Expedited ‘Diffusion of Innovation’: A reflection on the Ponseti Method in the current era of medicine

Asitha Jayawardena

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Basic physical fitness has been a prerequisite for survival since the early evolution of man. Despite technological and societal advances that currently allow humans to succeed without basic physical function\(^1\), those who are not able to function at levels similar to the rest of society are labeled ‘disabled.’ Developed countries such as the United States attempt to accommodate for disability.\(^2\) We have laws that ensure the construction of handicap-accessible buildings, motorized wheelchairs that enhance mobility, and other accommodations that allow the physically disabled to function more normally within our society.\(^2\)

Unfortunately, the same cannot always be said about the developing world.\(^2\) These regions of the globe often rely more heavily on physical labor to make a living. Therefore, the physically disabled are unable to contribute to society as they might have if they lived in a resource-rich county. In fact, many of the physically disabled are relegated to a life as ‘beggars.’\(^3\)

Advances in medicine in the past few hundred years have been profound. The disease burden has been shifted from infectious disease to chronic disease – a trend so successful that we have eradicated diseases such as smallpox completely.\(^4,5\) Other examples of our success include the near eradication of polio; a disease that previously left affected survivors in a state of profound physical disability.\(^6\) However, our battle against physical disability is not over. In fact, the most common
congenital musculoskeletal disorder that leads to disability worldwide is a condition that is found most often in the developing world.\textsuperscript{7,8}

That disorder is called tilas equinovarus, but is more commonly referred to as clubfoot.\textsuperscript{8} At least some aspect of the disease transmission is hereditary, although the exact pathogenesis remains unknown.\textsuperscript{10} The disorder is found in 1-8/1000 newborns\textsuperscript{9} and is characterized by an inward and downward positioning of the foot that makes it impossible to walk with a physiologic gait when it is left untreated.\textsuperscript{10,11} Untreated clubfoot is not only very painful, but often results in social neglect and life as a beggar.\textsuperscript{11,13} Some cultures even believe that clubfoot is a curse from the Gods and choose to pursue witchdoctor/voodoo medicine versus typical Western healing.\textsuperscript{12,13}

\textit{History of Clubfoot Treatment:}

Historical documentation of clubfoot occurred as early as 1000 B.C. where the deformity was first depicted in ancient Egyptian tomb paintings.\textsuperscript{14} In fact, posthumous radiographic evidence suggests that the famous Egyptian pharaoh Tutankhamen and several members of his family were burdened with untreated clubfoot.\textsuperscript{15} Later documentation of clubfoot occurs in 400 B.C. when the father of Western medicine himself, Hippocrates, describes clubfoot and clubfoot treatment.\textsuperscript{14,16,17,18} Hippocrates, whose writings and thoughts on the field of medicine have withstood the test of time, is not commonly known for his writings on clubfoot.\textsuperscript{18} Hippocrates, however, describes various important principles in the management of clubfoot that 2400 years later remain important aspects of the current treatment
Hippocrates emphasized that early treatment was paramount to success. He also suggested serial manipulations using bandages that result in overcorrection, followed by bracing was a preferred treatment. Unfortunately, the treatment Hippocrates documented was soon disregarded by his predecessors.

Various alternate treatments emerged throughout the Middle Ages. The details of treatment of clubfoot in the middle ages are not currently understood. However, it has been documented that barber-surgeons, charlatans, and bonesetters were the professions responsible for clubfoot treatment.

In 1658, the famous Spanish surgeon Arcaeus documented treatment that included stretching and the use of two mechanical devices to maintain correction. In the 1700s, a similar stretching technique was documented. In 1803, the Italian anatomist Scarpa documented a technique including forceful manipulation and the use of a complicated device as treatment for clubfoot. Dr. Timothy Sheldrake, a British physician, documented the use of bandages similar to those used by Hippocrates in his treatment of clubfoot in 1806.

In 1823, the French surgeon Delpech recorded the first subcutaneous tenotomy of the Achilles tendon, albeit to unfortunately poor results. However, the German surgeon Louis Stromeyer continued to practice the subcutaneous tenotomy in 1831 and eventually taught the practice to a young British surgeon W. J. Little, who perfected the technique to much success. The method arrived in the US in 1834 and 1835 due to the work of Drs. Rogers and Dixon. In 1838, one of the most celebrated orthopaedists in Europe, Dr. M. Jules Guerin first demonstrated the use of plaster of paris in the treatment of clubfoot. In the 1860s, advanced
surgical techniques allowed for the use of complex surgeries to attempt to correct the anatomical deformities associated with clubfoot. In 1939, John Hopkins surgeon Dr. Joseph Kite published his non-surgical method to treat clubfoot. His method soon became the standard of care within the orthopaedic community.

However, as it is understood today, the principles of Kite’s method were not sound, leading to alterations in its practice and surgical additions resulting in most cases being treated by extensive surgery. Clubfoot centers around the world began publishing and presenting on alterations to the surgical technique to achieve ‘better’ results. Unique surgical procedures for clubfoot were published by a number of different physicians including: Dr. Dilwyn Evans, Dr. Vincent Turco, Dr. Leonard Goldner, Dr. Douglas McKay, Dr. George Simons, Dr. George Lloyd-Roberts, Dr. Anthony Catterall, Dr. G Imhauser, Dr. Henri Bensahel, Dr. Sherman Coleman, Dr. Alain Dimeglio, Dr. John Roberts, Dr. Arthur Steindler and Dr. Norris Carroll. The novelty of surgery and the tendency of orthopaedic surgeons to favor surgery allowed surgical treatment of clubfoot to be the preferred method of treatment until the past 15 years. However, in parallel to the surge in publications about surgical treatments in clubfoot, Dr. Ignacio Ponseti at the University of Iowa was perfecting a non-surgical method of his own.

Dr. Ponseti began work on what would soon become the Ponseti method in the 1940s after Dr. Arthur Steindler of the University of Iowa asked Dr. Ponseti to review the technique Steindler had created. Dr. Ponseti concluded the technique was unsatisfactory and left children with stiff ankles and a compromised gait. Ponseti understood what others had failed to understand – that ‘calcaneal internal
rotation (adduction) and plantar flexion are the key deformity.’  

He developed a specific non-surgical manipulation technique that required up to 5 weeks in plaster of paris casts followed by the use of a foot-abduction brace during the child’s sleep for 4 years. The 5-6 casts are a progressive treatment that corrects all deformities of clubfoot simultaneously. The foot abduction brace is an essential component for preventing painful and debilitating clubfoot relapse. To complete the correction, a percutaneous tenotomy is performed to lengthen the Achilles tendon. This procedure can be completed in an outpatient setting with local anesthesia.

Despite publishing his specific method of serial casting and percutaneous tenotomy to treat clubfoot in the 1960s, Dr. Ponseti’s method did not gain popularity amongst the orthopaedic community until recently. However, despite its late dissemination, today the Ponseti method is considered the standard of care for clubfoot treatment throughout the world. Studies have shown the method to be over 95% effective when administered correctly. The low cost, highly efficient Ponseti method is especially important in developing countries, where the majority of clubfoot occurs, because of their lack of capital to pursue highly complex surgical treatments.

*Diffusion of Innovation:*
Everett Rogers first described the 'Diffusion of Innovation' theory in 1962. Rogers was a rural sociologist at Iowa State University who grew up on his father’s rural farm. He developed the 'Diffusion of Innovation' theory after watching his father fail to adopt the best-practice farming techniques of his time. His model outlines the adoption of any innovation until it is accepted as commonplace amongst a society.

Initially, only the innovator uses an innovation. The innovation is eventually spread to early adopters, who are characterized by their willingness to try new things. This group makes up 13.5% of society. Next, the early majority will accept the innovation. The early majority represents 34% of society and adopts the innovation only after having observed others’ success. The late majority tends to be more conservative in their approach and adopts only after observing the early majorities continued success. They make up 34% of society. Finally, the laggards are those who refuse to adopt until they have no other option. This often occurs when the previous product (i.e. VCRs) is no longer being sold because the industry standard has shifted (i.e. DVD/Blu-ray). Laggards represent 16% of society.

Rogers suggests that various factors influence an innovation’s diffusion throughout these groups. The factors, which describe the innovation, include: relative advantage, compatibility, complexity, trialability, and observability. An individual carefully weighs these factors when deciding to utilize a particular innovation. Other factors that influence an innovation’s diffusion include the social context of the innovation and the communication channels used for dissemination.
The Clinical context of Diffusion theory:

The decision-making process an individual undergoes when accepting an innovation in a clinical setting is described by RW Sanson-Fisher. First, knowledge must be attained by researchers regarding the clinical change. In the context of the Ponseti method, this was initially completed by Dr. Ignacio Ponseti and his colleagues at the University of Iowa. The individual physician then must be persuaded by the advantages of the innovation over their current practice. The clinician then independently engages in activities that help them choose to reject or accept the new practice. These activities may include attending conferences, conversing with ‘expert’ colleagues in the field, and reading medical journals. The innovation must then be incorporated into the daily activities of the physician. Once this innovation is incorporated, the clinician then seeks reinforcement from their peers and results justifying their acceptance of the innovation.

The hierarchal nature of the field of medicine may hinder effective diffusion. Despite being a field of constant innovation, the tendencies of our mentors are inevitably passed on to our students. Despite an effective trend towards enhancing evidence-based medicine, a gap exists between evidence-based practice and current care. This gap has previously been characterized as the Knowledge Gap.

Relative Advantage:

Innovation in the field of medicine is passed through rigorous scrutiny regarding its relative advantage over previous techniques. Easy-to-access online medical databases with up-to-date medical literature such as Pubmed,
Uptodate.com, and others allow physicians to access recent evidence-based medicine techniques.\textsuperscript{26,27} Strict peer-reviewed publication guidelines establish a necessary statistically significant difference to be demonstrated in treatment results.

Exactly 244 studies populate a Pubmed search for ‘Ponseti method.’\textsuperscript{26} Most all of these studies agree that the Ponseti method is the gold standard treatment for clubfoot, with an over 95\% treatment success.\textsuperscript{9} The previous surgical treatment for clubfoot has been documented with over a 50\% relapse rate. The relative advantage of the Ponseti method is made remarkably clear in the field of medicine by access to peer-reviewed journal articles.

Physicians, however, might be hindered in their perspective of the innovation if they observe physicians claiming to be practicing the true Ponseti method, but are practicing a method with inadequate technique. Observing the limited success of these substandard manipulations might negatively influence one’s perception on the Ponseti method.

\textit{Compatibility:}

The Ponseti method, especially when first proposed, provided a clear contrast to the previous treatment standard of surgery. Surgery has been especially popular with orthopaedic surgeons, the specialist of choice for clubfoot patients, for multiple reasons.\textsuperscript{16} Surgeons, who have spent decades training about the art and complexity of surgery, exhibit a certain bias towards surgical methods of treatment versus non-surgical methods. Additionally, surgeons are trained in a culture that
favors short immediate fixes. The Ponseti method is a patient method that requires at least 5-7 weeks of casting and up to 4-5 years in a foot abduction brace.

Most groundbreaking innovations in the current era of medicine involve technological advances such as nuclear imaging, use of stem cells, etc. The Ponseti method of a simple casting and bracing technique was not compatible with the medical innovation orthopaedic surgeons have grown accustomed to. In fact, the Ponseti method may remind surgeons of the very first treatments of clubfoot described by Hippocrates himself over 2400 years ago. The ‘compatibility’ of non-surgical treatment in the circles of orthopaedic surgeons may play a role in hindering clubfoot’s dissemination throughout the orthopaedic social sphere.

Complexity:

Although the Ponseti method is a complex maneuver that requires experienced hands to achieve the most successful manipulation, it is not a technique that many in the orthopaedic world would consider remarkably difficult. In fact, many have described the method as one that non-orthopaedic specialists can perform. This flexibility in administration makes the method especially useful in the developing world. However, the perceived simplicity of the method might hinder surgical perceptions on effectiveness.

Trialability:

Another remarkable feature in the Ponseti Method’s diffusion is its trialability. Practitioners can learn the basic method themselves in a weekend long workshop administered by the Ponseti International Association from the University of Iowa. Additionally, the method is one that can be taught from
practitioner to practitioner. The ease of use when it comes to trying the method is favorable to its dissemination.

Observability:

Clubfoot and the Ponseti method are assisted in their diffusion by some remarkably observable results. Clubfoot is an easily distinguishable deformity that is characterized by a midfoot cavus, forefoot adductus, hindfoot varus, and hindfoot equinus. The widespread extent of clubfoot throughout the world as well as its characteristic appearance have led to many different names for the deformity within each culture. Parents and physicians can easily observe the characteristic clubfoot deformity return to a physiologically normal looking foot within weeks. The easily observable correction with each applied cast helps practitioners observe the utility of the method.

Communication Channels:

In addition to characterizing the factors of an innovation, one must also understand the communication channels in which the innovation is presented. In fact, communication channels are one of the most important elements in an innovation’s dissemination speed. Communication channels can include both micro-level communication and macro-level communication. Micro-level communication includes face-to-face interactions between like-minded people. Macro-level communication includes mass media campaigns including television, radio, and billboards.
Medically, innovations are often initially published in medical journals.\textsuperscript{24} The higher rank and viewership of the medical journal results in expedited diffusion. Additionally, face-to-face communication occurs at medical conferences.\textsuperscript{16,24} Specialty-specific medical conferences offer physicians to not only speak with the innovator themselves, but also with their medical peers who are similarly weighing whether or not to utilize a particular innovation within their own practice.\textsuperscript{24}

The Ponseti method underwent a unique dissemination within the field of medicine. Despite documenting his success in the medical literature the method was not widely disseminated until an additional communication channel was introduced. In the 1990’s, the use of the Internet amongst parents of children with clubfoot jumpstarted the demand for the Ponseti Method at the University of Iowa.\textsuperscript{21} Five large support groups with a total of 30000 messages were the primary communication channel for parents wishing to share either their treatment success with the method or their frustration with surgical treatment.\textsuperscript{21} After the University of Iowa Hospitals and Clinics posted a virtual hospital webpage on the Internet about their Ponseti care, they received a drastic increase in patients from previous years.\textsuperscript{21} Morcuende, Egbert, and Ponseti reported 790,084 hits to the virtual hospital web pages.\textsuperscript{21} The University received requests for information from all 50 states and 72 different countries.\textsuperscript{21} The Internet and clubfoot support groups were a major communication channel to spread the Ponseti method amongst physicians. Physicians were soon introduced to a new communication channel – parents requesting information about the Ponseti method.\textsuperscript{21} After this surge of popularity in
the 1990s, Dr. Ponseti and the University of Iowa began educating physicians who wished to become familiar with the Ponseti method.

*Strategic Implementation of Diffusion Theory Eradicate Neglected Clubfoot:*

Traditionally, physician education on the Ponseti method has been administered through weekend long hands-on workshops in which Ponseti experts travel to areas of the world bereft in Ponseti care and teach local practitioners how to utilize the method. While this method was initially successful, careful analysis of Everett Rogers’ Diffusion of Innovation Theory suggests an alternate education method.

Rogers describes heterophily and homophily as important aspects in communication channels when it comes to dissemination. Heterophily is described by Rogers as, ‘the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like.’ Homophiles are very effective communicators because of their similarities in behavior, attitude, and knowledge. However, complete homophily is detrimental to initiating change because the two participants are so alike, no information can be exchanged. Unfortunately, the previous method to spread the Ponseti method resulted in heterophiles, the opposite of homophiles, spreading information about the innovation. The differences in language, interests, healthcare systems, socioeconomic status, etc. resulted in inadequate diffusion. The ideal situation would be two near-complete homophiles, alike in every way except for knowledge of the innovation, to interact in order to spread the method.
The new strategy in the diffusion of the Ponseti method utilizes this theory-based concept. The Ponseti International Association with support from a Ronald McDonald House grant and funds raised by the American Medical Student Association Iowa chapter are utilizing a ‘fellowship’ system that brings individual physicians from areas of the world in Ponseti need to the University of Iowa to master the Ponseti method from the Department of Orthopaedics, Dr. Ponseti’s former department. These physicians will then return to their country as homophiles, however, with a thorough knowledge of how to both use the Ponseti method as well as teach it to their peers.

To best enhance diffusion, Rogers suggests targeting ‘change agents.’ Change agents, or opinion leaders, are very influential (positive and negative) in the diffusion of an innovation. Change agents are typically more innovative, charismatic, have many social contacts, have a high socioeconomic status, and have much social experience and exposure. By targeting these change agents as fellowship participants, we can use our knowledge of Rogers’ Diffusion of Innovation Theory to expedite the spread of Dr. Ponseti’s best-practice method to treat clubfoot.

The fellowship model may be the most cost-effective way to ensure physician understanding of the Ponseti method throughout the world. Worldwide physician education on the Ponseti method is certainly the best way to eradicate neglected clubfoot and the resulting physical disability. Strategic implementation of the ‘Diffusion of Innovation theory’ will be instrumental in achieving this goal.
References:


