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Optimized progression of Full-Body In-Bed Gym workout: an educational case report

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Abstract

People suffering from fatigue syndromes spend less time exercising each day, thus aggravating their motor difficulties. Indeed, muscles and mobility deteriorate with age, while exercising muscles is the only sure countermeasure. It is useful to offer a safe and toll-free rehabilitation training: Full-Body In-Bed Gym, easy to learn and performe at home. We suggest a 10–20 min daily routine of easy and safe physical exercises that may improve the main 200 skeletal muscles used for every-day activities. Many of the exercises can be performed in bed (Full-Body In-Bed Gym), so hospital patients can learn this light workout before leaving the hospital. The routine consists of series of repetitions of 15 bodyweight exercises to be performed one after the other without time breaks in between. Alternating sequences of arm and leg exercises are followed by moving body parts in lying and sitting positions in bed. These are followed by series of tiptoeing off the bed. Progressive improvements can be tested by a series of push-ups on the floor. Starting from 3-5, number of repetitions are increased by adding 3 more every week. To maintain or even shorten total daily time of workout each movement is weekly speeded up. The devoted time every morning (or at least five days a week) to train all the major muscles of the body can remain under 10 minutes. Because there are no breaks during and between sets, the final push-ups become very challenging: at the end of the daily workout heart rate, depth and number of ventilations and frontal perspiration increase for a few minutes. We here provide an example of how to implement the progression of the Full-Body In-Bed Gym presenting an educational Case Report of a trained 80-year old person in stable pharmacological managements. In addition to strengthening the main muscles, including the ventilatory muscles, Although performed in bed, Full-Body In-Bed Gym is a resistance training equivalent to a short jog.. Started in early winter and continued regularly throughout spring and summer, Full-Body In-Bed Gym can help maintain independence of frail people, including those younger persons suffering with the fatigue syndrome related to the viral infection of the recent COVID-19 pandemic.

Key Words: skeletal muscle weakness; borderline mobility disorders; full-body in-bed gym.

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There are about 700 skeletal muscles in the human body, including roughly 200 that are serious bone-movers and another 100 little muscles of hands, feet, head and face. The aim of this report is to convince persons-in-need, and their practitioners, to counteract age- or rest-muscle decay, maintaining at their best function, strength, fatigue resistance and shape of the main body muscles.[1] Geriatric subjects, due to advanced age and/or associated diseases, spend only short time for daily physical activity. The consequent disuse muscle atrophy contributes to limit their independence, ultimately enforcing them to bed and to hospitalization for longer periods. Low mobility-related muscle atrophy

Fig. 1. *From left to right the Panels 1, 2 and 3 show the 14 exercises that are a routine that could be a seasonal warm up also for active persons, i. e, those able to make at least 10 consecutive push-ups (Panel 3, Exercise 15). The cardiovascular responses to a challenging series of trainings are exemplified in Panel 4: Arterial pressure and cardiac frequency before and after 10 minutes of Full-Body in-Bed Gym (20 repetitions of each exercise, including push-up) during seven consecutive days (November 8 to 14, 2016). Mean +/- SD. After a self-challenging routine, cardiac and ventilatory frequency increased together with the maximal, but not the minimal arterial pressure. Indeed, the latter is more related to peripheral blood resistance. If the series of exercise reach the level of fatigue threshold, the workout induces an increase of blood perfusion of all the body skeletal muscles.*[13]

is associated with neuromuscular weakness, functional limitations, thromboembolism, and high costs.[2-4] All progressive muscle contractile impairments need permanent management. Besides eventual pharmacological treatment, a home-based physical exercise approach is helpful in counteracting muscle atrophy. Awaiting development of implantable devices for muscle stimulation, as effective as pacemakers for cardiac arrhythmias,[5] implantable stimulators for ventilatory supports,[6,7] or cochlear implants for hearing loss,[8,9] education of sedentary patients to perform home physical exercises could be an effective low-cost alternative during and after hospitalization.[10-13]
Cardiovascular and respiratory physical rehabilitation protocols of surgical patients are well established approaches, whose main goal is to reverse muscle weakness/atrophy.[14,15] We extended those routines to a daily short (10–20 min) sequence of easy-to-learn, safe and tool-free volitional physical exercises to be performed in bed (Full-Body in-Bed Gym) to improve muscles and, hence, mobility of impaired persons.

Materials and Methods

In untrained persons the series could start from 3-5 repetitions of each of 15 free-body physical exercises: 1. closing of hands; 2. extend and flex ankles; 3. extend arms and close hands; 4. Cyclic movements of the legs in a lying position in bed; 5. Deep inspirations aided by arm movements; 6. Lying in bed flex the chest; 7. Sitting in bed, left and right torsion of the neck and head; 8. Sitting on the bed, raise the body on the hands; 9. In a sitting position on the bed extend and flex the spinal cord; 10. In a sitting position stretch your legs; 11. In sitting position rotate the head; 12. Stretch and rotate your arms above your head; 13. Get out of bed, even on tiptoe to load the body weight on the soleus muscle; 14. (only after a few weeks of bed training) push-ups on the floor; 15. one final stand-up from the floor. The suggested workout can be seen in panels 1, 2 and 3 of Figure 1 (redrawn from figures of an earlier EJTM typescript).[13]
The following educational case report will detail the yearly progression of the Full-Body In-Bed Gym program. This workout could be a seasonal warm up, specifically after a long winter to recover fitness for demanding physical activities also for active persons, i. e., those able to make at least 10 consecutive push-ups. After advice of his/her family physician to avoid the very low risks of exercise pain and eventual muscle and joint damage, any sedentary people may start with five repetitions of each exercise. After one-two weeks of training, they may add groups of five additional repetitions, up to 30, every additional week. If compliant, even older olds will progressively increase their muscle strength if they reach and continue to perform 15 or 20 daily repetitions of the 14 exercises.
It is prudent to start performing the exercises at slow speed, but when the maximum number of each exercise is reached (15 or 20 repetitions), improving effects will be obtained by speeding up each exercise and thus increasing volume and intensity of the workout and maintime decreasing its time. The daily routine may last from 10 min (in the beginning) to 30 min (for complete sessions in accustomed persons). Alongside the panels in Figure 1, a video dynamically depicts the Full-Body in-Bed Gym sessions, both at low and higher speeds (Link to: https://youtu.be/pcHKmxCLYFs).[16]
If sedentary persons with rest-related muscle weakness, but without major comorbidities, challenge themselves avoiding much stress in a few weeks of Full-Body in-Bed Gym they may increase their muscle strength, fatigue resistance and independence in daily life activities.

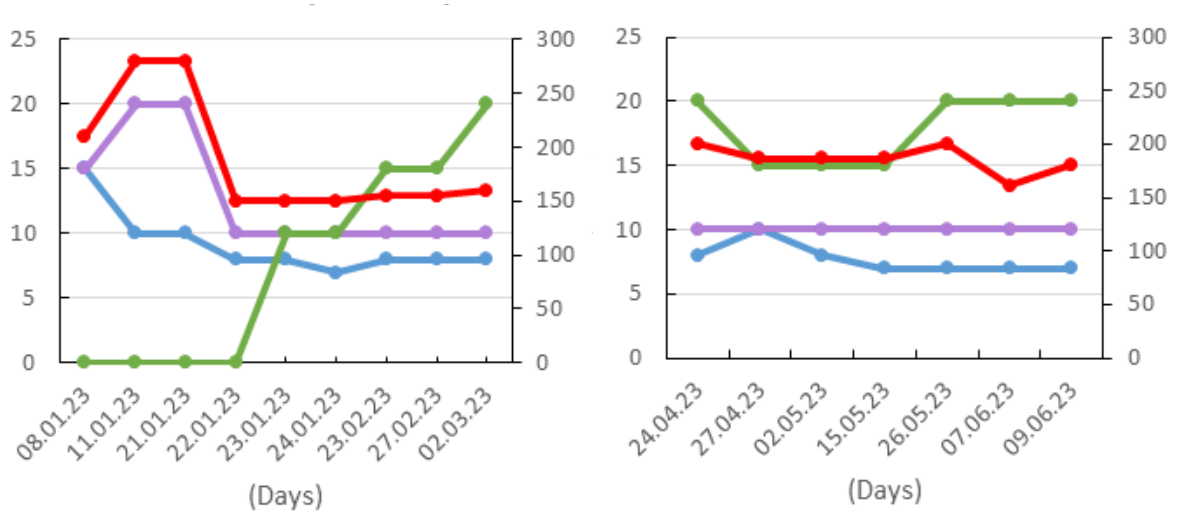

Fig. 2. *Left abscissa: Minutes or Number of repetitions of each of the 14 exercises or Number of repetitions of push-ups; right abscissa: Total muscle events per day.*

In particular, cautious Full-Body in-Bed Gym may help patients to recover earlier after hospitalization, decreasing the risk of thromboembolism after surgical interventions, and concurring to reduce eventually present arterial hypertension. [17-19] In fact, after a series of exercises that challenge personal fitness, i. e., which induce sweating of the forehead and an increase in the cardio-respiratory frequency, the maximum blood pressure, but not the minimum, increases to then return in a few minutes to the pre-exercise values. An example of those behaviors of the cardiovascular system to demanding exercises is presented in panel 4 of Figure 1. This is strong evidence that peripheral arterial resistance is decreased during the demanding exercises because blood perfusion is increased by relaxation of the perforating arteries of the main skeletal muscles of the body, i. e., for functional hyperemia of the main muscles of the body.[13]

Results and Discussion

An educational Case Report

We here provide an example of how to implement the progression of the Full-Body In-Bed Gym describing an educational Case Report of a well trained 80-year old person in stable pharmacological treatment for high arterial pressure, and anti-colesterol, vitamins and dietetic measures.

UC, born February 23, 1943, started in 2013 to do some voluntary exercise right after waking up. Year after year he has come to realize that many of the traditional bodyweight exercises can be done in bed. Then during his hospitalizations for cardiovascular complications and an acute intestinal blockage resolved by surgery, he realized that his workout could be continued in the hospital: Full-Body In-Bed Gym was born!

For the past 10 years he has been making notes about his in-bed-gym and its effects on his high blood pressure, concluding that it was worth circulating results among friends and eventually into the scientific arena. Although most of the colleagues were skeptical about the value of the naïve protocol and its eventual results, some publications came out and a first protocol was established.[10-13] The state of the art of UC training is published below, along with the report on full-body-in-bed-gym progression performed in early 2023. The main finding from this year's experience is that less than 10 minutes of morning exercise is enough to look and feel five to ten years younger — a big improvement if you are in your 80s. It is fully accepted that age decline occurs between the ages of 40 and 80 at 1% per year:[1,20-22] improving muscle strength by 10%, a goal achievable by Full-Body-in-Bed-Gym, is a 10-year rejuvenation, at least of major bone-mover muscles, if not of skin and joints.

Figure 2 shows the progression of the Full-Body In-Bed Gym from January to June 2023, the seventh year of a discontinuous Full-Body In-Bed Gym life style. Indeed UC was able to maintain his country house garden and the vegetable garden using heavy tools such as electric saws for pruning hedges or pickaxes for uprooting bamboo roots, which invariably invade the garden surrounding the areas dedicated to them. Figure 3 shows the pea production, Figure 4 a hedge bordering a garden path, while Figure 5 the pressing of the wine grapes harvested from the 50 wine trees that UC, often alone or with the help of his wife Annalisa, prunes, takes care of and harvests from February to the end of August in his country house in Trebaseleghe (Padua, Italy). The results of these farming activities are those that a very imprecise amateur can obtain, but who has a physical work capacity not too much inferior to that of a mature adult. Certainly

Fig 3. *Planting and weeding of flowering peas during spring 2021.*

not that of an octogenarian pensioner who limits himself to short walks every day to buy food. Naturally, this opens up the question of whether work capacity is linked

Fig 4. *Hedge maintenance during spring 2023.*

to the in-bed-gym or to agricultural activities. A rational answer is that both are essential factors, but that the morning exercise period at the end of winter establishes the preconditions for exploiting and maintaining better fitness during spring and summer activities.

After few months of discontinued In-Bed-Gym during the Autumn of 2022, the left panel of Figure 2 show that the new year work-out started January 8, 2023 with 15 repetition of the 14 In-Bed exercises for a total of 210 repetitions performed at slow speed in a total time of 15 minutes, but push-ups were not performed. Because during the following two weeks, despite increasing the number of repetitions to 20, the speed of movements were not increased, but their total number decreased to 140 (10 repetitions of the 14 In-Bed exercises) the total time of the workout decreased from 15 to 10 minutes. The day after the improved fitness allowed to perform ten push-ups at the end of the work-out that lasted less than 10 minutes. Having slightly further increased the speed of the 10 repetitions of the 14 physical exercises of the In-Bed-Gym the total time during the following months (February, March and April, see left panel of Figure 2) stayed regularly around 7 to 9 minutes, but included an increasing number of push-ups that steadily increased from 10 in late January up to 20 for a total number of around 200 repetitions, a non-trivial performance for a 80-year old man.

Discussion

That behavior is in line with the general expectation, but it must be stressed that it was achieved with less than 10 minutes per day of the in-bed special training. Increasing the speed of each movement, the time to devote every morning (or at least five days a week) to training of all the major muscles of the body can remain under 10 minutes.

To exercise attention and memory, it is recommended to sequentially count the number of daily repetitions, starting from 3 x 13 + 1 = 40 to reach 20 x 14 +1 = 281 exercises. Adding the post-workout 30-40 contractions of the diaphragm sustaining deep ventilation, a total of more than 200 strong sustained contractions of major muscle's groups with agonists-antagonists co-contractions were performed. The last contraction modality is well known to substantially increase the anti-atrophy effects of even passive muscle contractions induced by electrical stimulation in experimental animals in the vivo and in vitro studies of Jarvis J. et al.[23,24] and in functional electrical stimulation of permanent denervated muscles in human SCI cases.[25-31]

Since there are no breaks between sets of exercises, the final set of push-ups can become very challenging if continued until fatigue of the arms' muscles: at the end of the daily workout heart rate, depth and number of inhalations-exhalations and frontal perspiration increase, but only for a few minutes.

Furthermore, Full-Body in-Bed Gym routine mitigates the bad mood that is usually associated to mobility

Fig 5. *Grape harvest and pressing (upper panel) and happy friends at work (lower panel).*

limitations,[32,33] strengthening confidence of patient in recovering partial or total independence, and in reducing risks of accidental falls. Eventually, during hospitalizations the monitoring of the responses to challenging trainings could include oxygen saturation and many more fitness variables. Furthermore to speed-up positive changes, the trainings could be performed twice a day to improve fatigue resistance and cardio-respiratory reserve.[34,35] Wearable devices are an emerging and cost-effective technology that allows to monitor several biometric data,[36] and have been tested in many diseases.[37] It might be interesting to add one of these devices (e.g. smartwatches, fitbands, smartphones, etc.) which could represent a guide for the patient during workout (heart rate monitoring and oxyhemoglobin saturation, reminder to perform exercises every day, stopwatch for timing workout.[38]

In any case, during the initial learning period of Full-Body In-bed Gym, all seniors, if not hospitalized, must be supervised by at least one trainer, if not a health professional to avoid harmful exercise. These, in fact, are linked to their fitness and, nothing to say to comorbidities often present in elderly population. In young people these complications include the recent Chronic COVID-19 pandemic syndrome that is characterized by the psychological response to the global problem of COVID-19 pandemic, and often by muscle weakness that negatively influences the quality of life of persons for weeks or months before or after resolution of the infection.[39-41] Certainly it changes in people the ordinary lifestyle for the forced lockdown measures imposed to control the epidemics.[42,43] However, the most severe responses are expected later on after recovering COVID-19. In this case the pandemic syndrome is similar to post-traumatic stress disorders. The problem is that pandemic syndrome will affect the working capacity of population even when economic recovery will be possible and essential. Adequate prophylaxis and management of the syndrome in high-risk groups are important for maintaining global mental health and economy. Beside pharmacological support and psychotherapy in the acute phases, it will be mandatory to prevent and control the mild cases by general prophylactic measures and healthy lifestyle, i.e., by normalization of sleep-wake schedule, by controlling dietary intake of vitamins and microelements and by inducing moderate physical activity. All these measures are important to maintain a good physical condition that improves body adaptive potentials and the immune system. Altogether, our results demonstrate that volitional physical exercise improves the functional performance of skeletal muscles, including those essential for ventilation, a main problem in COVID-19 patients.

On the other hand, we have an ethical obligation to add that, if people, usually patients, are unwilling or unable to engage in voluntary physical activities, a very useful option is to offer them Functional Electrical Stimulation (FES), even in the worst cases of long-term peripheral denervation of skeletal muscles.[10,11,25-29,31,44-48]

In conclusion, it is never too early, and it is never too late to increase tool-free daily levels of volitional muscle contractions in aging and early-aging syndromes. Full-Body in-Bed Gym could help patients suffering with mild cases to prevent chronic COVID-19 syndrome and to counteract the decay of skeletal muscles, an inevitable consequence of normal aging as well. Here our contribution is to convince practitioners,[49-55] and the population at large that Full-Body in-Bed Gym is an option to be taken seriously, despite being toll-free and requiring seemingly minimal efforts.[10-13]

List of acronyms

COVID-19 - Coronavirus disease 2019
FES – functional electrical stimulation
SCI – spinal cord injury

Contributions of Authors

Authors equally contributed to writing and editing of the typescript. All authors have read and approved the final edited typescript.

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Conflict of Interest

The authors declare no financial, personal, or other conflicts of interest.

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We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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