

Factors Affecting Healing, Recovery and Outcome after Injury

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Abstract

Following injury, any casualty will attempt to restore the state, which they were in prior to the incident. This period varies greatly in time and is supplemented by interventions during this time, such as resuscitation and surgical intervention. By physiologically and anatomically stabilizing a patient, they are simply 'pointed' in the correct direction. What follows is a period of resolution, which gives rise to an outcome based upon the nature of the injury, the adequacy of intervention, and the efficiency of healing/recovery.

Healing

Healing ('*hælan*' of Germanic origin meaning 'to make whole') can be defined as 'the restoration of health to a diseased or damaged organism' [1]. It has physical and psychological aspects, both of which compliment each other's healing process.

Physical healing

During injury, the casualty will sustain a physical trauma, which will alter their anatomical environment and stimulate a physiological response. This physiological response is the body's innate response to save life, limb and function.

On a microscopic scale tissues will heal by regeneration, repair or a combination of both, via inflammation pathways. This will depend on the type of tissue that is injured, but also on the environment in which it heals. This environment can diminish healing efficiency, for example age, vascularity, presence of diabetes [2], infection [3] and malnutrition [4], alongside well. There are also 'unnatural' factors, which promote wound healing, such negative pressure therapy [5] and hyperbaric oxygen [6] and pharmacological environment.

On a macroscopic scale it is very hard to define 'fully' healed. This could be described as a return to normal physiology, through a process of inflammation, proliferation, maturation and remodeling. However unless pure regeneration has occurred, there is likely to be some permanent change in the physical makeup, for example scarring of the skin, or fibrosis of the liver.

Psychological healing

This is very difficult to define, however Gordon describes the psychological component of healing as "a process in the service of the evolution of the whole personality towards ever greater and more complex wholeness" [7]. This component of healing is complex and multifactorial, including patient's coping mechanisms [8], support structure and the nature psychological stress evoked by the injury [9].

The physical and psychological facets of healing interact, for example, psychological stress slowing wound healing [10]. However, these are not necessarily mutually dependent. A relatively recent qualitative study found the wholeness of healing was not considered dependent on physical cure [11].

Recovery

Recovery is defined in the Oxford Dictionary of English as 'a return to a normal state of health, mind or strength' [1].

One of the key points from this definition is the use of the word 'return'. I will discuss how recovery following injury depends on many

factors; however the largest limiting factor is pre-injury function. This definition also correctly identifies that recovery is more than just a physical process, but involves a return to psychological functioning.

Physical recovery

Physical recovery is well described by the Chartered Society of Physiotherapists as being to 'restore movement and function when someone is affected by injury' [12].

With regards to recovery involving health, this can be as acute as recovery of vital observations, for example recovering a blood pressure following hypovolaemic cardiac arrest. It also can be focused on a long-term goal, such as recovering from agoraphobia following a blast injury, or indeed anywhere between.

Physical recovery begins with, or shortly following healing and as a process it aims to minimize disability by restoring function. Much of this is natural, and with time of healing recovery of function will occur. For example, healing of fractures causes boney stability, and patients will naturally begin moving again. However, recovery often extends beyond the healing phase, such as building up strength in accessory muscles, or using neuronal remodeling to 're-learn' limb function.

There is a doctrine of priorities in trauma which states, 'life before limb, before function, before aesthetics'. Following salvage of life and limb, the next priority is to recover function.

Functional recovery is limited by a variety of factors. General factors include the motivation of the individual and the services available to them. For example a young motivated individual, with limitless physiotherapy will likely recovery more effectively from the same injury, than an elderly, demented, non-compliant patient who has no access to physical assistance [13-15].

The role of the physiotherapist, particularly following limb trauma is crucial; 'Physiotherapists help people affected by injury, illness or disability through movement and exercise, manual therapy,

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education and advice' [11]. They not only educate and build confidence, but facilitate early active mobilisation of joints which change the way injuries heal by minimising scar tissue and adhesions [16].

Beyond the above general factors of the environment in which the patient recovers as the nature, severity and extent of the injury plays a large part in the degree of recovery a patient will gain. For example, a simple injury such as a fifth metatarsal tubercle fracture frequently heals rapidly with complete recovery. However an ulnar collateral ligament injury of the thumb often results in a non-uniting 'Stener' lesion [17] and has significant functional deficit. There are also high-energy injuries that following healing have good functional outcome, for example femoral fractures in isolation. In contrast, there are those which consistently do poorly, for example open calcaneal fracture [18].

Psychological recovery

The psychological impact of injury is a spectrum from no psychological impact, e.g. in a demented patient with no recollection of events, to severe implications, such as social withdrawal and post-traumatic stress disorder (PTSD) [19].

Where present, milder forms of psychological impact of injury include fear of reinjury, for example demonstration of a patellar apprehension test following traumatic dislocation. Other factors, such as confidence in beginning to weight bear on a recovering limb, or dealing with the impact on lifestyle following disfiguring injury, are examples of the psychological strain induced by injury, which require recovery and adaptation.

Although frequently under recognized, the life time risk of developing PTSD in an epidemiological study from the USA, was found to be 7.8% [20]. It is diagnosed using the 'Diagnostic and Statistical Manual of Mental Disorders IV' [21], and has six criteria; exposure to traumatic event, persistent re-experiencing, persistent avoidance, persistent arousal, duration for more than one month and finally significant impairment. A recent meta-analysis investigating the predictors of PTSD, found that social support, peri-traumatic emotion/dissociation and history of prior trauma/psychological problems, were all predictors of developing PTSD [22]. The paper however, did not analyze the independent impact of these factors on recovery following trauma, unlike a much smaller study, which found psychosocial morbidity was a poor indicator for return to work at 5 months, independent of pre-injury psychology, injury severity and ambulatory status [23].

Although many patients sustaining injury will undergo a degree of psychological trauma, it is difficult to draw a boundary between psychological healing and recovery. Nevertheless, the ultimate goal of psychological recovery is to return to pre-morbid state of mind, including reintegration into society. Another key goal of psychological recovery is to minimize the impact of poor co-operation, on physical recovery.

Difference Between Healing and Recovery

The relationship between healing and recovery was addressed in my clinical practice this week. Regarding a poor reduction of an intra-articular distal humeral fracture; "well, that simply won't heal" - Surgeon X. This statement was pointed out to be somewhat inaccurate, as in truth the injury will heal very well, however the recovery of function would be poor.

Outcome

Outcome can be defined as 'the condition of a patient at the end of

therapy or a disease process' [24]. In practical terms, outcome following injury is a comparison of the patients residual disability compared to their pre-injury state. This is in contrast to outcome following elective surgery, where the outcome is to measure improvement from a disabled state.

The condition of the patient encompasses a wide variety of biological, psychological and social factors. As clinicians, we frequently attempt to measure outcome to evaluate our interventions, both scientifically and anecdotally.

As the overall outcome is dependent on a large number of variables, we tend to subdivide patients' conditions into different subjects. A good description of the core subjects is described by the International Classification of Disabilities Function and Health (ICF) [25]. Although it describes the following domains with reference to disability, as stated above, this is relevant to outcome in trauma.

These four domains are:

1. Body structures (anatomical makeup)
2. Body functions (physical, mental, sensory)
3. Activities (such as activities of daily living, recreation)
4. Participation (social interaction and participation in the community)

What subject should be measured as an outcome?

Following injury, we use a variety of outcome measurements, for a number of reasons. As injury is primarily a disturbance to the anatomical and physiological state, many outcome measures aim to measure the return to these pre-morbid parameters. As thus we frequently measure anatomical variables, such as range of movement or boney alignment, as an indicator of a successful operation.

Similarly, measurements of healing, such as time to union and surgical site infections are commonly quoted in papers deliberating mode of fixation. These are seen as high priority, particularly in orthopaedics, when two surgical techniques have similar abilities to re-establish anatomical environment.

Recovery is very hard to calculate, and is often measured by functional scores, such as the Oxford Knee Score [26] or Harris Hip Score [27]. These are tools developed to measure improvement following arthroplasty for knee or hip arthritis, and are not validated in trauma, however have made their way into the literature [28,29]. Other surrogate measurements of recovery include pain scores, grip strength or return to residence (often seen in patients with fractured neck of femur). The lack of specific outcome score available for recovery, indicates the wide variety of physical and psychological factors which effect a 'complete' recovery.

Even more general outcome measures have been developed, indicating to which degree a casualty has returned to a normal lifestyle or integrated to society. These scoring systems, such as EuroQol (EQ-5D) [30] or Short Form-36 (SF-36) [31], require the patient to answer various questions to ascertain which aspects of their life have been affected by their condition. They are not specific to trauma and are used in a wide variety of disease processes.

From a service provision and quality improvement perspective, we have outcome measures, which calculate a value of a service we provide. This is particularly prevalent in the National Health Service, and the National Institute for Clinical Excellence (NICE) takes this

into consideration when they develop guidelines. Calculations such as length of hospital stay, readmission rates, quality assured life years (QALYs) and costing of implants are frequently deliberated.

Can we rely on the outcomes, which we measure?

Information collected in the above subjects are objective markers using the patient as a subject and we measure the variables which we think important.

We then use these measurements, to consider whether the outcome was considered good or poor.

However, it is becoming increasingly appreciated, that the role of patient perspective should be the priority. By using qualitative research, we study the perceptions and priorities of the patient, with the overall aim to develop management strategies, which make the patients' desired outcomes of highest priority. One recent systematic review, describes a 2 fold increase in published qualitative research since the turn of the century [32]. For example, if a patient sustains a closed tibial fracture, and their worst fear is the development of knee pain: The insertion of a tibial nail with perfect reduction and rapid union is not a success if the patient develops anterior knee pain. In contrast, if a patient sustains an open tibial fracture, and their worst fear is amputation: Even if they undergo a lengthy recovery complicated by infection, delayed union and traumatic arthritis, if the limb is salvaged, then the procedure should be considered a success (even though these complications would traditionally be considered poor outcomes).

The examples could be expanded to encompass a variety of patient concerns, such as aesthetic outcome, gait abnormalities, return to work/hobbies, and social integration (fear of crossing the road again). Again, these fall into the four domains discussed in the ICF.

One recent qualitative paper questioned 9 patients who had undergone a variety of open tibial fractures [33]. The recurring themes included pain and mobility (both of which have objective measuring tools), but also fear, sleep and appearance, which are much more difficult to measure. Perhaps, the reason why we, as clinicians, measure quantitative outcomes is because they are more readily collected, comparable and repeatable. Although adopting a quantitative approach is not necessarily patient centered, it is interesting that in this paper, several of the respondents considered themselves 'recovered' when the surgeon told them they were.

What effects outcome?

Outcome is affected by a variety of factors, which can be due to the above domains; structure, function, activity and participation. It is the healing and recovery process in these domains which influence the overall outcome. However, the way in which we measure the improvement in these areas also has an effect.

When considering the outcome in each area, it is important to remember that they are not independent of one another. A poor outcome in return to function may not necessarily be attributable to a physiological weakness, it may be a structural abnormality (e.g. heterotrophic bone formation) or participation issues (anxiety, agoraphobia).

Structural and functional outcomes are areas which weas surgeons are most familiar with. Delays in healing attributable to instability, infection and malnutrition are all common aetiologies [34].

Activity and participation outcomes are a much broader subject matter, and although depend on good structural and functional

recovery, have a multitude of biopsychosocial factors [35]. As discussed above, the outcome is also influenced by the nature of the injury and the support framework (both psychological and social) in which they have prior to injury, and ones which we can augment following injury.

Conclusion

Healing is a process in which is the body's natural response to injury repairs or replaces tissue with the aim of restoration of body (and mind) to a pre-injury state.

Recovery is the term, which describes the ability of the patients to regain function, and is dependent on pre-injury function and the healing process.

Outcome is a measurement of the success of healing and recovery. The relevance of the outcome depends largely on which factors measured, and ideally should be based on patients' priorities.

A wise surgeon once said, "Life is movement, movement is life"- Maurice Müller. This highlights the high priority we should place on gaining a good functional outcome following injury. As trauma surgeons, in order to gain the most successful outcome, we must tailor our intervention to patients' requirements, then optimize the anatomical environment, allowing healing to occur and to enhance recovery.

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