The Overuse of Diagnostic Imaging for Musculoskeletal Pain/Disorders

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1. Introduction

Never has more money and time been spent on exercise science and rehabilitation, than in our current era. Thanks to an explosion of technological advances over the last few decades, we have more electronic tools at our disposal for the treatment of disease and the rehabilitation of injury than ever before. Modern running shoe technology provides cushioning and motion control previously unheard of, radio chips track professional team players for conditioning analyses, fit-bits that monitor our deep sleep rhythms and calories burned per day, holographic 3D navigation system to help with surgery, and we have access to three dimensional high resolution medical diagnostic imaging...

Yet, there is an increase in repetitive strain injuries, and the incidence of musculoskeletal pain has never been higher than right now. There is rise in the number of pain and anti-inflammatory prescriptions, and more and more cases of chronic pain and chronic fatigue than ever before. Arthritis and other musculoskeletal conditions are recorded as the most common reason for chronic disabilities in working adults, and in the USA alone there are nearly 157 million doctor visits for musculoskeletal conditions per year.[1] While having the best technology at our disposal in the history of mankind, we clearly seem to be missing the mark.

In this paper I will shed light on the extend of the overuse of diagnostic imaging in the diagnosis of musculoskeletal disorders and pain. I will also demonstrate how this over reliance on technology is part of a much bigger problem in modern medicine, and discuss the costs of the misuse of these modern diagnostic tools.

The most commonly used diagnostic imaging (medical imaging) tools today, are Radiography (X-rays), CT-scans, MRI, and Ultrasound. X-rays are the oldest form of diagnostic imaging. Although not as advanced as 3D imaging, X-rays are the fastest and therefore still most frequently used type of imaging for applications where 2D is regarded as sufficient. Magnetic resonance imaging (MRI) has been used since the early 1980s. It “uses powerful magnets to polarize and excite hydrogen nuclei [...] of water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body”.[2] MRI produces high-quality 3D images non-invasively, which is why it's the preferred imaging technology in orthopaedics for detecting pathologies in soft tissues, such as meniscal, ligament, and tendon tears, and in occult bone injuries. It also has the advantage of not having the risk of radiation, but the disadvantages of higher costs and less availability than computerized tomography.

A CT scan (computed tomography scan) uses computer-processed combinations of multiple X-ray measurements taken from different angles to produce tomographic (cross-sectional) 3D images of a body.[3] Due to its radiographic means, multiple studies have linked CT scans (and PET scans) to an increased risk of the development of radiation-induced cancers.[4]

Ultrasound uses high-frequency sound waves through the body to produce real-time video images of the organs and tissues. It is best known for its role in viewing a fetus during pregnancy, but this diagnostic imaging technique is also used for imaging of the abdominal organs, heart, breast, muscles, tendons, arteries and veins. While it provide less anatomical detail, its advantages are that it emits no ionizing radiation, and contains speckle that can be used in elastography.[2]

2. What Does the Research Show?

In 2014 the American Board of Internal Medicine Foundation (ABIM), commissioned a survey conducted by PerryUndem Research/Communication to explore the attitude of physician regarding the overuse of medical services in the United States. 73 % of physicians said the frequency of unnecessary tests and procedures is a serious problem. 72 % felt the average medical doctor prescribes an unnecessary test or procedure at least once a week. 47 % of physicians said their patients ask for an unnecessary test or procedure at least once a week, and 53 % said that even if they know a medical test is unnecessary, they still order it if a patient insists.[5]

The blame for unnecessary diagnostic imaging is therefore to be shared by both medical doctors and patients. However, as doctors have an ethical responsibility to guide patients with the most informed advice in regards to decisions about their health and well-being, surely they should carry more blame. This responsibility is confirmed by the fact that 70 % of physicians in this survey said that after they speak with a patient about why a test or procedure is unnecessary, the patient often avoids it.[5]

The use of diagnostic imaging has increased significantly over the last two decades, particularly using expensive new technologies such as computed tomography (CT), magnetic resonance imaging (MRI), and nuclear medicine positron emission tomography (PET). Rebecca Smith-Bindman, M.D. and colleagues, of the University of California in San Francisco, conducted a retrospective cohort study of 135 million imaging examinations conducted in 7 US integrated health care systems and in Ontario.

The results of this 2019 study showed that among adults and older adults in the United States, CT increased from 204 per 1000 person-years in 2000, to 428 per 1000 person-years in 2016 (relative rate for 2016 compared with 2000, 2.1 times more) and in Ontario, CT increased from 161 to 409 per 1000 person-years (relative rate, 2.5 times more). Magnetic resonance imaging increased from 62 to 139 per 1000 person-years in the United States (relative rate, 2.3 times more) and from 13 to 89 per 1000 person-years in Ontario (relative rate, 6.7 times more) and ultrasound increased from 324 to 495 per 1000 person-years in the United States (relative rate, 1.5 times more) and from 332 to 580 per 1000 person-years in Ontario (relative rate, 1.7 times more).[6]

In children, imaging rates continued to increase, but at a slower rate, except for CT, which has stabilized or declined in more recent periods. The decline of CT in children, particularly in Ontario where it has declined since 2006, as well as the greater increase in MRI may reflect greater awareness of the concern regarding radiation exposure and harm in children.[6]

The above data corresponds well with a previous study of retrospective analysis of electronic records of members of six large integrated health care systems from diverse regions of the USA. The 15 year study period included a total of 30.9 million imaging examinations, reflecting 1.18 tests per person per year, of which 35% were for advanced diagnostic imaging (CT, MRI, nuclear medicine, and ultrasound). The *annual increase* in usage of advanced diagnostic imaging from 1996 to 2010 was found to be:

- Computed Tomography examinations (CT) = 7.8% per year

- MRI = 10% per year
- Ultrasound = 3.9% per year

While Nuclear Medicine decreased by 3% annually, after 2004 PET imaging rates increased by 15.2% annually.[7]

"Medical imaging is an important part of health care and contributes to accurate disease diagnosis and treatment, but it also increase costs and can lead to patient harms such as incidental findings, overdiagnosis, anxiety and radiation exposure that is associated with an increased risk of cancer," said lead author Rebecca Smith-Bindman, MD, a UCSF professor of radiology, epidemiology and biostatistics, obstetrics and reproductive medicine.[8]

The authors also found that the increase in the utilization of CT was associated with an increase in estimated exposure to radiation, with the average per capita effective dose increasing from 1.2 mSv in 1996 to 2.3 mSv in 2010. The percent of enrollees who received high (> 20-30 mSv) or very high (> 50 mSv) radiation exposure during a given year also approximately doubled across study years (1996 to 2010). It was further found that imaging rose steeply with age, particularly for CT and nuclear medicine examinations, resulting in high radiation exposures received by the oldest enrollees. Among enrollees age 45 and above who underwent imaging, nearly 20% received high or very high radiation exposure annually.[4]

In order to help put these typical patient doses into context, 20 mSv is the annual allowable occupational exposure to radiation in Europe, and 50 mSv is the annual allowable occupational exposure in the United States. The National Academy of Sciences' National Research Council concluded, after a comprehensive review of the published literature, that patients who receive radiation exposures in the same range as a single CT (10 mSv) may be at increased risk of developing cancer. Since the utilization of imaging is higher in older adults, and the potential harm from these tests may also be higher in these patients, it is particularly important to quantify the benefits of imaging in these patients.[8] It's certainly a concerning thought for those patients having a CT done (usually a PET Scan) every few weeks during their cancer treatment.[9]

Researchers estimate that 30% or more of imaging examinations may be unnecessary, costing the United States approximately $30 billion annually.[6] For this reason the "Choosing Wisely" campaign was launched in 2012 by the ABIM to address the overuse of diagnostic testing, which was endorsed by 85 professional medical societies. This initiative urges physicians to talk with their patients about whether an imaging study is necessary, discuss the possible harm and whether it is supported by evidence. They also provide clinician lists with detailed recommendations on which tests not to order in certain condition status.[5,10]

The use of any health care service should be guided by a balanced consideration of benefits and harms. Yet for imaging, very little relevant data is available to quantify either. Although guidelines have been developed for imaging, they are primarily based on expert opinion rather than evidence[11] and have not shown to cause a reduction in the use of diagnostic imaging.[12] Imaging examinations are often adopted into clinical practice before evidence supports their use, and once incorporated into practice, withdrawing the use thereof is more difficult. It is therefore not surprising that imaging rates have not declined substantially despite multiple policy and clinical efforts (like Choosing Wisely) focused on reducing their use.[6]

The increase in imaging use across all systems of medical care over the last 20 years was likely driven by a variety of factors:

- improvements in technology that allowed for the expansion of clinical applications,
- patient- and physician-generated demand,
- defensive medical practices,
- and medical uncertainly.

The improvement in technology certainly has changed the game for medicine, and one could argue that while we have the technology, why not use it. However, the inappropriate use of diagnostic imaging comes at a high cost, and that's not only in monetary value. JAMA Internal Medicine published an article titled *Low-Value Health Care Services in a Commercially Insured Population, which stated:* "More than $750 billion of US health care spending annually represents waste, including approximately $200 billion in overtreatment."[13] Overtreatment or overdiagnosis is the diagnosis of a "disease" that will never cause symptoms or death during a patient's lifetime. "It is a side effect of testing for early forms of disease which may turn people into patients unnecessarily and may lead to treatments that do no good and perhaps do harm." [14]

With back pain (especially low back pain) being the second biggest reason for medical consultations, and the leading cause of disability worldwide, the discipline of orthopaedics is also where diagnostic imaging is mostly overused. Clinical assessment of the causes of back pain is challenging due to the complex anatomy and function of the spine, as well as the regional interdependence of different sections of the spine with the extremities. Due to a lack of holistic / functional movement knowledge in medical education (for reasons which will be demonstrated in part 3 of this paper), most practitioners are in the dark about the causes of back pain. Their medical uncertainty therefore inevitably leads to the misuse of MRI. A magnitude of studies have however found that "advanced imaging methods are often not sufficient for a definitive diagnosis because similar findings could be present in either asymptomatic and symptomatic subjects" [15]

In one of the modern era's first studies of its kind, Dr. S.W. Wiesel, a George Washington University Medical Center orthopedist, published his team's findings in the September 1984 edition of the medical journal Spine (The Incidence of Positive CAT Scans in an Asymptomatic Group of Patients). 35 to 50% of the people without pain had overt disc pathology on their CT SCAN.[16]

In the March 1990 renowned orthopedic surgeon Scott Boden published a paper titled, "*Abnormal Magnetic-Resonance Scans of the Lumbar Spine in Asymptomatic Subjects. A Prospective Investigation",* in the American Volume of *The Journal of Bone and Joint Surgery.* He performed magnetic resonance imaging on 67 individuals who had never had low-back pain or sciatica. The scans were interpreted independently by three neuro-radiologists who had no knowledge about the presence or absence of clinical symptoms in the subjects. About one-third of the subjects were found to have a substantial abnormality. "Of those who were less than sixty years old, 20 per cent had a herniated nucleus pulposus. In the group that was sixty years old or older, the findings were *abnormal* on about 57 per cent of the scans [...] There was degeneration or bulging of a disc at at least one lumbar level in 35 per cent of the subjects between twenty and thirty-nine years old and in all but one of the sixty to eighty-year-old subjects."[17]
Another paper on the same topic was Dr. Maureen Jensen's *Magnetic Resonance Imaging of the*

Lumbar Spine in People without Back Pain, published in 1994 in the July 14 issue of the *New England Journal of Medicine.* This study found that only 36 % of the 98 *asymptomatic* subjects had normal disks at all levels, and 52 % of the subjects had a bulge at at least one level. It concluded that, "Given the high prevalence of these findings and of back pain, the discovery by MRI of bulges or protrusions in people with low back pain may frequently be coincidental."[18]

In 1995, Volvo's award winning 'Clinical Sciences Study of the Year' (*The Diagnostic Accuracy of Magnetic Resonance Imaging*) was published in the December issue of *Spine*. "The present study has presented evidence that [...] asymptomatic patients show a high incidence rate of disc herniations (76%). Individuals with minor disc herniations (i.e. protrusion, contained discs) are at a very high risk that their magnetic resonance images are not a causal explanation of pain because a high rate of asymptomatic subjects (63%) had comparable morphologic findings."[19] Thus, more than three out of four pain-free individuals in this study presented with disc herniations as is commonly diagnosed via advance imaging techniques. This study also found a whopping 85% of the asymptomatic subjects had class 3-5 disc degeneration on MRI!

The Institute for Research in Extramural Medicine, Faculty of Medicine, Vrije Universiteit, Amsterdam, did a systematic review of published observational studies to examine the causal relationship between radiographic findings and non-specific low back pain. Their study, which was published in the February issue of 1997 of *Spine* journal, concluded that, "there is no firm evidence for the presence or absence of a causal relationship between radiographic findings and nonspecific low back pain".[20]

A year later, the December 1998 issue of the journal *Radiology* published a study by a group of prominent Swiss researchers and radiologists. They used 60 hospital employees with no history of back pain, and then ran all of them through MRI's of the lumbar spine. Although the paper's conclusion infers that MRI is a wonderful tool for diagnosing back pain in the under 50's group, reading between the lines tells a very different story: 40% of the volunteers had "Disc Protrusions" even though they did not have back pain, and almost 1 in 5 of the asymptomatic test subjects had a "Disc Extrusion" (severe Disc Herniation)! Makes one wonder what standard of accuracy these radiologist aspire to in order to qualify MRI as a valuable tool for diagnosing back pain? [21]

A study by the University of Washington's Department of Radiology (*The Longitudinal Assessment of Imaging and Disability of the Back*) published in a 2001 edition of the journal *Spine,* were more unequivocal in their conclusions. While they found "back pain to be the second most common symptom-related reason for clinician visits in the United States, [and] up to 84 % of adults to have low back pain at some time in their lives, they concluded: "Many MRI imaging findings have a high prevalence in subjects without low back pain. These findings are therefore of ***limited diagnostic use***." [22]

In 2010, the Indian Journal of Orthopedics published a study called *Correlation Between Clinical Features and Magnetic Resonance Imaging Findings in Lumbar Disc Prolapse*, where the authors determined that the only finding that was easily correlated was a "centrolateral protrusion or extrusion with gross foramen compromise" (in other words a bulge that is lateral of centre and big enough to push on the nerve that exits the cord through the Intervertebral Foramen). On the other hand they found, "central bulges and disc protrusions [to] correlate poorly with clinical

signs and symptoms." [23]

What if you already had spinal surgery? A study by Lebow et el on post-surgical asymptomatic disc herniations published in the December 2011 issue of *Spine*, by a group of six researchers working at the Vanderbilt University Medical Center in Nashville, Tennessee, concluded by saying: "Nearly one-fourth of patients undergoing lumbar discectomy demonstrated radiographic evidence of recurrent disc herniation at the level of prior surgery, the majority of which were asymptomatic [...] Clinically silent recurrent disc herniation is common after lumbar discectomy." [24]

A *Systematic Literature Review of Imaging Features of Spinal Degeneration in Asymptomatic Populations,* published in the *Spine* journal in 2014, looked at 33 studies reporting imaging findings for 3110 individuals, with sample sizes ranging from 8 to 412 individuals. The research team aimed to estimate the prevalence by age, of common degenerative spinal conditions. They found the prevalence of disk degeneration in asymptomatic individuals to increase from 37% of 20-year-old individuals, to 96% of 80-year-old individuals. Disk bulge prevalence increased from 30% of those 20 years of age to 84% of those 80 years of age. Disk protrusion prevalence increased from 29% to 43% for the above age groups, and the prevalence of annular fissure increased from 19% to 29% between the same 20 and 80 year age groups. The study concluded that, "Imaging findings of spine degeneration are present in high proportions of asymptomatic individuals, increasing with age [and] likely part of normal aging and unassociated with pain. These imaging findings must be interpreted in the context of the patient's clinical condition." [25]

What all these studies have in common is the absurd number of false positives of MRI and other radiographic tests. If scientific evidence is to be respected, then diagnostic imaging should be rendered useless as orthopaedic diagnostic tool for determining causality of pain. Any confidence in its diagnostic value is purely based on those "coincidental" findings referred to by Dr. Jensen's study. The established lack of diagnostic accuracy of electronic imaging for identifying the causes of pain, is certainly not limited to the spine. Possibly the most famous orthopaedic surgeon in the history of modern sports, Dr. James Andrews, did an informal study with big league pitchers who were visiting him for other reasons, *not* related to problems *or* pain in their throwing shoulders. He ran throwing-shoulder MRI's on these "asymptomatic" individuals and discovered that over 90% of these 31 pitchers had serious enough issues on their MRI that would have justified him to recommend surgery. He concluded that, if you want an excuse to operate, just run an MRI.[26]

And herein lies the crux of the matter: when looking through the microscopic lens of an MRI at the joints of any person who's lived an active life or is older than 2 decades, you are going to find imperfections. That is exactly what the mountain of research evidence on asymptomatic individuals shows. While this data has been around for decades, why are medical doctors the slowest to catch on to this research evidence? Possibly because MRI has become the joker card in the hand of those benefiting from unnecessary routine orthopaedic surgeries. What chance has an uninformed patient to deny the 'hard evidence' of a high definition 3 dimensional photo?

The knee joint, which is second highest on the list for MRI referrals (after the lumbar spine), is arguably the biggest victim of unnecessary surgery. No wonder more than 34 % of all orthopaedic surgeons practice in this area of speciality.[27] Roughly 2 million people undergo arthroscopic knee surgery each year. Escalating evidence over the past decade has shown the procedure of meniscus

tear surgery (of which 95% are partial meniscectomies), not only to be ineffective,[28,29] but also to cause more arthritis than in the non-operative knee.[30] Furthermore, 7 of the 8 recent randomized studies reported nonoperative treatment to be superior to arthroscopic meniscectomy.[31]

One of the reasons why arthroscopic meniscectomies continue to sell like hotcakes, despite evidence of its poor long-term outcomes, is the belief in the orthopaedic community that a torn meniscus or cartilage loss, as defined in arthritis, is the cause of knee pain. This belief however, is also not backed by research of the last decade. The meniscus, shaped like a figure 8, snugly fits to acts as a spacer between the cartilage surfaces of the knee. It makes sense therefore that certain types of tears in this structure might be associated with the onset of arthritis. However, does it cause the arthritis, or is it a feature of the arthritis? What we do know, since a 2008 cohort study called *Incidental Meniscal Findings on Knee MRI in Middle-Aged and Elderly Persons*, is that meniscal tears are common in the general population, with or without pain.[32]

This study recruited 991 persons from Framingham, Massachusetts, who were drawn from census-tract data and random-digit telephone dialling. Subjects were 50 to 90 years of age (mean age of 62.3 years) and ambulatory (able to walk), and not selected on the basis of knee or other joint problems. Subjects with a history of bilateral total knee replacement, rheumatoid arthritis, dementia, or terminal cancer and those with contraindications to MRI, were excluded. They assessed the integrity of the menisci in the right knee through MRI scans obtained from subjects. In the overall sample (of which 57% were women), the prevalence of meniscal damage in the right knee (i.e., meniscal tear or destruction) was 35%. The study concluded that, “Incidental meniscal findings on MRI of the knee are common in the general population and increase with increasing age.” [32]

Between 1991 and 2010, the annual volume of Total Knee Arthroplasty (TKA) surgeries among Medicare beneficiaries in the US increased 161.5% and per capita utilization increased 99.2% over the same period.[33] While a 2014 study published in *Arthritis & Rheumatol* found that around one third of TKA surgeries were inappropriate, as these patients' arthritic symptoms weren’t severe enough to merit aggressive intervention.[34] Another TKA study published in Pubmed in 2012 found that 33% of the 45 subjects in their study of patients with persisting pain after total knee replacement, actually had degenerative hip and lumbar spine disease. Their pain resolved after injections of the hip and lumbar spine joints, which brings doubts over the accuracy of the original diagnosis of the need for a TKA.[35] I will discuss this natural phenomenon of the cause and the source of pain not being the same in more detail in part 3.

Two very large studies, the Osteoarthritis Initiative (OI) and the Framingham Osteoarthritis Study, tracked patients with knee arthritis with many different modalities such as x-ray, MRI, exams, blood work, questionnaires and biomarkers. The Framingham study reported that although the prevalence of (bone) attrition, bone marrow lesions, and subchondral cysts, was higher in participants with painful knees than those without pain, “the prevalences for the other features [cartilage loss or damage] were within about 4% of one another among painful and painless knees with no significant differences.” “Indeed, the prevalence of at least one type of MRI detected pathology (“any abnormality”) was high in both painful (91%) and painless (88%) knees”. [36]

The OI study which looked at the degree of knee cartilage loss in almost 500 patients, also

determined a weak correlation between WOMAC and KOOS symptoms (including pain) and the degree of tibiofemoral cartilage loss shown on radiography and magnetic resonance imaging (MRI). They concluded that Osteoarthritis is a multi-factorial process and that we need to treat patients based on their symptoms, and "rely on radiographs as confirmatory modalities, *and not diagnostic modalities*, when talking about OA and medical intervention". [37]

Another very popular surgical procedure of our day, thanks to MRI, is hip arthroscopy for repairing labrum tears. Between 1999 and 2009, arthroscopic surgery of the hip joint increased 18-fold, with a 365 % increase between 2004 and 2009![38] The labrum is a ring of cartilage that surrounds the socket of the ball-and-socket hip joint, and a tear in the labrum is believed to be the source of pain and discomfort in the hip. Labrum tears are often associated with femoroacetabular impingement (FAI). What does research say about the prevalence of labrum tears?

A study called *Acetabular Labral Tears Are Common in Asymptomatic Contralateral Hips With Femoroacetabular Impingement,* published in the May 2019 edition of *Clinical Orthopaedics and Related Research*, looked at 100 patients (47 females, 53 males) with a mean age of 33 years who were diagnosed with unilateral symptomatic FAI. The MRI of both hips was independently evaluated by two orthopaedic surgeons, who found a labral tear in 97% and 96% of symptomatic hips, respectively. More interestingly, a labral tear was also detected in 41% and 43% of asymptomatic hips. The study concluded that "the decision to perform [...] labral surgery in patients with FAI should be made with caution considering the relatively high prevalence of labral tears in asymptomatic hips, and the low chance of development of symptoms".[39]

A 2015 Systematic Review by Frank et al (published in Arthroscopy) on Prevalence studies of femoroacetabular impingement (FAI) in asymptomatic volunteers, looked at 26 studies, which included 1,057 participants (57.2% male, 42.8% female), and 2,114 hips (mean age of 25.3 ±1.5 years). Labral injury was found on MRI in **68.1% of the general population**. The prevalence in athletes was 65.4%. The study concluded that FAI and labral injuries are common in asymptomatic people.[40]

Tresch et al (Switzerland) did a Cross sectional study in 2016 with 63 asymptomatic volunteers, age- and sex-matched with 63 patients with femoroacetabular impingement (FAI). Labrum tears were seen in 44% of volunteers versus 61% of symptomatic patients. The location of defects was similar in asymptomatic and symptomatic subjects.[41]

A Briggs et al study (United States) called *Prevalence of acetabular labral tears in asymptomatic young athletes*, published in BJSM online 2017, recruited 101 young (11 to 19 years of age) sports people via a screening program. The group consisted of 93 males and 8 females (skiers and ice hockey players), with an average age of 15. Labral tears were identified in 70 of the asymptomatic hips, with 89% of participants aged 16 or older having labral tears, and 56% of participants aged 16 or younger having labral tears.[42]

A cross sectional study by Lee et al (New Zealand) in 2015, recruited asymptomatic volunteers from medical students and allied health professionals at Christchurch Hospital. The group consisted of 70 physically active young adults, with a mean age of 26 (range 19-41) years. 70 % of the subjects were regular or occasional participants in "impact sports" (rugby, football, hockey, martial arts, running, ballet). Labral tears were found in 27 of these pain-free participants

(38.6%). Lee and associates concluded that, “given the high prevalence of labral pathology in asymptomatic people, it is important to confirm that a patient’s symptoms are due to the demonstrated abnormalities when considering surgery. The decision to treat should not be based on the presence of an MRI- detected labral tear alone”.[43]

As such, study after study shows that labral tears are very common among the pain-free population. In the same way that heaps of research evidence show torn cartilages, cartilage loss, disc bulges, disc protrusions, torn labrums of the shoulder, etc., etc., to be common among asymptomatic people. And why is that important again? Because if these 'conditions' are commonly present in MRI of people who do not experience any pain as a result of it, MRI findings of these 'abnormalities' has zero scientific value for diagnosing the cause of pain in anyone. This is based on the very basic condition underlying the entire discipline of scientific research: the principle of causation. “Scientific research [...] can be considered to be primarily the practical application of the principle of causation based on observation, analysis (deductive or inductive), experiment, formation of hypothesis, and the formulation of theories and models”.[44] If observation finds no causal relationship 40 – 60% of the time, there is nothing to analyse, no hypothesis to be formed, and no theories can be developed!

A last factor to mention which might conbtribute to overuse of diagnostic imaging, is what is referred to as *defensive medical practice*. Clinical negligence claims and litigations against orthopedic surgeons are constantly on the rise, with the second most common cause being wrong, delayed, or failure diagnosis (the first being post operative complications). In a web-based survey of 1214 orthopaedic surgeons in the USA, 96 % of surgeons reported that they practised defensive medicine by ordering laboratory, imaging, consultation, and hospital admissions to avoid possible litigations. On average, 24 % of all tests were reported to be for defensive reasons.[45] A big part of this defensive approach is of course a product of medical uncertainty, which in regards to orthopaedic conditions at least, stems from a lack of functional knowledge. We will look at this in depth in the next section.

3. The Real Problem Defined

3.1 Sometimes the problem is the way we look at the problem.

The fundamental reason for the blatant overuse of diagnostic imaging in modern medicine when looking for the cause of musculoskeletal pain, is an epistemological issue. To unpack this problem, we have to take a look at how the modern scientific approach was developed.

All current scientific investigation is governed by the reductionistic - empirical framework. Descartes, often sited as the father of Modern Philosophy, laid strong foundations for reductionism (the philosophical position that explains or studies complex phenomena by reducing it to its simplest constituents). With his statement "I think therefore I am", he reduced the existential essence of the total human being to the single dimension of rationality.[46]

While rationality emerged as one of the new legs of early modern philosophy, empiricism was established as the other through the vindication of the natural sciences. It was the Enlightenment philosophers of the 18th century however, Locke and Hume, who developed an empiricism of extreme contrast to rationalism, and argued that the only knowledge one can have is that based on empirical evidence.[47] Sense experience became the foundation of all knowledge, and rationality came to be understood as the mere power of organization and calculation, rather than an insight into reality.[48]

Both reductionism and empiricism contributed to dramatic transformation in scientific and philosophical thinking, which became known as the Scientific Revolution of the 17th and 18th century. A fundamental development was the scientific method which insisted on deducing results from observable data, rather than developing ideas which fitted into a specific philosophic belief. This led to the rejection of superstitions and the medieval doctrines of the Roman Catholic Church at the time. Natural philosophers had to be sure of their data and required independent and critical confirmation of their discoveries. Scientific societies sprang up where natural philosophers could gather to examine, discuss, and criticize new discoveries and old theories. Societies eventually began to publish scientific papers as a platform for these discussions.[49]

While reductionism and empiricism contributed hugely to our knowledge in areas like physics, chemistry and micro biology, the adverse effects of it's overpowering dominance on Western thinking has gone unnoticed. European philosophers of the modern period became so hypnotized by science and it's technology, and obsessed with the materialistic framework, that they quite forgot themselves as holistic beings (Nicolson 2008:21).[50] Coupled with the strong influence of the Industrial age, a number of epistemological paradigms contrary to the holistic essence of nature, has become so ingrained in modern scientific thinking that they are no longer contested:

- The qualitative essence of nature has been substituted for the quantitative.[49] This obsession with the quantifiable, has lead to a complete ignorance of that which cannot (or has not yet been) measured. No one answers this ignorance more appropriately than Albert Einstein: "Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted".
- The view of man as a machine rather than as an organism. Descartes' *Treatise of Man* (1633) is an illustration of this, in which he describes the human body as a machine, and

reduces all bodily functions to matter in motion.[51] Herbert Muller, referring to microbiology, would have responded this way: “To say that a man is made up of certain chemical elements is a satisfactory description only for those who intend to use him as a fertilizer (Muller 1943)”.[52] What we gain from reductionism only adds value to our understanding of nature and life, if this is synergized with knowledge of the whole.

- The development of the scientific method that sought definite answers to subjectively formulated hypothesis (research questions) to formulate specific theories. Carl Popper, one of the greatest philosophers of the 20th century, stressed that “all observation-statements are theory-laden”, and are as much a product of purely subjective factors such as a scientist’s interest, expectations or wishes, as they are a function of what is objectively real.[53] As a wise man once said: “The most objective person in the room, is the one who knows he is not”.

The dismantlement of rationality from the indisputable champion of modern scientific investigation, namely empirical evidence, has led to a situation where research finding are often given authority regardless of whether it logically fits into the bigger picture. For example: huge amounts of money and time is spend on gait analysis with the latest pressure mats, scanners and software, all backed by 'evince based' research of course, to then develop expensive 3D footwear products. And while many debate about the exact amount of 'motion control' your running shoes should have, there is ignorance to the fact that your gait cycle might be a product of any number of functional limitations or compensatory patterns higher up in the movement chain.

For example, an externally rotated pronating foot is a common functional strategy the body uses when the femur cannot externally rotate during the weight acceptance (late contact) phase of gait, due to a hip that lacks external rotation, and this possibly due to an anteriorly rotated ilium... Gray Cook (Physical Therapist, Certified Orthopedic Specialist, Lecturer and Author) brilliantly coins it this way: “Attempts to correct gait patterns on a dysfunctional system with poor fundamentals, is like manually wagging the tail of an angry dog to make him happy. […] Make the dog happy and the tail will wag automatically.”[54] Without common logic, scientific advances are often focussed on the wrong end of the dog. In our rush to explore new technological advances in measurement of quantitative output, certain aspects of human movement have become overvalued, while qualitative aspects of movement are undervalued.

3.2 Anatomical science vs Functional science

The mechanical perspective on human functioning is in part a product of our current understanding of anatomy, which is only an artefact of our methods of dissection, and the tools available to us over the last 400 years. From the early anatomists' knifes, to later scalpels and lasers, these are used to cut along the often bilaminar tissue and separate individual parts from its connective tissue syncytium, which functions as a whole.[55] For academic study, dissection is of course necessary and appropriate for differentiation and labelling. However, more knowledge of the now *manageable* individual parts without increased knowledge of how they function as a whole, does not help us grow in understanding of functional movement.

Functional movement science of the last few decades teaches us that the brain records movement patterns instead of isolated muscle and joint activity, in order to create practical perception and execution of synchronized movement. Thanks to genetic encoding, motor learning and natural

development, the brain learns to organize muscle synergy in execution of familiar activities, for the sake of harmony, economy and efficiency. It is supported by the sensory system's monitoring and involuntary adjustment of movement, as well as the dynamic web-like connective tissue (fascia). Therefore, to concentrate on individual muscles or joints when approaching movement, corrective training or rehabilitation of injury, is complete ignorance of nature.[54]

The 'isolated muscle theory', as referred to by Thomas Meyers, is also void of the role myofascia often plays as 'hydraulic amplifier' in pushing out against and thus pre-tensing its neighbours. Neither is there room in this theory for discussing the longitudinal connections between muscle and fascia in their functioning (like the consistent attachment between the iliotibial track and the tibialis anterior in the *Spiral Line*).[55]

Based on the reductionist anatomical perspective, many health care practices operate from the perspective that managing a dysfunctional system's defective *part* will correct the entire system. Dealing only with parts is safe, and more assured of giving the appearance of successful management of a problem. As Gray Cook puts it, *"focussed piecework ignores synergistic power and the integrated patterns that produce true function"* (2010:19).[54] A great example of the *part vs pattern* phenomenon is what happens when a person breaks a leg, and continues to limp long after the healing of the leg. The body has repaired the damage, but the new dysfunctional pattern which was adopted to deal with the temporary problem, often remains. It shows that the system does not always reset to a functional norm once healed.[54]

In the acute phases of injury the isolated treatment of injured parts, which focuses on tissue physiology and the control of pain, is of course necessary and beneficial. However, when the treatment of pain is the only objective in rehabilitation of injury, with no attention given to possible movement dysfunction that might have caused the injury, then treatment is deemed successful when pain is gone, or reduced to a tolerable level. Being pain-free does however not mean functional competency or integrity has been restored or improved.

Chronic pain (lasting for more than 6 months) often does not have the benefit of a directly identifiable cause, and is therefore much more difficult to treat. Dealing with chronic or *persistent* pain (pain that doesn't respond to intervention of a treatable condition), with the anatomical-parts-orientated approach, is even more ineffective. For example, thousands who undergo arthroscopic knee surgery or total knee replacements, continue to experience knee pain years after the surgery (or elsewhere in the movement chain).[35] Reason being is the movement dysfunction that was responsible for the compensation that caused strain on the knee joint initially, was never addressed. Functional movement science has caught on to the more holistic systems of healing (like Osteopathy and Chinese Medicine), which has been advocating for centuries that the source of pain is not necessarily the cause of pain. This perspective is well explained by the concept of Regional Interdependence, which states that *seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with, the patient's primary complaint*. [56,57]

A 2013 study published in the medical journal *Modern Rheumatology* discussed the complexities of hip pain and how it affected other areas of the body. They showed how distribution of pain originating in the hip, could be misinterpreted by causing:

- groin pain in 89% of patients,

- buttock pain in 38% of patients,
- pain in front of the thigh in 33% of patients,
- knee pain in 29% of patients,
- greater trochanter pain in 27% of patients,
- low back pain in 17% of patients,
- lower leg pain in 8% of patients. [58]

Similarly, a 2017 study published in the journal *Clinical Orthopedic Surgery,* found that in patients who experienced continued pain after total knee replacement, 25.6% of those were found to have nerve entrapment in the spine, and 15.4% were found to have hip osteoarthritis or femoral head avascular necrosis. [59]

Changing the tyre does not solve the wheel alignment problem, it only provides a temporary cover-up. The shortcomings of this analogy between the motorcar and the human body however, is that in many cases (especially in younger patients) the body could have repaired the damaged cartilage once the 'wheel alignment' was corrected, since there would no longer be constant strain on the joint. In the same way the a callous becomes softer with time once you stop wearing those tight shoes. That's what the human body instinctively does, it heals. This is also true of damage around the ball-and-socket hip joint, often diagnosed as the infamous labral tear. Up to 95 % of patients with a labral tear present with clinical signs of FAI (femoroacetabular impingement), and therefore related to repetitive strain. FAI primarily causes pain in hip or groin related to certain movements or positions, and patients may complain of stiffness, catching or locking of the joint. However, forced external rotation of the hip can also cause acute labral injury. [60]

From a functional movement perspective, FAI occurs in a hip that lacks joint centration: poor neuromuscular control (instability) of the hip and lumbopelvic regions result in the development of abnormal recruitment patterns of hip musculature. These compensatory movement patterns often include excessive internal rotation of the hip which can negatively impact force generation of the gluteus maximus. This inhibition of specifically the deep fibers of the gluteas maximus during active hip extension, coupled with decreased contribution of the deep fibers of the psoas major during active hip flexion (both the gluteas maximus and psoas are part of the *local system*), result in greater anterior hip forces. This lack of joint centration ultimately results in forward migration of the femoral head in the acetabulum (Sahrmann 2002, Gibbons 2005).[1]

An alternative compensatory mechanism that can also lead to a loss of hip joint centration and predisposes an individual to impingement and groin pain, is referred to as 'but gripping'. This occurs due to over-activation of the deep hip rotators, which posteriorly rotates the ilium and drives the femur anterior in the socket (Lee 2008).[1] Whichever the initiating limitation (or imbalance) that led to the lack of joint centration, the outcome is a hip joint that lacks neuromuscular control (integrity), and therefore doesn't have the ability to maintain an optimum axis of rotation. This negatively effects joint play, and eventually leads to wear on the articular surfaces. This wear, whether a torn labrum or diffused groin pain, is the symptom, not the cause of a dysfunctional hip. When the causes of the lack of joint centration (i.e. the muscular imbalance of tension and tone around the joint, and the lack of lumbopelvic stability), are restored through a systematic program of manual therapy and corrective exercise, the strain on the articular surfaces will be removed.[61] This will allow the body a chance to heal that area, naturally.

A common contributor to the development of FAI and subsequent articular damage, is of course overuse. As with any movement dysfunction or imbalance, it is the volume of movement on an unsound base that turns a smaller problem into a bigger one. When it comes to competitive athletes, this factor often carries more weight. 20 years experience of working with sportsmen and women of all kinds has taught me that putting unreasonable demands on their bodies through years of over-training (i.e. a lack of recovery), is more often than not the fundamental reason for their dysfunction and pain. The biggest challenge of my work as movement specialist is to get these athletes, many of whom are addicted to exercise, to stop training for a period of time to allow us the opportunity to help their bodies heal. (The human being is the only mammal that continues to move while in pain- but that's a phenomenon that deserves a dissertation of its own). The biggest 'benefit' of surgery, and the reason why some do experience pain relieve from surgical repair of the labrum, is the forced rest that comes with it. Now the headstrong athlete has to stop training, and the body finally gets the opportunity to heal, which it so desperately longed for.

The late Czech neurologist Vladimir Janda, an early pioneer of clinical evaluation of movement quality who linked chronic pain syndromes with muscle imbalance and faulty posture, together with associates did a fascinating study on the influence of a localised injury in a distal joint on the neuromuscular function of a proximal joint. They compared muscular function of the hip in subjects who previously suffered a severe unilateral ankle sprain, to matched control subjects. They tested the pattern of muscular activation of the whole posterior chain on both sides during hip extension in a prone lying position. The patterns of activation of subjects with previous injury were markedly delayed compared to the normal control subjects, and changes appeared to present on both the injured and uninjured sides of the body. Conclusions of the Janda study stressed that the existence of remote changes of muscle function following an injury could be due to:

- proximal changes resulting from an inhibitory protective response to decrease the risk of further injury;
- altered proprioception at the distal injury site, which leads to lowered coordination of proximal muscle activity during functional movements;
- residual inhibitory effect from the pain response to the original injury.[62]

Pain, inflammation, swelling, joint effusion and immobility all compromises neuromuscular coordination and control, and could lead to altered movement patterns as a result. Even after tissue damage and pain from the original injury has healed, the adapted movement patterns which was recorded below the level of conscious control, remain in tack. As confirmation of the impact of this neglected reality, guess what researchers found the number one risk factor for injury to be? *Previous injury.*[63] Too many patients are cleared for activity without having shown improved or restored whole movement pattern competency after treatment. It's only logical to deduce that the current model of rehabilitation, with its myopic emphasize on fixing parts, is not working.[54]

In the current model of rehabilitation, most of the rehabilitation/therapeutic exercise target tissue physiology and not motor control. Standardized pre-packaged exercises are used to rehearse faulty movements, in the hope that adding arbitrary resistance loads will somehow create strength and integrity. Without checking function against a movement pattern standard, these rehab programs are ignorant of a patient's movement limitations or asymmetries, and therefore often forces the individual into developing more compensations or imbalances on the road to 'recovery'.

This is how Gray Cook reflects on the standard protocol he was taught as young physiotherapist: “Many physicians and therapists assumed that if they provided activity at or around the dysfunctional region, motor control would spontaneously reset. Yet, we were not so much causing a reset as we were creating greater opportunity for compensatory behaviour” (Movement, 2010:26).[54]

4. Credibility of the "Evidence" in Evidence-Based Medicine.

Why if there is so much evidence available on the *inefficiency* of MRI and CT scans to identify the causes of chronic pain, are these still regarded by medical practitioners as the gold standard? Or why is arthroscopic surgery on the meniscus still the most common orthopaedic procedure in the United States, even though more than 87% of studies shows this procedure to be no more efficient that physical therapy?[31] The answer to both these questions are closely related, and speaks volumes for the lack of respect for best evidence in orthopaedic medicine. With 700,000 arthroscopic surgeries on the meniscus annually performed in the USA alone, at an estimated cost of $4 billion, the answer to the above question becomes even more obvious.[28]

With rates of knee replacement surgeries having doubled since 1999, 3.5 million of these procedures a year are expected by 2030.[64] "We do too many knee replacements," said James Rickert, an orthopedic surgeon in Bedford, Indiana, and president of the Society for Patient Centered Orthopedics (which advocates for affordable health care). "People will argue about the exact amount. But hardly anyone would argue that we don't do too many." Yet hospitals and surgery centres market knee replacements heavily, with adds that show patients running, cycling, even playing basketball after the procedure, said Nicholas DiNubile, a Havertown orthopedic surgeon specializing in sports medicine. While many people with artificial knees can return to moderate exercise (such as doubles tennis), it's unrealistic to imagine them playing full-court basketball again, he said. Knee replacements, which cost $31,000 on average, are "really crucial to the financial health of hospitals and doctors' practices," said DiNubile. [65]

Emergency physicians and other critical care providers are paid to save lives. For example, when doing an emergency intubation (making a non-breathing person breath again), an emergency physician in the US actually gets paid $112 to save that life. It would be wrong therefore to say that everyone in medicine is greedy. The total cost of approximately $40,000 for 'saving' a hip alone, does seem outrageous in comparison.[66] Not surprisingly then, orthopaedic surgeons earn more than any other type of physician (second only to neurosurgeons), with an average annual salary of $535,668 in the US.[67] Somehow, the system (medical insurers, hospitals, surgeons, ect.) that benefits from providing surgical intervention for orthopaedic dis-ease, has managed to condition consumers to accept these fees. Orthopaedic medicine has been turned into a huge business, with bigger profits being priority number one. This inevitably brings with it the temptation of corruption...

While there is enough evidence to show that *evidence-based medicine* in general, is not as evidence based as we are made to believe, the evidence base for orthopaedics compares even more unfavourably with other fields of medicine. It took "*some 20 years after the general introduction of knee arthroscopic surgery, with millions of patients treated, before the first randomized controlled trial was published"*.[68] In fact, only 20% of surgical orthopaedic procedures are estimated to be supported by at least one low-risk-of-bias randomised controlled trial, showing that surgery is superior to a non-operative alternative.[69] It is no wonder therefore that the sacred cows of orthopaedic medicine (arthroscopic knee surgery, total knee replacements, labral tears, etc.) continue to live on.

More telling evidence of the lack of evidence in orthopaedic medicine comes from a paper published by J. Bruce Moseley et el in the July 2002 edition of The New England Journal of

Medicine (*A Controlled Trial of Arthroscopic Surgery for Osteoarthritis of the Knee).* While in uncontrolled studies of knee arthroscopy for osteoarthritis, about half the patients report relief from pain, there is no evidence that arthroscopy cures or arrests the osteoarthritis, or clarity over the physiological basis for pain relief. Moseley et el therefore set out to conduct a randomized, placebo-controlled trial to assess the efficacy of arthroscopic surgery of the knee in relieving pain and improving function in patients with osteoarthritis.

"A total of 180 patients with osteoarthritis of the knee were randomly assigned to receive arthroscopic débridement, arthroscopic lavage, or placebo surgery. Patients in the placebo group received skin incisions and underwent a simulated débridement without insertion of the arthroscope." Both patients and assessors of outcome were blinded to the treatment assignment. Outcomes were assessed at various stages over a 24-month period with the use of five self-reported scores for pain and function, and one objective test of walking and stair climbing. The result? "At no point did either of the intervention groups report less pain or better function than the placebo group." [68] Similar findings were reported by a 2013 systematic review of the evaluation of surgery, which found that in 51 % of trials the effect of placebo did not differ from that of surgery.[70]

Evidence-based medicine (EBM) was defined in 1996 by David Sackett as "the use of current best evidence, integrated with individual expertise to make the best decisions about the care of individual patients". He went on to state that the best evidence is usually found in clinically relevant research, conducted by using sound methodology. EBM is therefore supposed to improve the benefit vs risk ratio of any particular treatment option for patients. Sadly, 20 years on, a systematic review study of 2015 (*Patients' Expectations of the Benefits and Harms of Treatments, Screening, and Tests),* which looked at 35 studies involving a total of 27 323 patients, found people actually understand the risk-to-benefit ratio of their treatment or diagnostic testing less than 6 % of the time.[71]

Furthermore, since the birth of EBM, health care costs have increased, while there remains a lack of high-quality empirical evidence suggesting EBM has resulted in substantial population-level health gains. In 2020 more than 4 and ½ billion prescriptions will be filled in retail U.S. Pharmacies. This equates to over 13 prescriptions per year for every man, woman, and child in the United States (that's more than one per month). And for every person who doesn't use prescription drugs, someone is using 26 per year. It is no secret that, for the amount of money spend on healthcare in the US, the health of the average American ranks amongst the worst in industrialized countries.[72]

Allow me to digress a little more, as the issue of pharmaceuticals is central to the topic of EBM. Apart from the common side-effects of taking prescription drugs, the more pharmaceutical medicine a person uses, the greater the risk of ending up with a serious Adverse Drug Reaction (ADR). An ADR is an unwanted or harmful reaction or injury resulting from the administration of a single drug or combination of drugs under normal conditions of use.[73] The under-reporting of these ADR's are one of the medical industry's dirty little secrets... Another related to this, is that depressants, opioids and antidepressants are responsible for more overdose deaths (45%) than cocaine, heroin, methamphetamine and amphetamines (39%) combined.[74] Where do these statistics fit into the benefit vs risk ratio objective of EBM? An estimated 28.6 million Americans age 12 and older abuse prescription drugs (2016 National Study on Drug Use and Health). This is

more than the combined number who reported abusing cocaine, hallucinogens, inhalants and heroin.[75]

A publication in the February 1997 issue of the British Journal of Pharmacology, *Under-Reporting of Adverse Drug Reactions in General Practice*, reveals the magnitude of this scandalous phenomenon. After following over 80 GP's for only three days, the researchers found the average number of ADRs observed per day per GP to be 1.99. This indicates that, "as a whole, GPs might be expected to report only 1 out of every 24 ADR's to the pharmacovigilance centre. Under-reporting was lowest for serious and unlabelled effects and for drugs marketed recently". The study concluded that, "adverse effects due to drugs are part of GPs routine activities." It has become such a 'routine' activity that it is only reported around 4% of the time![76]

In 2015 the Canadian government came out with Canada's *Adverse Drug Reaction Reporting System: A Failing Grade*. Herein they concluded: "Less than 10% of ADR's and perhaps as few as 1-2%, are thought to be reported in SRS [the Canadian reporting system]. A review of 37 studies from 12 countries, including one from Canada, provided an estimated median rate of under-reporting of 94%." [77] Interestingly, a review of several studies demonstrates that most adverse drug reactions are reported by pharmacists and nurses, with physicians reporting the fewest.[78] Why is that? Do I smell the green eyed monster again?

In October 2014 the CMS (Centers for Medicare and Medicaid Services) made available a list of doctors and hospitals who were collecting money from the pharmaceutical and medical device industries, to enable civilians to assess whether the doctors and hospitals they visit may have motives other than patients' best interests. According to the database (which only included payments from a five-month period), half of all US physicians (546,000) and a large number of teaching hospitals (1,360) received 4.4 million payments, coming to nearly $3,500,000,000. Extrapolated, the figures imply that these industries are paying at least ***eight billion dollars*** a year to promote their products through physicians.[79,80]

Of course medical research is not immune to this. "Can we really believe that clinical researchers are more immune to self-interest than other people?", said Dr. Marcia Angell, past editor of The New England Journal of Medicine (from 2000's *Is Academic Medicine for Sale?*). Dr. Angell was fired from her position as editor-in-chief of the NEJM for an expose revealing that nearly 100% of medical research involved, "serious and often multiple financial conflicts of interest".[79] Several years after this she published a book in 2004, called *The Truth about Drug Companies: How They Deceive Us and What to Do About It*.

In the 1990's EBM could ward off the legion of pharmaceutical representatives because their promotional material was often devoid of evidence. Big Pharma then came to realise that EBM was actually an opportunity, and if they could buy the research, they would control the show. The increase of medical research funding by pharmaceutical companies from $1.5 billion in 1980, to $22 billion in 2001 (Warner & Roberts 2004), means they now control and fund most medical research.[80]

"EBM is now the problem, fuelling overdiagnosis and overtreatment…", writes Dr Des Spence in the January 2014 issue of the British Medical Journal (*Evidence Based Medicine is Broken*). In 2012 a billion prescriptions were written in England, which is a 66% increase in one decade. Dr

Spence says this is not a true reflection of an increased burden of illness nor an ageing population, “just polypharmacy supposedly based on evidence'. He goes on to say: “Corruption in clinical research is sponsored by billion dollar marketing razzmatazz and promotion passed off as postgraduate education. [...] How many people care that the research pond is polluted with fraud, sham diagnosis, short term data, poor regulation, surrogate ends, questionnaires that can’t be validated, and statistically significant but clinically irrelevant outcomes? Medical experts who should be providing oversight are on the take. The current incarnation of EBM is corrupted, let down by academics and regulators alike”.[81]

Between two-thirds and three-quarters of all randomized EBM trials have been funded by industry, although often these financial relationships are not disclosed.[82,83] There is strong evidence that industry-funded studies produce results that differ from independently funded studies. A research paper (*How evidence-based medicine is failing due to biased trials and selective publication*) by Susanna Every-Palmer and Jeremy Howick, published in the March 2014 edition of the Journal of Evaluation in Clinical Practice, found that compared with independent trials, industry-sponsored trials exaggerate treatment effects in favour of the products preferred by their sponsor. In fact, they reported on three systematic reviews which looked at all the studies ever published, and “found that overall industry-funded studies were two to four times more likely to report favourable results”.[84] The one who pays the piper calls the tune...

A 2018 study from the British Medical Journal, *Collaboration Between Academics and Industry in Clinical Trials: Cross Sectional Study of Publications and Survey of Lead Academic Authors*, looked at the most recent 200 phase III and IV trials published in the most respected medical journals (New England Journal of Medicine, Lancet, JAMA, BMJ, Annals of Internal Medicine, JAMA Internal Medicine, and PLoS Medicine). The researchers discovered that when it comes to “industry funded trials of vaccines, drugs, and devices”:

- Employees of industry funders co-authored 173 (87%) of the 200 publications;
- Involvement of funders in trial design was reported in 173 (87%) of the 200 studies;
- Data analysis involved the funder in 146 (73%) of the 200 trials;
- Trial reporting involved the funder in 173 (87%) trials;
- Contracted research organizations were involved in the reporting of 123 (62%) trials.[85]

Apart from the obvious conflict of interest issue in medical research, another big reason for the decline in credibility of 'evidence based medicine', is the practice of minimizing or simply not publishing trial results that are unfavourable to the funder's product, in order to gain FDA approval for a certain drug or therapy. The selective publication of positive results and non-publication of negative results is known as *publication bias*. The current best estimate is that half of all completed clinical trials have never been published in academic journals and some have never been registered.[86] This phenomenon has become so common in medical research that the reputed British Medical Journal (BMJ) published a paper in 2013 calling for these 'invisible and abandoned' trials as they refer to them, to be published. These trials which are purposefully abandoned due to their results not conforming to the goals of whoever was funding them, “have the potential to discredit earnest efforts towards evidence based decision making.” [87]

The heavy influence of drug companies and other industry funders with bigger wallets are not the only ones to blame for the loss of credibility in EBM. Medical journals have also succumbed to the commercial pressures of our time. Dr. Milton Packer, cardiologist and renowned medical blogger in his article titled *Medical Journals: A Sluggish Form of Twitter?*, links the reason why some of the best research are getting lost in the clutter of terrible research, to a man name Eugene Garfield.[88] Mr Garfield (now deceased) created the Institute for Scientific Information (ISI), a citation databases covering thousands of academic journals, which also included the SSCI and AHCI indexes. The database provides some measure of the academic impact of the papers indexed in it, in other words which articles have been cited most frequently. “Appearing in this database can double the number of citations received by a given paper.” [89]

According to Packer, Garfield’s chief contribution to the current system of academic medical science is that he invented the “impact factor.” “In the past, the dominant question [in editorial board meetings] was: Does the paper utilize valid methods to collect important original data that are interpreted in an unbiased way that makes a meaningful contribution to the field? Now the question is: Is the type, format, or topic of this paper conducive to it being repeatedly cited by other authors? Will it get attention?” The results is editors are welcoming low quality publications, often turning a blind eye to enormous faults, only because these papers have high 'impact value'. These are studies that receive much attention in the media, and has big promise titles for curing cancer or weight loss. On the other end, certain high quality papers are not welcome because they are rarely cited. “The end result: many journals have now become a form of Twitter. Their editors now focus on the number of “followers,” “retweets,” and “likes.” The only difference is: journals do not have a 240-character limit.”, says Dr. Packer.[88]

5. A Better Way Forward

According to Rebecca Smith-Bindman and colleagues, “The growth in advanced diagnostic imaging has almost certainly contributed to both improved patient care processes and outcomes, but there are remarkably few data to quantify the benefits of imaging. Given the high costs of imaging—estimated at $100 billion annually—and the potential risks of cancer and other harms, these benefits should be quantified and evidence-based guidelines for using imaging should be developed that very clearly balance benefits against financial costs and health risk.” [4] I would add to the above statement that without evidence based guideline for the use of diagnostic imaging, orthopaedic medicine will not grow in its functional knowledge and understanding of injury and chronic pain. Neither will it overcome the corruption and greed which is undermining the objectives of EBM.

I have demonstrated that the reductionist anatomical perspective on movement as is practised in orthopaedics, is hopelessly out of depth in dealing with the ever increasing musculoskeletal problems of our time. In the words of Thomas Myers, “Anatomy has been thoroughly explored in the previous 450 years. New discoveries and new therapeutic strategies will not come from finding new structures, but from looking at the known structures in new ways”.[55] Thanks to advances in functional science, we do not have to wait in desperation for better days of diagnosing to come, as they are already here.

Functional Movement Systems are one of the pioneers of a new perspective on movement, and their Selective Functional Movement Assessment (SFMA) is causing a huge paradigm shift in rehabilitation the world over.[90] The SFMA is a thoroughly researched total body movement diagnostic system for systematically finding the cause of pain. It consist of 7 top tier full body movement patterns, each of which that presents with dysfunction or pain, is broken out further with a hierarchy of specific tests for that pattern. Each of these pathways offer the clinician an opportunity to differentiate between mobility or stability (motor control) dysfunctions, in order to provide the most appropriate intervention for the problem at hand. By building an intervention plan based on the patient's movement dysfunctions or limitations (overall movement integrity), rather than medical diagnosis, the clinician is equipped to not only deal with the patient’s symptoms, but also to have long lasting positive outcomes for the patient's level of function.

Integral to this new perspective is the concept of regional interdependence, which reminds us to not become myopic about the source of pain, as the cause thereof may lie elsewhere. One of my favourite quotes in relation to this phenomenon comes from the well known physiotherapist Diane Lee: “It is the victims who cry out, not the criminals” (Myers, 2014:22).[55] As the study of Janda emphasized, when seeking to treat causes, it inessential to extend assessments beyond the site and side of injury. There must be a global view of the entire kinetic chain (as exemplified by the Mobility-Stability Model) in order to understand and address the causes of injury or chronic pain, as well as ensure improvements in movement pattern quality, and a lowered risk of future injury. The new model makes use of an objective movement screen (FMS) or assessment (SFMA), and chooses corrective exercise based on movement pattern dysfunction, not pain or medical diagnosis. With this approach, two patients with low back pain may receive similar symptomatic treatment, but could require completely different corrective exercise programs, based on their specific movement dysfunctions.[54]

In regards to restoring EBM, Dr Des Spence offers the following advice in closure to his article published in the BMJ: “We must first recognise that we have a problem. Research should focus on what we don’t know. We should study the natural history of disease, research non-drug based interventions, question diagnostic criteria, tighten the definition of competing interests, and research the actual long term benefits of drugs while promoting intellectual scepticism.” [81]

More investment in independent research is urgently required, which will allow for more trials of non-surgical treatment of orthopaedic conditions. Furthermore, evidence rating schemes should be formally modified so that research with conflict of interest bias is explicitly downgraded in value.[84] If not, we will most certainly get more of what we've got: Thousands of people going under the knife daily, for procedures that are not addressing the causes of their pain or disorder, based on diagnosis which are not backed by best evidence. These individuals often go from surgery to surgery, every time more burdened by the trauma and scar tissue of being cut open, and becoming more dependant on the symptomatic remedies for their continued discomfort provided by the same system...

As hinted to by Dr Spence, the first step to change and improvement is to “recognise that we have a problem”. This however, requires humility. A big ask of a medical system which has been enthroned as the only system of healing based on 'scientific proof'. Contemporary medicine, like all other systems of healing (Ayurveda, Tradional Chinese Medicine, Osteopathy, Naturopathy, ext.), is based on particular foundational beliefs. What makes it more dangerous than any other system of healing though, is the ignorance amongst consumers and practitioners alike about it being *a belief system*... Due to group think, vested financial interests and greed affecting medical research, as clearly demonstrated in this paper, EBM is nothing more than a marketing slogan.

In order to develop true evidence-based-medicine, contemporary medicine will have to come off its inflated sense of superiority, and acknowledge that it has much to learn about holistic health and healing.

“The greatest obstacle to discovery is not ignorance – it is the illusion of knowledge.”
Daniel Boorstin

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