THE NORTHERN HOSPITAL

PULMONARY EMBOLISM SEVERITY INDEX - SIMPLIFIED (sPESI)

"The Snail" gouache on paper cut out, mounted on canvas, 1953, Henri Matisse.

" I have attained a form filtered to its essentials"

Henri Matisse

Since antiquity the idea of empty space, half way between a "thing" and a "non-thing" had troubled thinkers. Democritus himself, who had placed empty space at the basis of his world where atoms course, certainly wasn't crystal clear on the issue: he wrote that empty space ***is*** *something - it is something "between Being and Non-Being: "Democritus postulated the full and the empty, calling one "Being" and the other "Non-Being" says Simplicius (in Aristotle's "Physics"). Atoms are Being, Space is "Non-Being" that, nevertheless, exists. It is difficult to be more obscure than this.*

Newton, who resuscitated the Democritean idea of space, had tried to patch things up by arguing that space was God's "sensorium". No one has ever understood what Newton meant by God's "sensorium", perhaps not even Newton himself. Certainly Einstein, who gave little credit to the idea of a God (with or without a sensorium) except as a playful rhetorical device, found Newton's explanation of the nature of space utterly unconvincing.

Newton struggled considerably to overcome the scientist's and philosopher's resistance to his reviving the Democritean concept of space; at first nobody took him seriously. Only the extraordinary efficacy of his equations, which turned out to predict always the correct outcome, ended up silencing criticism. But doubts concerning the plausibility of the Newtonian concept of space persisted, and Einstein, who read philosophers, was well aware of them. Ernst Mach, whose influence Einstein readily acknowledged, was the philosopher who highlighted the conceptual difficulties of the Newtonian idea of space - the same Mach who did not believe in the existence of atoms. (A good example, incidentally, of how the same person can be shortsighted in one respect and far-seeing in another).

Thus, Einstein addresses not one, but two problems. First, how can we describe the gravitational field? Second "what is Newton's space?"

And it's here that Einstein's extraordinary stroke of genius occurs, one of the greatest flights in the history of human thinking: What if Newton's space was nothing more than the gravitational field? This extremely simple, beautiful, brilliant idea is the theory of general relativity.

The world is not made up of space + particles + electromagnetic field + gravitational field. The world is made up of particles and fields, and nothing else; there is no need to add space as an extra ingredient. Newton's space ***is*** *the gravitational field. Or vice versa, which amounts to saying the same thing: the gravitational field is space.*

But unlike Newton's space, which is flat and fixed, the gravitational field, by virtue of being a field, is something that moves and undulates, subject to equations - like Maxwell's field, like Faraday's lines. It is a momentous simplification of the world. Space is no longer different from matter. It is one of the "material" components of the world, akin to the electromagnetic field. It is a real entity that undulates, fluctuates, bends and contorts.

We are not contained within an invisible, rigid scaffolding: we are immersed in a gigantic, flexible mollusk (the metaphor is Einstein's). The Sun bends space around itself,

and Earth does not circle around it drawn by a mysterious distant force, but runs straight in a space that inclines like a bead that rolls in a funnel: there are no mysterious forces generated by the center of the funnel: it is the curved nature of the funnel wall that guides the rotation of the bead. Planets circle around the Sun and things fall, because space around them is curved.

Carlo Rovelli, "Reality is Not What it Seems", 2017

For millennia, great Philosophers, Natural Historians and Scientists, have pondered mightily on the nature of "space". Is it simply nothing, or is it in fact something - albeit something that we are unable to perceive. Democritus who first described the concept of matter consisting of very small and indivisible units called atoms considered space to be something mysterious that lay half way between "Being" and Non-Being". Isaac Newton who discovered the laws of gravity attributed his "force" to be something conveyed or propagated across space. There was no doubt that a "force of gravity" existed, but just exactly what it was, he could not say, in the end merely attributing it to the "sensorium of God".....

"How can the Sun attract the Earth, without coming into contact with it?", Newton once wrote, "It is inconceivable that inanimate brute matter should, without the intervention of something else which is not material, operate upon and effect other matter, and have an effect upon it, without mutual contact....that Gravity should be innate, inherent and essential to matter, so that one Body may act upon another at a Distance thro' a Vacuum, without the Mediation of anything else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity, that I believe no Man who has in philosophical Matters a competent Faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain Laws, but whether this agent be material or immaterial, I have left to the Consideration of my Readers".

It would not be until the Nineteenth century that two brilliant Physicists, Michael Faraday an impoverished Londoner without formal education and James Clerk Maxwell, a wealthy Scottish aristocrat and one of the greatest mathematicians of that century, would make the next steps in our understanding of the nature of gravity. Faraday would make his famous discovery of the lines of magnetism. His brilliant intuition led him to believe that we must not think of forces acting directly between distant objects, as Newton had presumed must somehow be happening, even though he could scarce believe it, but rather that there exists an entity diffused throughout the whole of space that is modified by electric and magnetic bodies, and that in turn acts upon the bodies. He called this entity a "field", and it would be James Clerk Maxwell who would provide the mathematical equations that described the action and the laws by which these fields acted. Thus was born a concept that there must also be some kind of "gravitational field", that accounted for the action of gravity.

In the following century, of course it would be the genius of Albert Einstein who would describe space and time or the rather single entity of "space-time" as a field that permeated the Universe, just as Faraday's lines of magnetism. Space was in fact "space-time" and it was matter that affected this field - gravity was simply the "warping" of the

space-time field, there was no mysterious "force" acting through space. The dawn of the Twentieth century also saw the development of the astonishing theories of quantum mechanics. On the very small scale reality was not an infinite continuum, ad infinitum, rather it was made up of discrete "quanta". Paul Dirac, came up with the concept (just as Faraday had come up with his concept), then others equally brilliant, such as Niels Bohr and Werner Heisenberg came up with the mathematical equations that described Dirac's concept (just as Maxwell had described Faradays fields with his equations).

By the end of the Twentieth century there was now a theory on the very small scale of reality, (quantum mechanics) and a theory of the very large scale of reality (general relativity). The Holy Grail of Twenty First century physics remains the unification of these two theories into one coherent theory that may explain the whole of reality. Einstein understood Democritus's and Newton's space or rather space-time to be like a universal mollusk, a real entity that bends, vibrates, and deforms, under the influence of matter, and by so doing creates the apparent "force" we perceive as "gravity".

Today brilliant Physicists such as Carlo Rovelli think of Einstein's space-time not as a an infinite continuum but rather as a quantum field, whereby space itself is a real entity that consists of discrete and finite bits or "quanta" (the Planck length at an incomprehensible 1.6 x 10^{-35} meters) out of which come emergent properties such as time and gravity.

These ideas are very difficult to grasp, very few in the world have a good understanding of relativity, quantum mechanics or theories such as loop quantum gravity which seeks to unite the two. But perhaps we may gain some glimpse into the strivings of those geniuses who are perched on the shoulders of the giants who have preceded them, by looking at a simple but brilliantly elegant work by the one of the Twentieth century's greatest Artists, Henri Matisse.

Just as quantum physicists strive to break down reality to its most fundamental units, the better to understand the Universe we live in, so exactly does Matisse in his delightfully child-like-work "The Snail" 1953. He breaks down reality to it most fundamental units. He uses little brightly painted squares as the quantum bits of a reality he wishes to convey. The juxtaposition of bright complementary colours interact with each other in unusual ways as if particles within some mysterious golden field. From these various quanta the most beautiful emergent properties of warmth and joy arise with the image of a happy little mollusk undulating its way through a field of sunshine and deep blue Mediterranean sea that Matisse loved so much.

Once we have diagnosed our patients with a pulmonary embolism, we come to the difficult decision of disposition. One aid to assist our decision regarding who we may safely treat as an outpatient comes to us in the form of the PESI score. This score however can be quite complex and cumbersome to use. However, just as the great Artists and Physicists strive to understand the world by reducing it down to is most basic quantum components, so we may better understand the PESI by using its most indivisible components filtered to its essentials in the form of the simplified PESI.

PULMONARY EMBOLISM SEVERITY INDEX - SIMPLIFIED (sPESI)

Introduction

The **P**ulmonary **E**mbolism **S**everity **I**ndex (or **PESI**) is a risk stratification score that may be used to predict mortality and longer term morbidity at 30 days in patients with newly diagnosed pulmonary embolism.

The **Simplified** Pulmonary Embolism Severity Index (**sPESI)** was designed to remove some of the more complicated elements of the Pulmonary Embolism Severity Index (PESI) and aid in the risk stratification of patients with pulmonary embolism (PE).

The sPESI is **easier to remember** and **simpler to use** than its predecessor.

It classifies patients simply into **low** or **high risk** (as opposed to the more complex 5 classes of risk in the original PESI score)

The sPESI has been shown to be equally as accurate as, (if not more than), the original PESI.

Note that the sPESI is a **rule-out** type of tool. **All** criteria must be answered "**no**" in order for the patient to be considered **low-risk**.

In the setting of a patient diagnosed with pulmonary embolism, the sPESI can be utilized to determine if he/she is a *possible* candidate for outpatient management, if they are determined to be **low risk** (i.e an sPESI score of **0**, where mortality risk is very low at around just1.1%.)

Like the original PESI Score, the sPESI score is meant to *aid* in decision clinical making, *not* replace it. Clinical judgement should still always take precedence.

See also separate document on the PESI Score (in Respiratory folder)

Inclusion Criteria

These include:

1. >18 years old

2. A definitive diagnosis of PE has been established.

Exclusion Criteria

The diagnosis has not been definitively established.

The sPESI cannot be used to risk stratify patients who are *not* being treated for PE.

In the setting of a patient with renal failure or severe comorbidities, **clinical judgement** should be used over the PESI, (oe sPESI) as these patients were *excluded* in the PESI validation study.

Application

The sPESI does not require laboratory tests and is scored according to the following 6 parameters:

- 1 Demographic point
- 2 Points of History
- 3 Clinical examination findings

PARAMATER	**POINTS**
Age > 80 years	Yes or No
History of cancer	Yes or No
History of chronic cardiopulmonary disease	Yes or No
Heart rate ≥ 110	Yes or No
Systolic BP < 100 mm Hg	Yes or No
O_2 saturation < 90%	Yes or No

Note that the excellent website **mdcalc.com** has a scoring program for sPESI (as well as PESI).

Interpretation

Low Risk:

A patient is deemed low risk when **all** parameters are **NO.**

In this group there is an overall risk of death of 1.1 %

There is a 1.5 % risk of having recurrent thromboembolism or non-fatal bleeding

High Risk:

A patient is deemed high risk when **any** parameters is **YES.**

In this group there is an overall risk of death of 8.9 %

The risk (outside of death) of severe morbidity is 2.7 %

Management

In *selected* **low risk** patients with pulmonary embolism, outpatient care can be safely used in place of inpatient care.

The sPESI score however should not be used in isolation of other important factors such as:

- **Social situation**
- **Exact comorbidities**
- **Patient understanding and reliability**

Therefore, like the original PESI Score, the sPESI score is meant to *aid* in decision clinical making, *not* replace it. Clinical judgement should still always take precedence.

References

1. Jiménez D1, Aujesky D et al. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. Arch Intern Med. 2010 Aug 9;170 (15):1383-9.

   - doi: 10.1001/archinternmed.2010.199.

2. MDCALC Website:

   - www.mdcalc.com

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