The four “E” pillars of exercise prescription for health: The EFSMA program

J. Cummiskey¹, H. Lollgen², P. Zupet³, M. Borjesson⁴, K. Natsis⁵, A. Cummiskey⁶, K.M. Stafrace⁷, A. Debruyne⁸, N. Bachl⁹

¹Professor, Ireland, Pulmonologist and former President EFSMA
²Professor, Germany, Sports Cardiologist and Chairman of the Sc and Ed Commission of EFSMA, Former Pres German SMA
³Professor, Slovenia, SM Physician, Sec-gen Sc and Ed Comm of EFSMA
⁴Professor, Sweden, Cardiologist and member of Sc and Ed Comm EFSMA
⁵Professor, Greece, Orthopaedic Surgeon and Member EC of EFSMA
⁶Mr, Australia, Physiotherapist, SM Wolper Jewish Hospital, Sydney
⁷Dr, Malta, SEM Physician and Vice-president EFSMA
⁸Dr, Belgium, SM Physician and President EFSMA
⁹Professor, Austria, SM Physician Dean FSM U of V., and Hon Pres of EFSMA

Correspondence to: Joseph Cummiskey, RCSI, St Stephens Green, Dublin, 2, Ireland
e-mail: joecummiskey@eircom.net

ABSTRACT

What do clinicians need?
• An International Code of Disease for Exercise Deficiency Syndrome (EDS)
• Better education of our physicians on the Science and Economics of the problem
• A consensus agreement on tests for and follow up of EDS
• An understanding of all the players, especially the role in a condition that requires an individualized prescription
• Cooperation with others in the medical field interested in promoting Exercise Prescription for Health (EPH) e.g. European Alliance for the Promotion of Physical Activity (EAPPA).

INTRODUCTION

The European Federation of Sports Medicine Associations (EFSMA) is moving “Exercise Prescription for Health” (EPH) (Appendix 1) forward in a very constructive manner under the leadership of the Scientific and Education Commission of EFSMA. The most recent publications to the EFSMA website are evidence of that (http://www.efsma-scientific.eu). This has been an excellent starting point to what will be a fully comprehensive program on EPH.
EFSMA identified four “E” pillars for EPH

Pillar 1. Epidemiology and Education of a medical and scientific nature
Pillar 2. Economic factors that are in play around Cardiovascular-Respiratory Fitness
Pillar 3. Efforts of administrative bodies (hospital administrators, third party payers, funding agencies) to get the European population active to date
Pillar 4. Exercise Deficiency Syndrome (EDS) is a new clinical syndrome and familiarity should be gained with all available (simple and complicated) tests to confirm clinical diagnosis.

The individual patient has a pivotal role in any program. EFSMA has tried to see where the bottleneck to EPH lies. They asked the question “Should we be concentrated on the individual as distinct from various groups?” It has been established from genetic studies and response to exercise programs that an EPH is non-predictable in individuals. Personalized exercise programs and sport is now felt to be the solution. Emphasis should be given on the patient in the form of a design of thinking and patient motivation. This is best done by a physician-patient interaction. “What is the rank-order of what should be done”? A very strong argument can be made that doctors need to be educated in the motivation of exercise as medicine first, then all the other players in the equation; Patients, Physiotherapists, Paramedics, 3rd party payers, Medical Administrators, Politicians, City Councilors, the general public including healthy young, middle-aged and elderly people. The patient priority group should be the largest of 50% of adults with one or more Chronic Non-Communicable Diseases (CNCD).

The role of Public Health from World Health Organization (WHO) to regional authorities is also very important. The cost of care of CNCD in the community is currently unsustainable and needs to be highlighted. The euro healthcare needs to be redistributed if lifestyle and healthcare are to be sustainable.

We would add that there are more pillars in physical inactivity than the very important economic and public health reasons, to change patients’ approach to physical inactivity. These latter two have been well documented through epidemiological research and public health population encouragement over the last years and decades. We now need a bigger input from the other two pillars of physicians’ education and clinicians-patients interactions.

A major overlap exists between epidemiology, clinical medicine and education. What EFSMA has brought to the table has been the physician-patient interaction that was so useful in another lifestyle problem of smoking cessation. There are similarities between smoking cessation and physical inactivity and how the wider medical community has approached these problems.

In smoking cessation, we knew for 50 years that smoking was bad for our health. It was only when the clinicians got involved with individual patient advice, prescriptions for nicotine alternatives to cigarettes and public health legislation that meaningful changes in patient behavior were seen. We think we may be at this point now to deal with physical inactivity. This should be seen as a call for a greater team work in fighting physical inactivity. A lot of research has been done to the highest scientific level. The time to see, through physicians’ education and clinical intervention with patients, should now be given a major role, as the other two pillars of physical inactivity management.

1. EDUCATION OF A CLINICAL AND SCIENTIFIC NATURE IS THE FIRST PILLAR

At present primary care and hospital physicians are not prescribing enough exercise for their patients. The reason is unknown but is related to lack of education of sports medicine at both undergraduate and postgraduate level, lack of reimbursement or recognition for writing an EPH, lack of guidance and encouragement from a cohort of clinical specialists in Sports and Exercise
Medicine that continue to stress that exercise is useful in health and disease. A meta-analysis included 305 trials approximately 340,000 patients were evaluated to assess the benefits of exercise and drugs in preventing death.2

A very large medical and scientific literature showed that exercise is beneficial for the prevention and management of many diseases.2, 3, 4, 5, 6

Why are we not prescribing exercise?

Through EFSMAs wide relationships with our 42 European Continental Associations and the International Federation of Sports Medicine (FIMS), our parent world body, we have accumulated many opinions and first class research information and data. We now believe that there is a consensus among Physicians, Scientists and Administrators on where we are and what needs to be done. We are at this point in the failure to see exercise as a prescription for health being utilized.

We believe the Sports and Exercise Medicine Physicians and Scientists now see where the bottlenecks have formed. These are in understanding both empirically and genetically that individual prescriptions are necessary. Psychological reasons for not exercising must be understood and addressed. Finally implementation of exercise programs must have a structure, so that getting the patient into an exercise program and keeping him/her there is vital.

We asked “what is the rank-order of what needs to be done”? A very strong argument came back as feedback “the doctors need to be educated first, then all the other players in the equation. The priority group of patients must be the greater than 50% of adults with one or more CNCD. Patients are central to what needs to be done. We have to design the way people are, not the way we want them to be. Adapting things to people instead of expecting people to adapt to things (Figure 1).

Current wisdom suggests that our medical practice system first requires a diagnosis. This is also a fact for administrators and third-party payers for healthcare, to see that it is being implemented. Our Medical Chambers should consider the possibility of negligence for not prescribing exercise. Then there is a need for a management teaching plan, which will be part of medical education and public health responsibility. Plans should be in place for teaching the value of exercise in disease in medical schools and among postgraduate physicians. Research on prognosis and follow-up recommendations are also required.

FIGURE 1. Adapting things to people, rather than expecting people to adapt to things
Diagnosis is important

As we practice medicine today, we need a code for diagnosis (ICD) (it already exists for “Lack of physical exercise” as a lifestyle problem see ICD 10 Data.com a variant on ICD 10; Z 72.3 is present since 2015) “Exercise Deficiency Disorder” (EDD) has been suggested as a possible diagnostic code by Prof Faigenbaum of New Jersey. We at EFSMA prefer the term “EDS”. A more than lifestyle, a more major code of ICD is needed and EFSMA is pursuing this at WHO level. Once there is a code diagnosis, prescriptions can be charged by trained Sports Medicine Physicians in hospitals. The biggest objectors to this suggestion were our medical colleagues.

Essential

- We must accept that the top down approach on its own has failed
- What is needed is a patient–doctor consultation for ill-patients
- A diagnostic code for EDS is necessary
- An enticement system for doctors, administrators and patients is necessary
- Physicians, personal trainers, patients and administrators have to be trained. Potential adverse responses to exercise must be accepted and highlighted
- Importance of individual patient discrepancy must be acknowledged
- Genetics and response to exercise programs are individual
- Personalized exercise programs is therefore a solution, as exercise is an individual medicine for each patient
- Fortunately, there are some accurate diagnostics, but ongoing research will give us insight and better testing into this aspect.

The conundrum

- The prevailing and extreme positions of the group “we” versus individual approaches
- The group or the “we” position posits that we are all the same. Individual positions are simply ignored
- The individual or the “me” approach is anchored to the idea that we are all individually different and that personalized approaches are the best.

Biologic drivers

The main trainers of drivability are biologic

- Genomics
- Gene expression profile
- Protein level
- Metabolism

This is where exercise physiology meets biology. There is a theory, yet unproven, that exercise opens up capillary beds and allows the accumulation of hormones and proteins to be picked up from the hidden periphery and distributed more widely in the body by the vascular system.

Personalized exercise program roadmap

- Personal information and biomarkers
- Rare variants but they may have limited utility
- Common genomic variants would theoretically be more readily useful but have small effect size
- The central theme: strong diagnostic tools for information decision making and individualization
• We observe that we are in a probabilistic rather than deterministic model
• The rationale is that the variance in training is substantially greater than genetic variation.

What is different with EFSMA’s approach?

• Doctors play a pivotal role with hands on writing and follow up on a prescription. A 1,000 page Swedish book on EPH is available free on the EFSMA website12,13
• Exercise physiology and its principles are the basis of an exercise prescription. An exercise physiology book by Professor Vassilis Klissouras from Greece is available free on the EFSMA website14, 15
• Exercise is not an alternative to drugs for blood pressure Diabetes Mellitus-II, obesity, hypercholesterolemia, but a complementary form of therapy16
• Our approach is similar to the successful approach of the anti-smoking campaigns: A physician with a patient advising the patient over time will be successful. A trickle-down effect may be generated from this approach also. Patients will discuss the value of seeing a trained exercise physician and will follow in consultation or learn from the first patient’s experience
• We want the central idea of Sports Medicine “Sports is Medicine” to be a pivotal part of the undergraduate and postgraduate teaching programs in all medical schools
• We see the importance of nutrition, psychology, lifestyle and the holistic approach to the patient or athlete as an ongoing part of patient care by doctors and third party payers for healthcare
• This is our bottom up approach as distinct from the many tried but relatively failed top down approaches for exercise in the population. By bottom up approach we mean each patient is seen and prescribed an individual exercise program (Figure 2). The top down approach is distributing brochures or posters on the value of exercise and letting everyone decide what they should be doing themselves.

Let’s ask ourselves: “Why do professionals act?”

What will drive doctors to act? The answer is: The same as applies to other professionals once they trained:

<table>
<thead>
<tr>
<th>Hospital physicians refer to and Community general practitioners</th>
<th>EM physicians</th>
<th>Benefit Society/ and the Healthcare System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrow DOWN</td>
<td>UP</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>^</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Physiotherapists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport and exercise graduates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength and conditioning graduates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal trainers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 2. The referral patterns for patients to Sports Medicine.** Hospital physicians and general practitioners refer patients to Exercise Medicine (EM) physicians, which benefit society and the healthcare system. The prescribed exercise is supervised by physiotherapists, sports and exercise graduates, strength and conditioning graduates and personal trainers, who refer back to EM physicians.
FEAR of being sued for non-prescription of exercise
GREED with financial reward for prescribing exercise

The ethics of not prescribing exercise: “Is it negligence?”
The medico-legal consequences of a failure to offer an EPH in clinical practice are a real and worrying issue. Large studies from Europe and USA have shown that low cardio-respiratory fitness is the single highest risk factor for all-cause mortality (Figure 3).

The importance of sport and understanding that exercise is a form of medicine, in particular the benefits of physical activity in CNCD prevention and chronic disease management, should be incorporated into the core undergraduate and postgraduate teaching.

Sports Medicine physicians give added value to patients by
- understanding the patients' psychology and their reluctance to exercise as prescribed
- including education on nutrition, as part of the exercise program
- being ahead of complications of exercise by pre-participation screening with Electrocardiography (ECG)
- or possibly genetic testing that might predict who is likely to have a sudden cardiac death (SCD).

Education for physicians
- Enticement for and punishment for not prescribing exercise
- Reimbursement system of a diagnostic code for fully trained physicians
- Education through Weekend courses
  6-month partial attendance diplomas
- 1-2 years of part-time and full-time Master of Science (MSc) in Sports Medicine
- 4 year full-time higher medical training in basic Sports Medicine training.

**Aerobics Center Longitudinal Study**

**FIGURE 3.** A short summary of the value of Cardiorespiratory and Vascular (CRV) fitness versus other non-communicable diseases has been established.
2. ECONOMICS IS THE SECOND PILLAR: COST OF LACK OF CARDIOVASCULAR-RESPIRATORY (CVR) FITNESS

Prevalence of chronic diseases in US adults according to the Centers for Disease Control and Prevention (CDC) report for 2012 showed that up to 65% of all consultations concerned chronic noncommunicable diseases (CNCD) (Table 1). The problem is a very large part (50%) of medical practice. Chronic diseases and conditions—such as Chronic Obstructive Pulmonary Disease (COPD), heart disease, stroke, cancer, diabetes mellitus, obesity, renal disease, chronic arthritis, psychiatric conditions, Paediatrics, gastro-intestinal tract, Allergy/Immunology, Obstetrics and Gynecology are among the most common, expensive and preventable of all health problems (Table 2).

<table>
<thead>
<tr>
<th>TABLE 1. Prevalence of Chronic Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 50% of all US adults (117 million people) in 2012 were noted to have one or more chronic disease</td>
</tr>
<tr>
<td>• 25% of adults have two or more chronic disease</td>
</tr>
<tr>
<td>• 70% of the top causes of death in 2010 were chronic diseases</td>
</tr>
<tr>
<td>• Two of these chronic diseases (heart disease and cancer) together accounted for nearly 48% of all deaths</td>
</tr>
<tr>
<td>• Arthritis is the most common cause of disability. Of the 53 million adults with a doctor diagnosis of arthritis, more than 22 million say that arthritis causes them to have trouble with their usual activities</td>
</tr>
<tr>
<td>• 47% of US adults have at least one of the following major risk factors for heart disease or stroke: uncontrolled high blood pressure (BP), uncontrolled high low-density lipoprotein (LDL) cholesterol, or current smoking</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2. The Economic Factor: Cost of chronic diseases in US adults data from 2012 Centers for Disease Control and Prevention (CDC) report highlights the economic burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 84% of all healthcare spending in 2006 was for the 50% of the population who had ≥1 chronic medical conditions</td>
</tr>
<tr>
<td>• $315 billion was the total costs of heart disease and stroke in 2010</td>
</tr>
<tr>
<td>• $193 billion was for direct medical costs, not including costs of nursing home care</td>
</tr>
<tr>
<td>• $157 billion was the cost for Cancer care in 2010 dollars</td>
</tr>
<tr>
<td>• $245 billion was the total estimated cost of diagnosed diabetes in 2012</td>
</tr>
<tr>
<td>• $176 billion in direct medical costs and $69 billion in decreased productivity</td>
</tr>
<tr>
<td>• Decreased productivity includes costs associated with people being absent from work, being less productive while at work, or not being able to work at all because of diabetes</td>
</tr>
<tr>
<td>• $128 billion was the total cost of arthritis and related conditions in 2003</td>
</tr>
<tr>
<td>• $81 billion was for direct medical costs and $47 billion for indirect costs associated with lost earnings</td>
</tr>
</tbody>
</table>
3. EPIDEMIOLOGY AND PUBLIC HEALTH ATTEMPTS AT EXERCISE UPTAKE IS THE THIRD PILLAR

Resolution on European Sports Cooperation (89/2)

The European Ministers responsible for Sport, meeting at Reykjavik for their 6th Conference from 30 May to 1 June 1989, stated: “Reaffirming our belief that sport is an integral part of education and culture that it contributes to human development, plays an irreplaceable role in the life quality of citizens, and that successful policies for sport can contribute to personal and social well-being; we promote sport and want to make it healthier, fairer and better governed”.

Extended Partial Agreement on Sport (EPAS)

The EPAS aims (sports promotion and emphasis on its positive value) are supported by EFSMA: to establish international standards and develop a framework for a plan

- European platform of intergovernmental sports cooperation by helping at the same time the public Authorities of the EPAS member states
- International and National Sports Federations and
- Non-Governmental Organizations (NGOs) regularly contacted and meet alternate years by EFSMA.

European Alliance for the Promotion of Physical Activity (EAPPA)

EAPPA is the umbrella of a group of involved Physicians, Scientists and Administrators who are trying to get Europe to mobilize. They are made up of a wide group of organizations with a similar goal (Table 3).

<table>
<thead>
<tr>
<th>TABLE 3. European Alliance for the Promotion of Physical Activity (EAPPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAPPA: European Alliance for the Promotion of Physical Activity</td>
</tr>
<tr>
<td>EACPR: European Alliance for Cerebral Palsy Rehabilitation</td>
</tr>
<tr>
<td>ECSS: European College of Sport Science-Research</td>
</tr>
<tr>
<td>EFSMA: European Federation of Sports Medicine Promotion and implementation of “Exercise Prescription For Health” (EPH) and “Pre-Participation Screening” for healthy and ill persons together with relevant educational activities for Physicians</td>
</tr>
<tr>
<td>EIEIM: Promoting regular exercise and educational activities in the primary care</td>
</tr>
<tr>
<td>EOC: European Olympic Committee. Anti-doping</td>
</tr>
<tr>
<td>ESSKA: European Society of Sports Traumatology and Knee Surgery</td>
</tr>
<tr>
<td>HEPA: Regular physical activity with WHO policy</td>
</tr>
<tr>
<td>WHO: Task force for healthy hospitals (Eur branch)</td>
</tr>
</tbody>
</table>

The Council of Europe (CoE) has a greater role to admire

We understand the CoE, as an International organization that promotes cooperation among all the European countries in the fields of

- Legal standards
- Human Rights
– Democratic development
– The rule of law and
– Cultural cooperation.

CoE in its work on sport and culture is distracted by three major negative issues in sport:

• Integrity in sport to combat match-fixing, and in particular the pros and cons of negotiating an international convention, as opposed to continuing cooperation on existing conventions, complemented by decisions and non-binding legal instruments. A 140 billion euro problem.

• The second part deals with political issues of pan-European cooperation and the strengthening of the monitoring capacities of the Convention on Spectator Violence.

• Anti-doping in sport which we are all familiar with, but we should not be complacent.

The EU Committee of Ministers to Members States on Young People and Sport (Adopted by the Committee of Ministers on 12 October 1995)

• The Committee of Ministers, under the terms of Article 15.b of the Statute of the CoE, Recalling the 1989 United Nations’ Convention on the Rights of the Child, referred to in Articles 28 and 29, and in particular in Article 31, which provides among other things that state parties recognise “the right of the child ... to engage in play and recreational activities appropriate to the age of the child” and encourage “the provision of adequate and equal opportunities for... recreational ... activity”.

Cultural Cooperation occurred in the UK, Europe and the World

• The Foresight report of the CoE by the Gov office for Science 17.10.2007, highlighted the unsustainable health and economic costs of a nation that continues to be largely sedentary.

Where are we in 2017?

• We have disimproved!
• We need another approach to implement exercise programs in the general population

4. THE FOURTH PILLAR IS THE “NEW” DISEASE “EXERCISE DEFICIENCY SYNDROME”(EDS)

Etymology from online etymology dictionary

Has the word “EXERCISE” become meaningless? What do we mean when we use the term? Is it that we mean the attainment of “cardiopulmonary fitness and musculoskeletal conditioning”? The answer to this rhetorical question is “NO”.

Exercise is an old French word (13th c). It meant “Execution of power; physical or spiritual exercise”. The Latin derivation exercitium “training, exercise”; from exercitare frequentative of exercere “keep busy, drive on”, literally “remove restraint” from ex “off” + arcere “keep away, prevent, enclose”. The original sense may have been “the driving of farm animals to the field to plow”. The Noun (mid 14th c) condition of being “in active operation”; practice for the sake of training. Meaning “Physical Activity” first recorded in English in late 14th century and in reference to written school work from early 17th c. The verb appeared in the late 14th c. To employ or put into active use from exercise the noun originally “to make use of”, Also in regard to mental and spiritual training: Sense of “engage in physical activity”, 1650s.
Exercise deficiency was first coined as EDD in children by Faigenbaum et al. of New Jersey in 2011. It was not immediately accepted by the Paediatric exercise community. EDS was coined in Europe in 2014 by the EFSMA. Exercise deficiency is defined as a condition made up of history and a physical examination. Physiological abnormalities may also be used to confirm the syndrome diagnosis. EDS leads to a low Cardiovascular-Pulmonary Fitness, which is detrimental to the well-being and life of both healthy and chronically ill patients. It is more dangerous than cigarette smoking, type II Diabetes Mellitus and obesity all together. It is twice as important as smoking cessation and is better than hypertension control alone.

Some scientists would say that EDS or a low cardiovascular respiratory fitness is a behavioral disorder rather than a syndrome or a disease. Until we accept that it is among the most important syndromes in medicine, we will not be able to solve the problem between healthy or diseased people (Appendix 2).

Some definitions may help:

**Cardiopulmonary Fitness**

- A fitness level that permits one to endure cardiopulmonary stress for a longer time at a faster rate
- A level of exercise that shifts the anaerobic threshold to the right of the graph of serum lactate plotted against measures of exercise work on the horizontal.

**Musculoskeletal conditioning**

- The strength or power of a muscle activity that permits a person to function at a higher level
- Our goal is at the core muscles of the trunk and the large muscle groups of the arms and legs.

**Epidemiology tells us that there is a new syndrome or disease. Significant for this disease are**

- Sedentary lifestyle
- Physical inactivity
- “Screen time”
- “Sitting time”

These are among the four most significant risk factors for non-communicable diseases especially for cardiovascular diseases. Further, they are also risk factors for metabolic, neuropsychiatric, oncological and other diseases.

**EDS symptoms**

- Admit to less than 150 minutes of exercise per week in 3 separate sessions
- Hours of exercise per week should be a fifth vital sign in all medical histories (Hx) and electronic records
- Psychologically less alert
- Less control over eating habits
- Early exercise dyspnea
- Less regular bowel habits
- Urinary and bowel incontinence
- More fractures secondary to osteoporosis
- Muscular atrophy of large muscle groups
• Difficulty getting up from a chair
• Difficulty going down stairs
• Falls
• Reduced physical activity

Signs of EDS
• Weight gain at the beginning, weight loss eventually
• Muscle atrophy
• Shift from muscle to body fat
• Slow movements
• Less agile
• Higher heart rate (HR) at rest and on exercise

Simple office tests for EDS\textsuperscript{10}
A measure of the absence of the cardiovascular-pulmonary fitness includes:
• Anthropometric weight, height, blood pressure (BP), HR at rest, in a.m. (before midday) before and after exercise, respiratory rate (RR), abdominal girth at umbilicus
• Exercise 6 minute walk, timed up and go test, gait speed and Borg dyspnea test
• Balance Berg balance test

Office based tests with equipment
• Fat fold measure
• Walk with oximetry monitoring
• ECG and when a referral to a cardiologist is indicated (office test)

Strength
• Hand grip strength, as measured with a hand held dynamometer
• 5 repetitions with a 5-30 kg barbell weight in 30 seconds*
• Jumps: (250-1,000cm high) in 30 seconds*

Stress as measured with parasympathetic nerve activity
The removal of stress through exercise, as measured using the parasympathetic nervous system activity on HR variability.

Complicated laboratory testing is not required in all patients: laboratory based
• Gold standard is the clinical hospital based cardiopulmonary exercise stress test\textsuperscript{50, 51} VO\textsubscript{2} max, exercise hypoxemia, respiratory exchange ratio (RER), exercise-induced bronchospasm (EIB), serum lactate acid threshold\textsuperscript{50}, and this test interpretation (Appendix 3)
• Physiological assessment and environment effect on test\textsuperscript{52-54}
• Physician supervised physiological exercise test is done by continuous monitoring of cardiac, pulmonary and metabolic parameters, as required and includes HR on awaking and after exercise, arrhythmias and BP response to exercise.

Other objective tests
• DEXA scan may show evidence of osteoporosis
• **Blood tests** to include hemoglobin, thyroid function tests (TFT), adrenal hormone and protein tests
• **Bioelectrical impedance**
• **Mini-mental state**\* vocal responses\*: orientation, memory, attention
  - Ability to name\*: follow verbal and written commands
  - Write a sentence spontaneously
  - Copy a complex drawing

Some\* of the above are part of an application (app) “Virtuagym” for EDS management and are part of a two-year EFSMA research program commenced in 2016. This app also has videos, training and diet plans.

There is no simple set of guidelines for a normal exercise test. The risk of cardiovascular events with exercise increase, as a direct function of exercise intensity (vigorous > moderate > low exercise intensity). A family history of SCD or a history of dizziness during exercise is a specific indication for cardiologist referral. Clinically it is used to decide the cause of dyspnea and exercise limitation. It is used to note ECG changes of exercise that may reflect ischemia, cardiac arrhythmia, exercise induced asthma and exercise hypoxemia.

**Prescribing exercise is not enough**

*Achieving cardiovascular-pulmonary and musculoskeletal fitness is the goal*

Exercise has been shown to improve and prevent the progression of renal disease in Type II Diabetes Mellitus (DM)\(^3\), stroke prevention\(^4\), osteoarthritis and rheumatoid arthritis\(^5\), gastrointestinal\(^6\), liver disease\(^7\), psychiatric conditions\(^8\)-\(^12\), and many other fields of the Internal Medicine.

**REFERENCES**

1. Preface to EPH: http://www.efsma-scientific.eu/


32. Storer TW, Casaburi R, Sawelson S, Kopple JD. Endurance exercise training during haemodialysis


41. Mountjoy M, Bergeron MF. Youth athletic development: aiming high while keeping it healthy, balanced and fun. BJSM 2015; 841-842.


APPENDIX 1. An exercise prescription

LOGO National Association

Prescription for exercise

ENDURANCE TRAINING

- .....x/wk, each ..... Min
- Training Heartrate: ....../min
- Borg-Value:
- Warming up: 5 min, cooling down: 5 min

- Recommended training:
  Slow Walk  Fast Walk  Nordic Walk  Running
  Swimming  Cycling  Others

- Ergometer Training: ......Watt/ ...min for warming up
  ......Watt/min......... minutes

STRENGTH TRAINING

......% 1RM......REPs ......SETS
...........muscle groups

Gymnastics/ Balance/Coordination .........wk each...........min
Ball Games .........wk each...........min
Others (Golf, Dancing, ...) .........wk

Sport Physician :............ Date : ............

In case of dyspnoe, irregular heart beats, chest pain or dizziness, stop activity and counsel your doctor.
<table>
<thead>
<tr>
<th><strong>APPENDIX 2. Differential Diagnosis in Exercise Deficiency Syndrome (EDS)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Under use of exercise</td>
</tr>
<tr>
<td>• Low oxygen in air</td>
</tr>
<tr>
<td>• Decreased oxygen carrying capacity of blood</td>
</tr>
<tr>
<td>• Mitochondrial deficiencies</td>
</tr>
<tr>
<td>• Endocrine deficiencies</td>
</tr>
<tr>
<td>• Trace metal deficiencies</td>
</tr>
<tr>
<td>• Lung, neuromuscular, nutritional and heart disease</td>
</tr>
<tr>
<td>• Medication side effects</td>
</tr>
<tr>
<td>• Dehydration</td>
</tr>
<tr>
<td>• Infection and inflammation</td>
</tr>
<tr>
<td>• Cancers</td>
</tr>
<tr>
<td>• Depression</td>
</tr>
<tr>
<td>• Sleep disorders</td>
</tr>
</tbody>
</table>
APPENDIX 3. Interpretation of clinical cardio-pulmonary exercise test

<table>
<thead>
<tr>
<th>Pulmonary limitation to exercise</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. No pulmonary limitation or decreased effort or cardiac limitation</td>
<td></td>
</tr>
<tr>
<td>B. Mild diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>C. Mild gas exchange abnormality</td>
<td></td>
</tr>
<tr>
<td>D. Mild gas exchange abnormality and diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>E. Mild ventilatory mechanical limitation</td>
<td></td>
</tr>
<tr>
<td>F. Mild ventilatory mechanical limitation and diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>G. Mild ventilatory mechanical limitation and gas exchange abnormality</td>
<td></td>
</tr>
<tr>
<td>H. Mild ventilatory mechanical limitation, gas exchange abnormality and diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>I. Decreased effort or cardiac limitation</td>
<td></td>
</tr>
<tr>
<td>J. Moderate or severe diffusion type limitation</td>
<td></td>
</tr>
<tr>
<td>K. Moderate or severe gas exchange abnormality</td>
<td></td>
</tr>
<tr>
<td>L. Moderate or severe gas exchange abnormality and diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>M. Moderate or severe ventilatory mechanical limitation</td>
<td></td>
</tr>
<tr>
<td>N. Moderate or severe ventilatory mechanical limitation and diffusion-type limitation</td>
<td></td>
</tr>
<tr>
<td>O. Moderate or severe ventilatory mechanical limitation and gas exchange limitation</td>
<td></td>
</tr>
<tr>
<td>P. Moderate or severe ventilatory mechanical limitation, gas exchange limitation and diffusion-type limitation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulmonary parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A fall in FEV-1 of greater than 20% after exercise is indicative of exercise-induced bronchospasm (EIB).</td>
<td></td>
</tr>
<tr>
<td>Asthma is the most likely diagnosis although transient inflammation of the airway may cause EIB.</td>
<td></td>
</tr>
<tr>
<td>A fall of less than 15% is against a diagnosis of asthma but a methacholine or a hyperventilation eucapnic stimulation test may uncover hyperirritable airways or asthma.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum oxygen uptake (VO₂ max)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;110% predicted represents athletic performance</td>
<td></td>
</tr>
<tr>
<td>&gt;90% predicted normal or mild pulmonary or cardiac limitation</td>
<td></td>
</tr>
<tr>
<td>&lt;90% predicted represents moderate cardiac or pulmonary disease or deconditioning.</td>
<td></td>
</tr>
</tbody>
</table>

| Ventilatory reserve (VR) = [1-(VEmax/predicted MVV)] X 100% |  |
| Predicted maximum voluntary ventilation (MVV) = 41 X forced expiratory volume (FEV-1) |  |
| At VO₂ max the patient should have some ventilatory reserve |  |
| Normal = 20-40% > 15 L/min |  |
| >30% = no ventilatory mechanical limitation |  |
| < 30% = a ventilatory mechanical limitation is present |  |
| If RR > 50 breaths /min it is restrictive disease |  |
| If RR < 50 breaths /min it is an obstructive ventilatory abnormality |  |

| Efficiency of the lung as a gas exchange unit is a measure of the gas exchange limitation. It measures the ability of the lung ventilation to remove CO₂ |  |
| VE max /VCO₂ normal is 25-35 |  |
| >40 = Excessive ventilation necessary to overcome the lungs inability to remove CO₂ due to a gas exchange problem. This is suggestive of pulmonary vascular disease no other circulatory abnormalities. Anxiety is a possible cause for this abnormality due to an increased drive to ventilation at the beginning of exercise only. |  |

continue
### Oxygen saturation $\text{SaO}_2$

- $<4\%$ is normal
- $>4\%$ decrease is most commonly due to a diffusion limitation. Shunts and ventilation-perfusion mismatch are also possibilities.

### Oxygen pulse $\text{VO}_2 - \text{cardiac frequency (cf)}$

- Less than predicted is a sign of structural heart disease, pulmonary vascular disease and anaemia.

### Cardiac limitation to exercise

#### Cardiovascular parameters

**Heart rate response (HRR)** is a measure of the $(\text{HR max- HR rest}) / \text{VO}_2 \text{ max- VO}_2 \text{ rest (l/min)}$

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-35</td>
<td>Trained athlete</td>
</tr>
<tr>
<td>35-45</td>
<td>Sedentary or untrained athlete</td>
</tr>
<tr>
<td>$&gt;50$</td>
<td>Cardiac pump abnormality due to cardiomyopathy of deconditioning of moderate degree.</td>
</tr>
</tbody>
</table>

**ST segment changes** are a measure of cardiac ischemia

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly positive</td>
<td>$&gt;3$ mm parallel to baseline or decrease in early exercise</td>
</tr>
<tr>
<td>Positive</td>
<td>$1-3$ mm decrease at late exercise</td>
</tr>
</tbody>
</table>

**Ventilatory anaerobic threshold (VAT)** is a measure of exercise tolerance

It is expressed as the $\text{VO}_2$ at which ventilatory equivalents for oxygen (VE/$\text{VO}_2$) ratio increases $\text{O}_2$ consumption at VAT/$\text{VO}_2$ max or predicted $\text{VO}_2$ max

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;40$</td>
<td>Circulatory or pump limitation because an inability of the heart or circulation to provide the necessary oxygen for aerobic metabolism</td>
</tr>
<tr>
<td>55-60</td>
<td>Normal</td>
</tr>
</tbody>
</table>

### Cardiac or circulatory limitation

- Q. Moderate or severe cardiac pump limitation or deconditioning
- R. Cardiac pump limitation or deconditioning
- S. Cardiac pump limitation and circulatory limitation
- T. Moderate or severe pulmonary limitation or poor effort
- U. No obvious cardiac or circulatory limitation
- V. Circulatory limitation (pulmonary or peripheral disease)
- W. Ischemic heart disease.