from the damaging effect of reactive oxygen species, allow sufficient time for the repair or replacement of essential cellular components . . . and deal with other biochemical consequences of waking metabolic activity" [57,58]. Studies have shown that sleep deprivation results in decreased energy expenditure during the day. This is an attempt by the body to equalize the energy in - energy out balance disrupted by extensive waking hours. That is, the longer a person is awake, the more energy they are expending - such that the body then slows down metabolism and kicks out hunger hormones leading to increased intake in an attempt to compensate [58-62]. Worse, the body would rather consume energy itself during sleep as part of the rebuilding process [63].

What this means is that the body responds to less than optimal sleep duration by slowing metabolism, eating more, and foregoing rebuilding and strengthening activities - the latter of which would burn calories and energy itself. The same goes for poor sleep quality or interrupted sleep, which has also been shown to result in "increased hunger, uncontrolled and emotional eating, and cognitive restraint . . . as well as feelings of being less full," and lower resting metabolic rate [61,64]. The absence of adequate sleep creates a paradoxical scenario of unhealthy energy conservation and consumption for evolutionary survival, a principle demonstrated in studies examining fat retention in dieters who are sleep deprived, documenting worsened central obesity in women with decreased REM sleep, increased food intake and snacking during sleep deprived states, and food seeking behavior after partial sleep interruption [65,66]. Figure 5 demonstrates the disruption in equilibrium caused by sleep disturbance, which is worsened in the presence of exercise. The human body seeks to equalize the energy in - energy out balance for survival at baseline. The absence of sleep tips the balance toward energy conservation, which translates to weight gain, or in our case - the blocking of weight loss (Figure 5).

Diet: The proposed focus is categorically on structure and intake of the appropriate nutrients (Vs. Traditional calorie restriction protocols) [67,68]. If, while we are sleeping (above) the body sets out to build our scaffold, and there is no wood - there will be no change. The specific nutrients proposed for their roles in recovery are: *Tryptophan, Tart Cherries, cottage cheese, and toast, Lunasin, Sweet Potato Proteins, and Polyphenols, Lysine, Glutamic Acid, and Heat Shock Proteins, Selenium and Molybdenum, Chinese Walnuts, Fish, Garlic, Protein simple carb mixes, Raw Vegetables, Water, Vinegar, and Chromium* [40,67-108].

Active recovery: The term active recovery is meant to differentiate this change accelerant with the changes related to diet and sleep. Activities proposed under the heading Active Recovery are: *Visualization, Yoga, meditation, and focused imagery, Mindfulness, Progressive Muscle Relaxation, Heat and cold immersions, Massage, Active Release, and/or Self-myofascial release, Compression Devices, and Mind-Body Approach* [31,109-137].

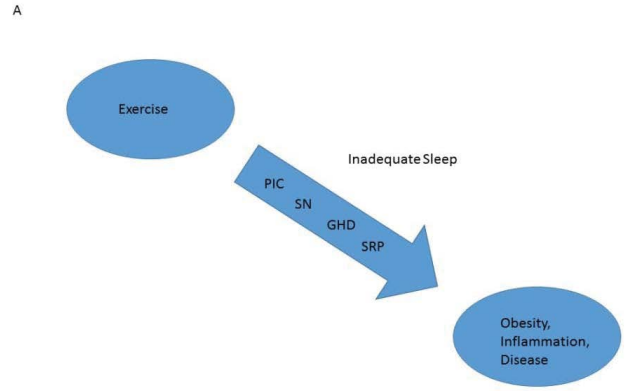

Figure 4A: In the absence of adequate rest, the body mediates change after exercise through proinflammatory cytokines (PIC), sympathetic nervous system activation (SN), growth hormone deficiency (GHD), and stress response proteins (SRP).

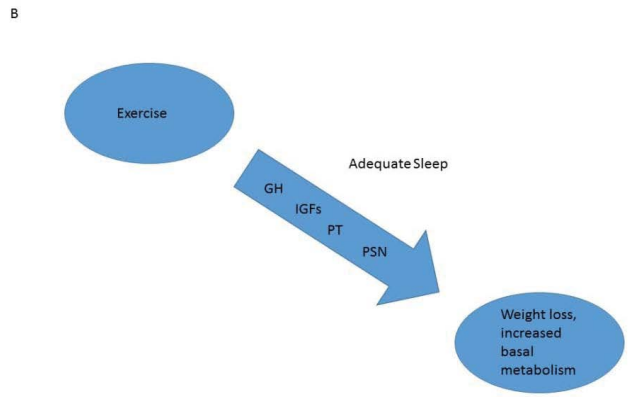

Figure 4B: In the presence of adequate rest, the body mediates change after exercise through growth hormone (GH), insulin like growth factors (IGFs), muscle protein transcription (PT), and parasympathetic nervous system (PSN) activation.

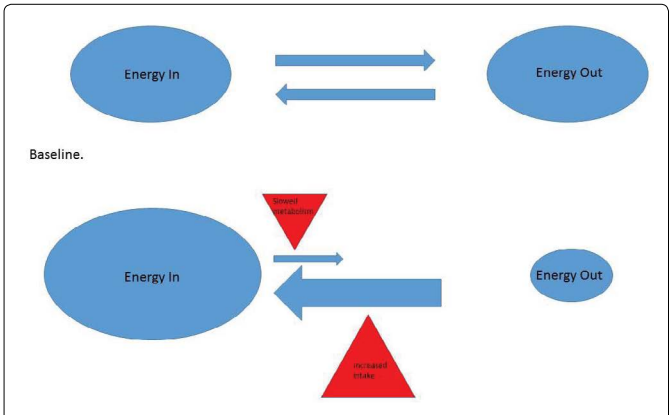

Figure 5: In the absence of adequate sleep, energy balance is tipped toward conservation

Table 1: Proposed, implementable principles of obesity medicine and bariatric intervention [3,7,10-19].

Something is better than nothing [20]
• The American Heart Association, Centers for Disease Control, and the American College of Cardiology (among others) categorically agree that "progress, not perfection" should be our goal. • Time and time again the pursuit of perfection leads to failure. Inability to keep a predetermined schedule leads to the all - or - nothing decision to "quit your diet." • Patients and the public should strive to accumulate as much change as possible in the long run. That is, successful weight loss will come for the person that is persistent about accumulating 15 workouts or 15 healthy meals or 15 recoveries *in total*, rather than necessarily in a specified amount of time (ie, 10 pounds in 10 days).
Flexibility is associated with success [2,4,5]
• Rigid structure leads to failure. Patients repeatedly fail attempts to follow generalized day by day schedules for a host of reasons: the body rebels, life gets in the way, motivation wanes, etc. • Weight Watchers is endorsed by many medical groups, and has been successful largely because of the implantation of flexibility to obtain the long term goal. This proposed program introduces a method by which users can enjoy the same control while staying on track with regard to fitness, recovery, and diet.
Recovery is essential for actual body change to take place [18,19,23-26]
• Successful people in the fitness space attend to recovery • Obese individuals do not have the exercise capacity to significantly affect calorie balance • Exercise in this group should be utilized to induce adaption so that: o Individuals will improve, in a kinetic fashion, their ability to burn absolute calories o The body will initiate neural signals from the periphery to the brain resulting in cortical (brain) reconstruction (change) that will ease the burden of exercise
The concepts of self-monitoring, stimulus control, specific nutritional choices, motivational interviewing, and physical activity are proven effective in weight loss[7-9,21,145]
• The combination of these techniques, introduced in a piecemeal, "digestible" fashion for the non-medical professional, may accelerate users through the stages of change toward long term effect by *teaching* them to apply these principles in their own lives
The hunger hormone system can be bypassed and appetite can be changed [7,11,15-17]
• A complex system of hunger hormones exist that drives human beings to eat in order to survive • This system is responsible for the intense hunger pangs, fatigue, and motivation "zap" that follows the onset of calorie restriction and new exercise • This system can be modified through careful (intentional) activity and supplemented recovery to keep patients and the public on track

Proposed Validation Strategy

In order to translate theory to guidelines, appropriate validation in necessary. The American Heart Association and The American College of Cardiology, in collaboration with the Centers for Disease Control here in Atlanta, GA - have published guidelines regarding the number of minutes of recommended physical activity for adults [138,139]. These minutes are reflected as "activity minutes" by the Fitbit (and other similar devices) through a combination of three dimensional accelerometry and heart rate recording. The data from these two inputs is correlated with user input regarding height, weight, and other physical characteristics so that metabolic equivalents of activity (METs [kcal/kg*hr]) can be determined for each user. MET data is then compared to existing data tables to determine activity intensity - and then converted to a digital output for the user labeled "activity minutes". This output has been validated and can be easily tracked via software linking to each study subject [140,141].

Secondly, retention rates are quantifiable. Using published absolute success rates (15% at month one, 10% at month 2, 5% at month 3, and 1% at month 6), the calculated sample size requirement to demonstrate a significant difference following implementation of this program is 54 subjects. Accounting for non-study related attrition over six months, a single arm of 75 subjects creates a cohort based on $\alpha < 0.001$, power = 0.9, and an assumed population standard deviation of 8%. This translates to a 5% difference in "all or nothing" values, with the corresponding sample sizes for 3% and 2%, using the same parameters, at 149 and 335, respectively.

Using estimated activity minutes at the same temporal points (1, 2, 3, and 6 months), the required sample size is a bit less. Assuming the upper limit of the AHA/ACC/CDC guideline of 30 minutes 3-4 times/week to be 120 minutes, and a standard deviation of 40 minutes, to demonstrate a significant difference in activity minutes (designated as one activity day [30 minutes]), the sample size is 38. Any smaller designated difference would be difficult to for the public to interpret.

A multiple regression analysis should further be built in order to assess the impact of the following variables on outcome: age, race, sex, prior attempts to lose weight, prior number of pregnancies, starting BMI, and number of co-morbid conditions. Potential differences in the outcome variables of absolute attrition and activity minutes may be analyzed via analysis of covariance (ANCOVA) using baseline scores as covariates and a paired, two-sided t-test to evaluate least-squares mean changes, compared to baseline. The Bonferroni correction may be used to adjust for multiple comparisons.

Conclusion

At risk patients for obesity related complications primarily garner their information regarding health and fitness through marketing campaigns [142-145]. As a result, large companies are able to promulgate random information aimed to affect revenues, rather than long-term healthy adaptation. Medical and surgical management of bariatric patients in the 21st century has elucidated several principles of effectiveness with regard to obesity (Table 1). These principles may be incorporated into a new type of program to induce transformation and long term engagement, as above.

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