Stem Cell Reports
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How to Peddle Hope: An Analysis of YouTube Patient Testimonials of Unproven Stem Cell Treatments

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https://doi.org/10.1016/j.stemcr.2019.05.009

Providers capitalize on patient testimonials to market unproven stem cell treatments (SCTs). We evaluated 159 YouTube videos and found patients discussed health improvements (91.2%), praised providers (53.5%), and recommended SCTs (28.9%). In over a third of the videos, providers posed questions to patients, thereby directing narratives and making them a powerful marketing tool.

INTRODUCTION

Unproven stem cell treatments (SCTs) are marketed globally to consumers via the internet and have resulted in physical, financial, and emotional injuries to patients (Bauer et al., 2018). Clinics are found all over the world, including those in highly regulated countries such as the US, Australia, Japan, and the UK (Berger et al., 2016). Providers often use misleading claims, hard sell promotional techniques, and base efficacy claims on patient testimonials.

Knowing the marketing practices of providers is key to understanding their business models and developing strategies to counter misinformation. Interventions that improve health literacy, patient-physician communication, and counseling might be more suitable countermeasures because the effectiveness of strategies to regulate the industry or discipline bad actors remains questionable (Knoepfler, 2018a; Shapiro et al., 2019). The media has been utilized by providers who appear with experts or celebrities, thereby adding credibility to their practice (Knoepfler, 2018b). Perhaps the most potent marketing tool is the use of testimonials where patients share their medical struggle and therapeutic journey. Patient narratives are powerful messages because other patients can relate to the story and sympathize with the storyteller (Hinyard and Kreuter, 2007). People find that "a person like you" is one of the most credible sources of information (Edelman, 2018), and narratives have been shown to increase belief and message uptake more than statistical information (Greene and Brinn, 2003).

Patient testimonials of unproven SCTs are found on clinic websites, blogs, social media sites, and are uploaded onto YouTube. Video testimonials may be particularly persuasive. Not only are they able to communicate messages to individuals with varied health literacy levels, but internet users have been shown to identify more strongly, and rate products more favorably, with audio/video testimonials as opposed to text or picture-based testimonials (Appiah, 2006). With over 1 billion users, YouTube has greater reach than any television network and presents a formidable platform to market unproven SCTs.

To date, no study has examined patient testimonials and provider infomercials of unproven SCTs on YouTube. In this study, we examined the content of 159 YouTube videos of patient testimonials and provider infomercials for unproven SCTs addressing five major diseases and injuries, including amyotrophic lateral sclerosis (ALS), cerebral palsy (CP), multiple sclerosis (MS), Parkinson disease (PD), and spinal cord injury (SCI).

Patient Testimonials of SCTs on YouTube

We identified 159 videos (7 ALS, 39 CP, 37 MS, 37 PD, and 39 SCI) totaling 563,842 views (ranging from 29 to 93,156 views) with an average of 3,546 views/video. Videos ranged from 32 s to 26:56 min. A total of 101,295 subscribers (ranging from 1 to 2,047 subscribers) were found in 157 videos. The three most highly viewed YouTube videos published by the International Society for Stem Cell Research (averaging 1,030 views/video) were viewed less than the average among those in our dataset although some SCT videos had views comparable with those published by the California Institute of Regenerative Medicine (averaging 16,792 views/video).

Video were published from 2007 to 2014, with 53.3% (N = 80) published in 2013–2014 (Supplemental Information). One study limitation is that our YouTube searches based on relevance resulted in capturing older videos. But among the 159 videos in

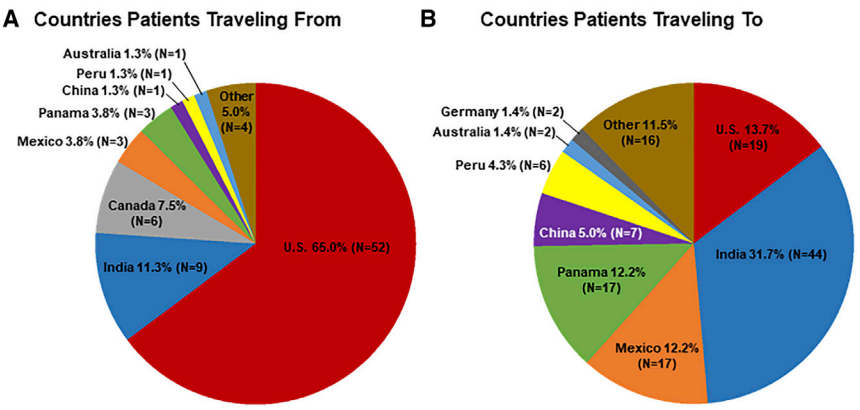

Figure 1. Countries Mentioned by Patients
(A) Countries patients travelling from.
(B) Countries patients travelling to.

our dataset, only 9 links were inactive in December 2018, indicating that most remain active. Other than 3 videos where the patient was the publisher, 98.7% (N = 156) of videos were published by clinics providing unproven SCTs. Seven clinics published 6 or more videos, constituting 78.8% (N = 123) of videos in our dataset.

Patient testimonials, where the patient or another person shares the patient's narrative, constituted 92.5% (N = 147) of videos. A few videos included a combination of a patient testimonial with an advertisement. Twelve videos were an infomercial published by a SCT provider containing no patient testimonials (see Supplemental Information). Patients were visually present in 98.6% of testimonials, in some cases via photos. In 73.5% (N = 108) of videos, the patient was an adult. In 26.5% (N = 39) of videos, the patient was a child. Children as patients were seen in all but one CP video. Additional people including parents, partners, friends, and other family were found in 47.6% of videos.

While SCT providers published most of the videos, the providers themselves appeared in 53.1% of videos. In 44.9% of videos, providers asked specific questions to patients. Provider-prompted questions were heard verbally (34.0%), either with/without their presence in the video, or seen as video subtitles (12.9%). Examples of provider prompts included questions about the patient's health issues, why they chose to undertake a SCT, cleanliness of the facilities, or health benefits post treatment among others.

Of the 80 videos where patients mentioned their country of origin, the majority were from the US followed by India and Canada (Figure 1A). In 139 videos, patients reported the SCT clinic location with India having the most, followed by the US and Mexico (Figure 1B). These results indicate that patients travel from and to different countries.

Patients described various features about the SCTs they received (see Table S2 for Codebook for YouTube Video and Audio Analysis). In about a quarter of the videos, patients mentioned a stem cell source, including adult, bone marrow-derived, umbilical, fat, placental, or fetal. SCT administration procedures were reported in 12% (N = 19) of videos, including intrathecally, subcutaneously, intravenously, or by injection. Patients mentioned risks in 10.1% (N = 16) of videos, all of which were underemphasized, except for one case. Patients mentioned benefits in 95% (N = 151) of videos which, in all but two cases, were overemphasized. Costs of SCTs were mentioned in 5% (N = 8) of videos and that providers can treat additional conditions in 16.3% (N = 26) of videos. Patients mentioned undergoing two treatments in 23.3% (N = 37) of videos and three or more treatments in 8.8% (N = 14) of videos, with one patient reporting having had eight treatments. SCTs were described as "experimental or controversial" (2.5%, N = 4) or "alternative" (1.3%, N = 2), but none were described as "unproven." Only one patient (0.6%) mentioned that the intervention had undergone ethics or regulatory approval, and 4.4% (N = 7) of patients mentioned that the treatment was based on previous research or publications.

The Power of Patient Narratives

We performed a qualitative analysis of the video, audio, and transcribed voices identifying seven major themes (Table 1 and see Table S3 for example quotes).

Nearly all videos generally described the benefits of SCTs as improving health, quality of life, or energy. Specific benefits included increased appetite, weight gain, strength, movement, flexibility, sensation, circulation, verbal abilities, cognition, physical appearance, vision, and urination, as well as improving shaking/tremors, seizures, pain, and drooling. In 58% of cases, patients acted out scenes, sometimes before/after scenes, showcasing health benefits such as improved mobility, decreased stiffness, or increased flexibility by getting out of bed, clapping, grabbing objects, sitting up, and performing exercises among others.

Patients or others offering praise and showing gratitude to the clinic, provider, staff, or SCTs more generally was a dominant theme. Words of admiration, commendation, approval, compliment, and salvation were routinely used by patients, and providers were described as

Table 1. Description of Major Themes of Patient Testimonials on YouTube

Theme	Description	Frequency, % (N)
Benefits	An improvement in overall health, quality of life, or specific improvement	91.2 (145)
Praise	Patients/others offer praise for the treatment, provider, or SCT	53.5 (85)
Choice	Patient/others explain the reason for choosing a specific clinic	34.0 (54)
Recommendation	Patient or provider recommends treatment to others	28.9 (46)
Hope	Patient explains that the treatment, provider, or the clinic offered hope	26.4 (42)
Procedure	Patient describes the procedure (step by step) or describes the procedure as low or no risk	24.5 (39)
Motivation	Patient describes why they sought an SCT	22.6 (36)

professional, knowledgeable, experienced, warm, kind, caring, compassionate, embracing, tremendous, fantastic, easy to talk with, and pleasant. Some patients made reference to their prayers being answered, being blessed, or owing their life to the providers and staff. In many cases where patients conveyed praise and gratitude, positive emotions of smiling, giving a high-five, or providers placing their hand on parents or patients were seen. Scenes of heightened emotion, such as crying, about to cry, appearing distressed, stuttering, or being unable to speak were seen in 16% of videos. Such heightened emotions were expressed in relation to patients or families reflecting back on their situation prior to receiving the SCT.

Over a quarter of the videos explained that the provider, clinic, or the SCT offered hope. Patients explained their motivation for seeking a SCT after exhausting other medical options, having no alternatives left, fearing disease progression, side effects or worsening of symptoms, avoiding the need to increase medication, and wanting to gain control over their condition. Several patients were reflecting on the lack of hope they experienced with respect to their medical care before reaching the stem cell clinic.

In several cases, patients explained their choice of specific clinics based on advertisements, research, or a recommendation. And perhaps the most powerful summative message was a recommendation of the SCT by the patient or provider to others.

Limited Audio and Video Sophistication

Overall, the videos were limited in video and audio sophistication. Few videos had different camera angles or cuts, and many appeared as a "talking head." Some videos were filmed in high quality and had good lighting while others seemed considerably less polished. Over half (57.9%) of the videos contained acted out scenes. Interestingly, videos of CP (87.2%) and SCI (74.4%), where movement improvements might be more easily noticeable, had more acted scenes compared with PD (51.4%) and MS (21.6%) patient videos. Special visual light effects, including flashes, scrolling words, or changing word sizes, appeared in 96.2% (N = 153) of videos. For example, a patient explaining 20% increased mobility would flash "20%." Instrumental music without words played in the background of 66.7% (N = 106) of videos, allowing voices to be heard. English was spoken in 75.5% (N = 117) of videos, and 25.2% (N = 39) of videos were spoken in another language with English subtitles.

Influential Marketing

Narratives, especially video-based testimonials, are likely to influence intentions, beliefs, and risk perceptions and have an impact on treatment choices (Appiah, 2006; Hinyard and Kreuter, 2007). Our study indicates that SCT patient testimonials on YouTube may be a potent marketing tool. A December 2018 search of the most highly viewed stem cell videos on YouTube resulted in a patient testimonial being the third highest, receiving over 2 million views. This Joe Rogan Experience podcast featured Mel Gibson and a provider who together discussed a SCT given to Gibson's father. By producing the video and prompting questions, providers can avoid conflicting or damaging messages and highlight messages of hope, praise, and improvements from SCTs (Michie et al., 2018). Compared with educational videos about SCTs from reputable scientific organizations, videos featuring patient testimonials are likely to have a wider reach and significant impact on influencing health behavior.

The positive nature of patient experiences showcased in testimonials is not surprising given that the majority are published by providers, likely as a marketing strategy. Exploring the veracity of the claims made was beyond the scope of this research. More importantly, the findings illustrate the ways in which patient testimonials could be used to provide an accurate and balanced representation about SCTs to the interested public. This is important given that there is limited comprehensive, online education on unproven SCTs (Master et al., 2014). These traditional text-based patient booklets and websites depend on conveying fact-based information about risks, among other information, to patients requiring them to make

rational choices. While helpful to some, these booklets are unlikely to appeal to the emotional side of reasoning when making health care decisions (Kahneman, 2011). Patient testimonials should be used to develop sophisticated health literacy tools to counter the hype and misinformed messages about unproven SCTs. Perhaps a patient testimonial where the outcome was not as had been expected could better convey the risks inherent to unproven SCTs and the spurious business practices of some providers. However, care should be taken not to fight anecdote with anecdote, and narrative-based strategies would need to be factual and accompanied by other modalities including discussions with physicians, as well as expanded options for patients to access clinical trials or medically innovative care. Adopting multiple approaches, including patient education, enhancing patient treatment options, and regulatory oversight, are required to make a significant dent in reducing the number of clinics providing unproven SCTs.

SUPPLEMENTAL INFORMATION

Supplemental Information can be found online at https://doi.org/10.1016/j.stemcr.2019.05.009.

AUTHOR CONTRIBUTIONS

Z.M., T.C., and A.Z. made substantial contributions to the conception and design of the project. B.H., A.R.P., D.P., and Z.M. made substantial contributions to the collection and analysis of data. Z.M. wrote the first draft of the manuscript and all authors revised the manuscript for important intellectual content. All authors approved the final version to be published.

ACKNOWLEDGMENTS

Z.M. would like to acknowledge support from Mayo Clinic's Center for Regenerative Medicine. A.Z. and T.C. acknowledge support from Canada's Stem Cell Network (grant 8000-RES0038798). We would also like to thank the anonymous reviewers for helpful feedback.

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Supplemental Information

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The Supplemental Information contains the Experimental Procedures and additional Results.

EXPERIMENTAL PROCEDURES

Identifying YouTube Videos

Using YouTube (www.youtube.com) we searched videos of five serious conditions including amyotrophic lateral sclerosis (ALS), cerebral palsy (CP), multiple sclerosis (MS), Parkinson's disease (PD) and spinal cord injury (SCI) where patients have sought unapproved SCTs (Master et al., 2014). Along with the keywords "stem cell therapy" and "stem cell treatment," we performed searches specific to each of the different disease groups (Table S1).

Table S1. Keyword search terms used to identify YouTube videos

Disease Group	Search Terms
ALS	stem cell therapy ALS
	stem cell treatment ALS
	stem cell therapy amyotrophic lateral sclerosis
	stem cell treatment amyotrophic lateral sclerosis
	stem cell therapy motor neuron disease
	stem cell treatment motor neuron disease
	stem cell therapy Lou Gehrig's disease
	stem cell treatment Lou Gehrig's disease
CP	stem cell therapy cerebral palsy
	stem cell treatment cerebral palsy
MS	stem cell therapy MS
	stem cell treatment MS
	stem cell therapy multiple sclerosis
	stem cell treatment multiple sclerosis
PD	stem cell therapy Parkinson's disease
	stem cell treatment Parkinson's disease
SCI	stem cell therapy spinal cord injury
	stem cell treatment spinal cord injury

Inclusion/Exclusion Criteria

We included videos where a patient is discussing an unapproved SCT for a specific disease. The video may also include general advertisement about SCTs or the specific SCT to treat a particular disease. Videos must mention the disease either in the title within the video, on the YouTube landing page, or by the patient or another person in the video. YouTube videos of news about the unapproved SCT industry or general educational videos of stem cell biology or stem cell therapies, documentaries and videos affiliated with universities, government agencies or clinical trials were excluded. All videos must have

spoken English or may be spoken in another language with English subtitles. Videos must also have discernible video and audio. Duplicates videos were excluded.

Codebook Development

A codebook was developed to analyze video and audio (voice and music) features of each YouTube video as 3 separate parts: 1) Coding Descriptive Content of YouTube Videos, 2) Coding Major Themes of Patient Narratives, and 3) Video/Music Coding. To develop a codebook on various Descriptive Content and Major Themes, we first assessed previously published (1) empirical research on unapproved SCTs (Berger et al., 2016; Master et al., 2014); and (2) literature analyzing YouTube videos of different topics (Ward et al., 2018). The codebook was modified after performing an inductive analysis of 10 robust English spoken videos (ALS2, CP6, CP24, CP34, MS4, MS16, PD7, PD17, SCI5 and SCI18). Items capturing video and music features were partly based on the validated 11-item message sensation value scale (MSV) scale (Morgan et al., 2003). See Table S2 for Codebook.

Coding and Data Analysis

Analysis was broken into three parts: Coding Descriptive Content of YouTube Videos, Coding Major Themes of Patient Narratives, and Video/Music Coding.

Coding Descriptive Content of YouTube Videos

Features of YouTube videos captured were: the number of views, video length, number of subscribers, patient location, clinic location, mention of costs, whether other conditions were treated, number of treatments patient received, whether patients received additional interventions e.g., physical therapy, cell source, administration procedure, mentioning risks and benefits and whether they were adequately portrayed or underemphasized/overemphasized, and whether the SCT was described as having been researched or having publications supporting its efficacy, experimental or controversial, unproven, alternative, requiring ethics approval, and requiring regulatory oversight. Please see Table S2 below for Codebook for YouTube Video and Audio Analysis.

Patient Testimonials: Patient testimonials were defined as narratives told by patients or other people including family members, friends or providers. Patients, family members or friends usually self-identify as a patient or family/friend and tell the narrative. In some cases, the testimonial may be written text (with/without a photo of the patient). The narrative can explain a range of features including description of the illness, the types of therapies the patient had underwent, the reason for choosing a SCT, description of benefits post-treatment, and other aspects about the SCT (see Coding Descriptive Content of YouTube Videos above for details).

Given the exploratory nature of the study, descriptive statistics were used to explain data. For intercoder reliability assessment, two coders (BH and AC) independently coded all videos and intercoder analysis of 50 randomly selected videos was performed using Cohen's kappa. Kappa scores ranged from 0.85 to 1.0 indicating excellent intercoder reliability (Neuendorf 2002). Specific kappa scores for whether videos were patient testimonials (κ=0.93), mentioning of risks (k=0.90), mentioning benefits (κ=0.97), whether patients described the SCT as unproven (κ=1.0), experimental (κ=0.97), alternative (κ=0.95), having undergone regulatory approval (κ=1.0), based on research (κ=0.97), published work (κ=0.97), and whether other interventions accompanied the SCT (κ=0.85). Coding discrepancies were discussed and a common agreement was reached by consensus.

People in YouTube Videos: We captured all people in the videos. To count people in YouTube videos, the person must be visually present or appear as still photos/images. *Provider Characteristics:* Providers

were those performing interviews and asking questions. Example questions include: what were your symptoms? What did the physicians treating you provide? How does the SCT help? Providers appear to represent the clinic and can sometimes use technical, medical or scientific language when speaking. Providers may not verbalize anything, but could also be working with patients, demonstrating movement, holding a patient up as they move or perform a motor test, or simply be present in the background. Providers may or may not be dressed in a medical uniform or white coat. *Patient Characteristics:* Patients are usually the people describing their own symptoms. In some cases, the patient is a child, incapacitated adult, or adult that does not speak but is known to be the patient because the provider is working with them, or another person (family or friend) may be speaking on behalf of the patient. A patient also acts out scenes by showing symptoms and improvement after receiving a SCT. This may include before and after SCT scenes. Adult patients were identified because they visually appeared over 18, or in most cases, their age was mentioned verbally or shown in subtitles. Patients who are children were usually accompanied by a parent. *Other People Characteristics:* Other people may include spouse, sibling, parent, other family or friend. Other people should appear to be "with" the patient, not just a bystander in the background of the video. Other people may or may not participate in discussing the patient's symptoms or improvements. In some cases, other people can be identified because they mention their relationship with the patient but this is not always clear.

Prompts: Provider prompts and presence were captured if the provider (i) is present in the video and interacts with patients, (ii) not present in the video but their voice is heard, or (iii) neither present in the video nor is their voice heard, but questions posed to patients are seen through English subtitles. For a provider prompt to be counted the provider must ask a question. See section People in YouTube Videos above for a description of providers and provider questions to patients. Subtitles that were used for non-English speaking translation were not considered a prompt unless it served to ask questions to patients.

Publishers: Publishers were identified by examining the landing page of each YouTube video or through an analysis of the video itself where a logo is shown or it is verbally explained who is the publisher. We analyzed publisher websites through Google.com searches of the publisher name to determine if it is a clinic that offers unapproved SCTs. Clinics offering unapproved SCTs were categorized if they provided a cell-based therapy (Berger et al., 2016).

Infomercials: Infomercials are videos published by SCT providers and do not contain a patient narrative, but do contain several similar features found among patient testimonial videos. Infomercial videos generally provide an explanation about the diseases treated; the goals of the provider to help patients; SCTs being supported by research; stem cell sources; the science of stem cells; and that SCTs are low risk, safe or reliable. Videos may contain one or more providers, or still images of providers and patients. In one case, a patient was present, but did not provide any detail in terms of a narrative or outcome of the SCT they received. All of the videos have animation (i.e., logos, writing). Many video have spoken voices in English. Most videos contained music. All videos explained SCTs as a panacea and can treat multiple diseases. Several of the videos also showcased other clinics offering SCTs which could be partnering clinics or satellite locations.

Coding Major Themes of Patient Narratives

To code the major themes, all YouTube videos were transcribed by a third party. For non-English speaking videos, the English subtitles were transcribed. Qualitative coding for major themes was performed based on 50 randomly chosen videos to inductively develop seven major themes: benefits,

praise, choice of clinic, recommendation given, hope, describing procedure, and motivation (see Table 1 in main text). Based on these themes, a single coder systematically analyzed all 159 videos.

Video/Music Coding

Video and music were examined by modifying the validated 11-item message sensation value (MSV) scale (Morgan et al., 2003). MSV examines the number of cuts in the video, intense special effects, slow motion, unusual colors, intense images, sound saturation, music, sound effects, acted out, expected format and super/twist end. Cuts are scored as low (0-6 cuts), moderate (7-14 cuts), and high (more than 15 cuts) as 0, 1, or 2.

Table S2. Codebook for YouTube Video and Audio Analysis

1) Coding Descriptive Content of YouTube Videos

Capture the following information either by viewing the YouTube videos or the information on the video's YouTube page.

- Number of Views (report number)
- Video Length (in minutes:seconds)
- Number of Subscribers
- Patient Location: Patient's home country (Country/unmentioned).
- Clinic Location: record provider's country (Country/unmentioned). If country/city/place is not mentioned in the video but the clinic name is provided, please look up the clinic's website to identify location.
- Cost: record amount (dollars & currency/unmentioned)
- Other Conditions Treated: record the other conditions that the clinic or the type of SCT treats beyond the main one searched (condition/unmentioned)
- Repeated Treatments: record the number of repeated treatments the patient received (number of times/unmentioned). Mentioning the treatments the patient plans to undertake in the future does not count. In addition, having more than one injection per visit does not count as multiple treatments.
- Additional Interventions: Did the patient receive additional interventions with the SCT e.g., physical therapy, physiotherapy, herbs, acupuncture, vitamins, yoga, massage etc. These additional interventions can be done with the SCT or after. This does not include the continuation of prescription medications by the patient (additional intervention/unmentioned)
- Cell Source(s): record the cell source in words (report type)
    - Adult autologous
    - Adult allogeneic
    - Adult unspecified
    - hESCs (human embryonic stem cells) or cells from embryos.
    - human mesenchymal stem cells (hMSCs) –likely adult allogeneic but patient/provider may specify
    - fetal stem cells
    - iPSCs (induced pluripotent stem cells)
    - cord blood
    - peripheral blood
    - Other: fat, cartilage, bone, teeth, etc.
    - Unspecified

- Administration Procedure: record the stem cell administration procedure (report type)
    - Intravenous injection
    - Intra-arterial injection
    - Subcutaneous injection
    - Unspecified injection
    - Surgical
    - Topical
    - Oral
    - Other
    - Unspecified
- Risks
    - Mentioned (Y) or Not mentioned (N)
    - If mentioned (the terms risks, side effects, or adverse events are specifically used), are they described adequately (AD) or underemphasized (UN)
    - For Adequately (AD), do they describe risks of immune rejection, tumor formation or cancer, pain discomfort, anesthetic risks (if applicable), surgical/transplantation risks of procedure.
    - For Underemphasized (UN), do patients/others describe risks as, non-existent, minimal, no more than standard therapy, only risks from the surgical/transplantation/implantation procedure, none of the patients get harmed, no reported adverse events of patients.
- Benefits
    - Benefit would be something specific e.g., improve health, relieve symptoms, cure disease
    - Mentioned (Y) or Not mentioned (N)
    - If mentioned, are they described accurately (AC) or overemphasized (OV)
    - For Accurately (AC), do they explain there may be little to no benefit, it is unknown/unclear.
    - For Overemphasized (OV), do they portray benefits as a cure, most patients improve.
- Description of SCT. Was the SCT described as:
    - Research or had Publications: Did the patient/provider explain that the treatment was based on research (preclinical or clinical) which may/may not have been published (Y/N).
    - Experimental or controversial: Does the patient/provider describe the SCT as experimental or controversial (Y/N)
    - Unproven: Does the patient/provider describe the SCT as unproven (Y/N)
    - Alternative: Does the patient/provider describe the SCT as alternative treatment or complementary alternative medicine (CAM) – i.e., not part of conventional medicine or accepted in conventional medicine (Y/N)
    - Requiring Ethics Approval: Does the patient/provider describe that the SCT requires ethics approval or that it had undergone ethics approval (Y/N).
    - Requiring Regulatory Oversight: Does the patient/provider describe that the SCT has undergone regulatory approval (Y/N)
- Provider Prompts: means the provider is giving 1 or more questions to patients/families about their experience receiving a SCT. Prompts can include the provider:
    - (i) being in the video and asking questions and interacting with the patient/family,

    - (ii) not being in the video but you are able to listen to a voice providing patients with questions, and/or
    - (iii) not being in the video or hearing them but you can see subtitles of questions on the screen. Combinations of the three types of prompts can be counted.
    - Provider prompts are not counted if a doctor or provider is present but does not say anything or you do not see subtitles of questions. In scenes where providers are only promoting the clinic and the patient testimonial is a different scene are not counted. Only count providers that are present, you hear the voice, or you see subtitles with the presence of the patient/family where the provider is asking questions are counted.
- Emotion: Patient, provider, family, caregiver is crying (or state they are about to cry), seen laughing, screaming, seriously distressed, or unable to barely speak/stuttering.

2) Coding Major Themes of Patient Narratives

Based on the inductive coding, categorize whether the video mentions one or more times the following major themes:

Benefits: Improved overall health/Quality of life/Energy

- Benefits can be explained by a patient, provider, family member, staff, a 3rd party narrator, or other individual who may or may not be in the video.
- The patient may/may not provide a demonstration e.g., increased movement
- Special effects can be displayed in video providing text explaining benefit.
- Examples of benefits include:
    - Improved ability to eat or increased appetite
    - Increased strength
    - Increased movement and/or flexibility, better (more defined/controlled) movement
    - Improved vision
    - Increased sensation/feeling
    - Increased verbal abilities and/or cognition
    - Easier to breathe
    - Improved urination
    - Weight gain
    - Decreased pain
    - Decreased tremors, seizures (not to be conflated with increased movement)
    - Decreased drooling
    - Decreased dependency on drugs or non-prescription supplements

Praise

- Praise can be offered by patients, family member, provider, medical team/staff, 3rd party narrator or other individual.
- Praises can be offered specifically of the provider, medical team/staff, the clinic in general, stem cell research, or the specific SCT offered.

Choice

- Patient, family member, provider, medical team/staff, 3rd party narrator or other individual describes how the patient came to choose the specific clinic.

- Choice of clinic could be based on:
    - conducting research or reading about the SCT on the internet or other source e.g., TV, web, newspaper, news media
    - Doctor/other provider's recommendation
    - Friend and/or family member's recommendation

Recommendation

- Patient has to verbally or through subtitles make a recommendation to viewers.

Hope

- Patient, provider, family member, medical team/staff, 3rd party narrator or other individual mentions hope more generally or hope for the future; that the treatment/clinic/providers offered hope; or hope for improvement in health.

SCT Procedure

- Patient describes procedure which would mostly be the benefits of the SCT. This could include some demonstration of improvement e.g., acting out scenes, and/or it may contain before and after shots/scenes in the form of video or photo.

Patient Motivation to Undertake a SCT

- The patient, family member medical team/staff, 3rd party narrator or other individual has to provide a specific reason as indicated below. We cannot presume that because they are sick, or they have a sick patient/child, that this was their motivation to undertake a SCT.
- One or more motivations can include:
    - No other alternative
    - Exhausted other medical options
    - Based considerably on recommendation by family, physician, or others
    - The disease has progressed and they wanted to do something about it to gain/maintain control
    - Fear of progression of disease, side effects, increase symptomatically
    - Wanted to avoid taking more medication

3) Video/Music Coding

Cuts

- A cut in video is when the camera goes from one visual scene to another. This include scenes with people to words on a screen.

Light Special Visual Effects

- Words on screen including clinic logo, information, prompts to learn more, patient information (disease, demographics, improvement etc.)
- Movement with words including changes in size, flashing, scrolling of words, symbols, logos
- Use of special lighting, flashes
- Photos included in video
- Slow motion – slowing motion of real-life action through technical intervention

Music

- Any background music at any time playing in the video.
- Describe both the: Type – instrumental, vocal
- Exposure – beginning and/or throughout and/or end

Acted Out (vs. talking head)

- Acted out is present, talking head is absent.
- Instead of being told about the benefits or risks of a SCT, viewers see action corresponding to the message i.e., a patient showing signs of improvement in movement, flexibility etc. This can include a caregiver moving the patient (especially in cases where the patient is a child). If the patient has any movement dysfunction but is not clearly demonstrating an action, then it would be considered Absent.

RESULTS

Among the 150 YouTube videos containing publication dates, more than half were found in 2013 (N=46) and 2014 (N=34) while the remainder were older: 2007 (N=1), 2008 (N=1), 2009 (N=13), 2010 (N=11), 2011 (N=26), 2012 (N=18).

Table S3 outlines several example quotes of the 7 themes identified from YouTube videos of patients undergoing unapproved SCTs.

Table S3. Example Quotes Describing the 7 Major Themes of Patient Testimonials on YouTube

Benefits
A wife explains the benefits to her husband after receiving a SCT: "[*Patient Name*] has some issues with slurred speech and uses an iPad. He's starting to be able to enunciate a little bit better. But we've also noticed swallowing changes which are way further better… His gait, we've noticed over the two weeks, has improved. He is now kicking his leg out. He started with a dropped foot, and now he is much improved. His steadiness and stability today is better. His overall stamina, we're hoping to see continuous improvement when we go home." (ALS3)
A mother describes her child's conditions after a SCT: "And her first stem cell treatment was in December of 2009, and since then, the biggest thing we've noticed is her ability to track people, her vision, her cognitive. I always tell people that it's like she was like a 50-watt light bulb and now she's like a 200-watt light bulb. That's the easiest way to describe it. She reacts more. Strength-wise, she is able to hold her head up more. Her hands, you can see her hands are nice and open. Before, they would be fisted, very, very tight. Her hand-to-mouth motion is much easier for her to do now." (CP6)
Praise
"I found help. God is good to me. I can't thank enough Dr. [*Name*] and [*Name*], all of the whole team is just remarkably good. They made a difference in my life. So I owe them a lot." (ALS6)
When referring to the physician and staff, one MS patient said: "I thank you and I love you because you are my extended family. For making me well again, thanks." (MS2)
Choice
"I found about this clinic through a friend and after speaking with my wife we decided to contact them to make an appointment with the clinic." (PD3)

Based on viewing a news segment of a spinal cord breakthrough from the University of Winnipeg, the patient explains "I ended up Googling spinal cord breakthrough and up popped these sites about stem cells and how stem cells were helping people. So when I started reading [about] some of the people and talking to them…I was amazed that the stem cells were actually helping people. So I really did a lot of investigation on it and I decided that this is what I'm going to attempt because I'm not going to take my life sitting down. I was active before person before and I intend to be active again. So I pursued it and I came upon Dr. [Name's] website. After numerous discussions with him, I wanted to make sure that everything is on the up and up and that everything checked out. I was impressed with his degrees and the work that he has been doing with stem cells. He was much more reasonable than some of the other stem cell clinics, so we made a deal. I came down here as soon as I could." (SCI5)

Recommendation

As a patient explains, "To all the people suffering from MS, I would advise them to try out stem cell therapy. They would definitely see some improvements over their current physical condition…that's my message to them." (MS9)

As a patient explains, "The message is not to give up. Be strong. If possible, go for the stem cell therapy, which will really help you. You should really try. Don't just give up. There's hope. Don't give up." (SCI8)

Hope

When the patient's mother was asked what she would suggest to other patients about the clinic, she responded: "Definitely. Because in my country there is no hope for people who have cerebral palsy. But at least coming to [*Clinic Name*], I've seen at least there is hope for them to improve. So definitely I would suggest it to people that have similar cases." (CP29)

In a final message, the medical director (provider) explained: "[*Patient Name*] came here with a lot of doubt in his mind and now he's going back with lots of hopes [*sic*] of going back and resuming his life as it was before…They are stronger internally and outside. What we have achieved, I think, is instilling in them a hope for the future, a dream which they had seen, but they were not sure will come true." (SCI8)

Procedure

"For me, again, just kind of researching the literature and how many stem cells they can now get out of just the fat in your body so you don't get your allergic reaction to it or the difficulties you might have with the bone marrow or other ways of getting stem cells. This is a very convenient easy way that produces millions and billions of stem cells, and a fairly easy, pretty much painless procedure that I think will make a big difference." (ALS2)

"So when I heard about [*Dr. Name*], I made an appointment to come down and it was about a half hour procedure – very, very comfortable and just two hours after the procedure, my appetite came back. I started walking straighter. My energy came back and it just amazed at how quick it happened." (PD23)

Motivation

"So when [*Patient Name*] was diagnosed with cerebral palsy which at that time he was 13 months old. Originally when he was diagnosed, our first neurologist that we went to see…and when I asked the question what can be done to improve his abilities, the neurologist said there is nothing you can do. Basically you can give your child some physiotherapy, but apart from that, there is really nothing you can do. Once they have a condition, that's a condition for life. I guess both me and my husband are not the type of people to give up, so we started doing things like kinesiology, chiro work, physio, point

percussion therapy, occupational therapy, and then we discovered stem cells. In Australia they don't do stem cells for neurological conditions, so we had to seek treatment overseas." (CP26)

"I'm very fortunate that my long-time boyfriend – he has an understanding of medicine and a medical background, and a degree in that. So we started looking at the journals...We started reading these papers that were peer-reviewed and published, and all the documentation. They had been doing treatment in animals. It's working great! Well, why can't we do it here in the US? So in this nine months of time, we figure out the science is there. We're just not able to do certain treatments here yet in the United States. I couldn't wait. I didn't have time to sit and wait for the FDA to say, 'You know what, this is beneficial and we're going to be able to do it across the board for everyone whether there's a risk or not, or whether it's successful for a hundred percent, which it's never going to be.' It couldn't wait! So nine months of research later, and we talked to clinics all over the world...So [*Clinic Name*] people were so great – the doctors at the time. They would call me between going from the laboratory and the hospital to do treatment…When do you get the opportunity that a doctor who is in this science and in this medicine calls you and answers your questions? I'm not trying to sell you on anything, but I'm saying this is what it is. Remarkable! I had my treatment done twice." (MS1)

SUPPLEMENTAL REFERENCES

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