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Response patterns for individuals receiving contingent skin shock aversion intervention to treat violent self-injurious and assaultive behaviours

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SUMMARY

A small proportion of patients with intellectual disabilities (IDs) and/or autism spectrum disorder (ASD) exhibit extraordinarily dangerous self-injurious and assaultive behaviours that persist despite long-term multidisciplinary interventions. These uncontrolled behaviours result in physical and emotional trauma to the patients, care providers and family members. A graduated electronic decelerator (GED) is an aversive therapy device that has been shown to reduce the frequency of severe problem behaviours by 97%. Within a cohort of 173 patients, we have identified the four most common patterns of response: (1) on removal of GED, behaviours immediately return, and GED is reinstated; (2) GED is removed for periods of time (faded) and reinstated if and when behaviours return; (3) a low frequency of GED applications maintains very low rates of problem behaviours; and (4) GED is removed permanently after cessation of problem behaviours. GED is intended as a therapeutic option only for violent, treatment-resistant patients with ID and ASD.

BACKGROUND

Autism spectrum disorder (ASD) is characterised by persistent deficits in social communication and interaction, restricted interests and repetitive patterns of behaviour. ASD is often accompanied by intellectual disability (ID), which is characterised by early developmental appearance of varying levels of deficits in intellectual and adaptive functioning.[1] Some patients with ID and/or ASD emit extreme behaviours such as physical aggression, self-injurious behaviours (SIBs), property destruction and other excessive idiosyncratic behaviours. Severe problem behaviours often result in limited educational and vocational opportunities, social isolation, limited community access, costly medical care and restrictive treatment practices (eg, physical holds, frequent restraints, seclusion/time out, protective equipment and loss of personal property.

The primary treatments used to address severe problem behaviours include applied behaviour analysis (ABA), psychopharmacology and various forms of restraint.[2] In addition, Electroconvulsive Therapy (ECT)[3] and deep brain stimulation[4] have been attempted but are rarely indicated or beneficial. Collectively, these treatments are not always effective; a subgroup of patients do not respond sufficiently even after years of function-based behavioural treatment. Moreover, while psychopharmacological treatments are used extensively to treat severe problem behaviours, drugs are ineffective or counterproductive for many patients.[5] Restraint is frequently required, which typically only serves to minimise harm rather than to treat the behaviour disorder.

Although controversial, contingent skin shock (CSS) can be extraordinarily effective in reducing the frequency of severe, treatment-resistant problem behaviours.[6] In the existing literature, there are examples of various responses to this intervention. For example, Salvy *et al*[7] used skin shock delivered from the 'self-injurious behaviour inhibiting system' (SIBIS) to completely eliminate head banging and hitting, and they were able to maintain zero rates for 7 months after SIBIS was discontinued. Williams *et al*[8] reported a case of an patient with ID with incapacitating SIB in which a low-intensity CSS was ineffective, but a higher-intensity stimulus resulted in long-term benefit. Ricketts *et al*[9] described the effective use of SIBIS for a 31-month period, after which the device was not effective. The authors suggested that the device may have lost efficacy because it was removed prematurely. Anderson *et al*[10] found that skin shock was ineffective and in fact increased the frequency of self-injury exhibited by five men with Lesch-Nyhan syndrome. This trial, however, applied low-level current (3 mA) to a small number of patients having a distinct inherited disorder known for numerous comorbidities (eg, hyperuricaemia, hypotonia, immobility and renal calculi). Ter Mors *et al*[11] used electrical aversion therapy (EAT) to treat a patient with traumatic brain injury who engaged in inappropriate sexual behaviours, including sexually assaulting a 4-year-old girl. For a number of years, the patient did not respond to behavioural and pharmacological interventions. When EAT was introduced, inappropriate sexual behaviours were rapidly reduced and there was no relapse.

Here, we describe the four most common response patterns observed over 20 years among 173 patients who underwent treatment with a graduated electronic decelerator (GED). Determined safe and Food and Drug Administration (FDA)-cleared in 1994, GED is a CSS device that delivers a 2 s train of low-voltage current and can be controlled remotely. GED is administered soon after a problem behaviour is witnessed by a trained staff member who first observes a specific topography of behaviour and verifies the behaviour with another trained staff member. Retrospectively, via digital video recordings, each application of GED

is examined to ensure it was administered correctly. There has been no evidence of physical or psychological adverse effects when GED is administered per protocol. However, it should be noted that the authors and practitioners do not endorse GED as a therapy for the majority of individuals with ID and ASD with behavioural problems. GED is used only for a small subgroup of individuals with intractable, treatment-resistant disorders in which violent, self-injurious and assaultive behaviour cannot otherwise be controlled.

CASE PRESENTATION

Participants

Participants were clients diagnosed with ID and/or ASD enrolled at the Judge Rotenberg Education Center (JRC) after failure of pharmacological and behavioural treatments at numerous other facilities. The participants engaged in dangerous assaultive behaviours and SIB that had been poorly controlled by restraint measures and sedating medications.

Materials

CSS was delivered via the GED, both of which were FDA cleared. GED delivered an average direct current of 15 mA root mean square (RMS) at 60 V RMS when applied to a 4 kΩ resistor. The stimulus was a 2 s train of square waves with a 25% duty cycle (meaning the current was on for 0.5 s during the 2 s application). The cycle consisted of 3 ms pulses (current on) at a rate of 80/s followed by 9 ms of no current. GED-4 was equivalent in every way to GED except the current was 41 mA RMS at 66 V RMS when applied to a 1.6 kΩ resistor. For a complete description of the electrode, battery and remote, see Israel *et al*.[12]

It is important to emphasise that GED output is direct current (not alternating current). Direct current is much safer at equivalent current levels when compared with alternating current.[13] In addition, GED delivers a very small amount of energy to the skin. For comparison, GED delivers 0.2% of the total energy of a defibrillator and less than 1% of the total energy delivered by a Taser M26.

Diligence in ethics and safeguards for participants

Prior to initiation of GED intervention, for each patient a strict protocol was followed that addressed safety, cost/benefit, ethical considerations, consent, approval and reporting. Specifically, the following criteria were satisfied: (1) the parent/guardian gave informed written consent to the use of GED; (2) if the participant was of school age, GED was placed in his or her individual education plan; (3) a doctoral-level clinician, with training in behavioural psychology, headed the participant's treatment team and composed a treatment plan that included the option to employ GED; (4) a physician and, when appropriate, a neurologist and/or cardiologist certified the absence of medical contraindications to the use of the GED for each participant; (5) an internal peer review committee reviewed the plan and deemed it appropriate; (6) a human rights committee composed of the patients' parents as well as community members approved the plan; (7) a Massachusetts probate court judge authorised the treatment plan through a 'substituted judgement' petition in an individual court hearing in which the participant was represented by his or her own court-appointed attorney; (8) the court-appointed attorney retained his or her own mental health expert (psychologist or psychiatrist) to provide advice concerning the proposed treatment; (9) reports on the participant's treatment status were submitted to the probate court every 3 months, and the judge held a formal review at a minimum of once a year; and (10) each participant was treated with a range of differential reinforcement, extinction, and other behavioural interventions based on behaviour function before and while GED was implemented.

The fulfilment of all aforementioned safeguards resulted in an approved behavioural treatment programme that enumerated precisely which behaviours (eg, biting others, hitting others, head banging and scratching self causing bleeding) were authorised to undergo GED treatment. Trained staff members carried on their person a copy of the treatment programme. When the staff member observed an authorised behaviour, he/she enlisted a second staff member to 'verify' the behaviour was so authorised. On verification, the staff member depressed a remote control transmitter causing a 2 s skin shock. The verification process introduced a slight delay between the behaviour and the GED application but minimised error. With continuous video monitoring, all GED applications were documented with video as well as written records.

CASE PRESENTATIONS

Pattern 1: P

P is a 26-year-old man with ASD, severe ID and a normal neurological exam. Prior to his admission, he received early autism intervention, underwent special education and was treated at a day programme specialising in ABA. On admission to JRC, his problem behaviours were characterised as *aggressive* (hitting, scratching, kicking, head butting, hair pulling, biting and spitting at others), *destructive* (banging, throwing and kicking objects) and *self-injurious* (biting and hitting self, and head banging). These behaviours resulted in fractures, lacerations and bruising to his face and head, chronic bite wounds to his hands and severe injuries to staff caring for him (concussions, lacerations and bone fractures).

P's guardians vehemently objected to the prospect of using GED for several years. As a result, he was treated with select behavioural interventions (differential reinforcement, antecedent interventions and extinction), protective equipment (helmet and protective arm guards), a restraint chair (to prevent injuries associated with head banging) and psychopharmacology (aripiprazole, trazadone, clorazepic acid and chlorpromazine). Over 74 months, he received these interventions, and he required forceful emergency restraint on 976 occasions.

Exhausted and exasperated, P's guardians consented to a trial of GED. The effect was immediate and dramatic (figure 1). Prior to the addition of GED to P's programme, he exhibited aggressive behaviour and SIBs at a mean monthly frequency of 1273.7. Over the course of 92 months of GED treatment, his aggressive behaviour and SIBs were reduced to a mean monthly frequency of 3.84. All forms of restraint and protective equipment became unnecessary, and he was able to go out with his family for the first time in many years. Subsequently, he frequently attended family events and participated in regular field trips and other school activities.

To date, GED has functioned as a "prosthetic treatment" in that it is necessary for P to continue wearing the device as it serves a prophylactic function; its removal results in rapid recurrence of dangerous self-injurious and aggressive behaviours.

Pattern 2: L

L is a 26-year-old man with ASD, moderate ID and a normal neurological exam. L's history is remarkable for appearance of problem behaviours at 3 years old. He initially underwent in-home ABA therapy followed by 13 separate day treatment

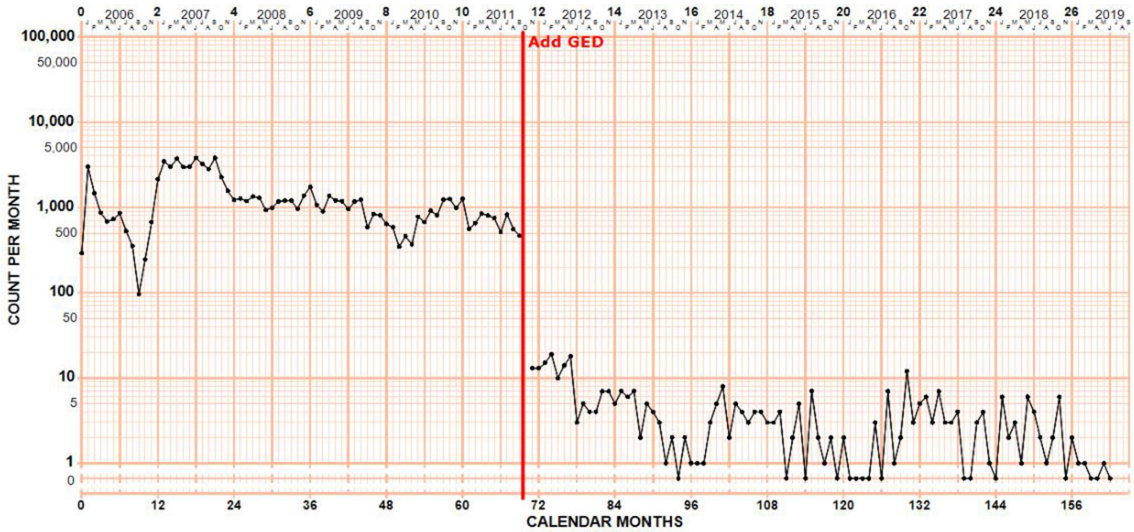

Figure 1 Monthly frequency of Peter's aggressive and self-injurious behaviours before and after the introduction of GED. GED, graduated electronic decelerator.

programmes, 11 of which expelled him because of the severity of his problem behaviours. Within the home, L continued to undergo ABA therapy over the course of 13 years. Behavioural procedures included discrete trial instruction, differential reinforcement, extinction and antecedent interventions among other protocols. L received unsuccessful trials of the following psychotropic medications: aripiprazole, olanzapine, valproic acid, guanfacine, escitalopram, riluzole, alprazolam, atomoxetine and methylphenidate. Despite these interventions, L continued to engage in behaviours that included hitting, scratching, biting, head butting and pulling the hair of others, resulting in lacerations, concussions and other injuries, and he required frequent emergency restraint. Other dangerous incidents included throwing large rocks and hot beverages at peers, jumping through a glass window, breaking off the emergency handle on a bus and attacking the driver, and choking his father in their car. The severity of his problem behaviours resulted in multiple psychiatric hospitalisations and failed placements. At the age of 17, he was rejected from four residential treatment programmes because of their unwillingness or inability to manage his severe behaviours.

On admission to JRC, L's behaviours were characterised as aggressive (biting, hitting, slapping, head butting, kicking, throwing objects at others, scratching others and spitting at others), self-injurious (biting and hitting himself, dropping himself to the floor, head banging, inflicting injury to the oral mucosa and severe excoriative behaviours), destructive (breaking objects, tipping/flipping tables and banging objects) and *non-compliant* (refusing instructions). It is notable that non-compliance was determined to be a direct antecedent to self-injury and aggression.

After GED was approved and initiated, L demonstrated a significant reduction in aggressive, self-injurious, destructive and non-compliant behaviours, and these behaviours continued to decline over subsequent months (figure 2). Prior to the introduction of GED, L's major problem behaviours occurred at a mean

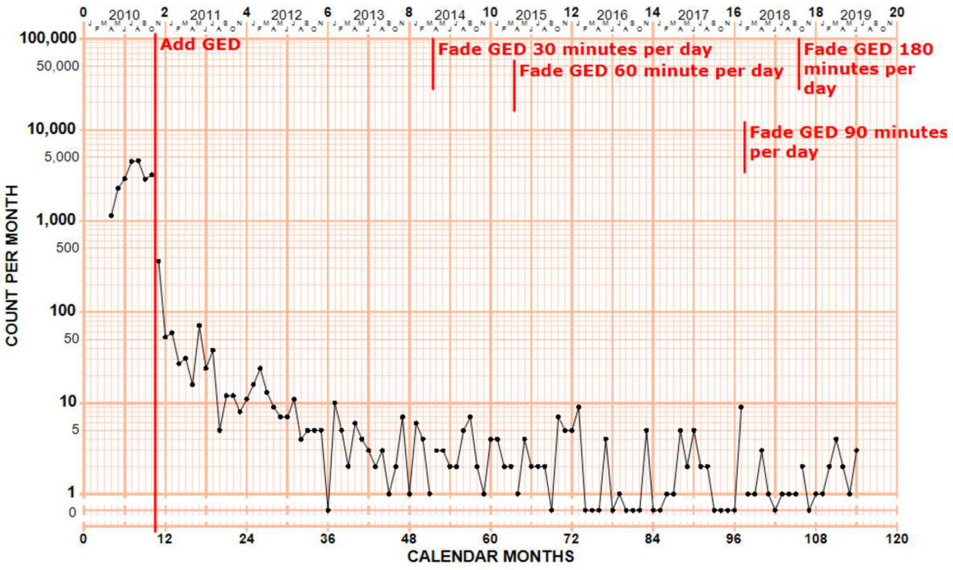

Figure 2 Monthly frequency of Larry's aggressive, destructive, self-injurious and non-compliant behaviours before and after the introduction of GED. GED, graduated electronic decelerator.

monthly frequency of 3075.29. With GED, the mean frequency decreased to 1.61 per month. Figure 2 illustrates the ongoing protocol for tapering off GED or 'fading' (eg, removal of devices from the body) for progressively increasing periods of time. The need for emergency restraint was eliminated, and L became able to safely attend regular home visits and travel by air on numerous occasions with his family. In L's case, the introduction of the GED was effective in dramatically reducing the frequency of his problem behaviours, and a gradual tapering procedure is ongoing.

Pattern 3: M

M is a 29-year-old man with ASD and mild ID and a normal neurological exam. M's problem behaviours began at the age of 6, and he was placed in special education settings and received counselling. Subsequently, he was repeatedly hospitalised because of aggressive behaviours until he was admitted to a residential programme at age 9. He received treatment in two residential programmes and was eventually expelled because of his aggressive behaviour. He was also denied admission to other facilities because they were unable to manage his aggression and were unwilling to bear the liability. Over the years, a range of behavioural procedures were attempted without success, including differential reinforcement, exclusionary time out, functional communication training and escape extinction. Further, M was treated unsuccessfully with various classes of medications, including quetiapine, olanzapine, fluoxetine, sertraline, buspirone, trazadone, lithium, oxcarbazepine, valproic acid, guanfacine, clonidine, lorazepam and diphenhydramine. With the failure of these interventions, M remained completely withdrawn socially and continued to engage in violent behaviours. He banged his head on protruding bolts and other objects; slammed his nose onto the floor or ground; hit himself in the face, causing haemorrhage; and regularly assaulted staff members. In order to protect staff and prevent self-injury, M was mechanically restrained most of the time, including when showering and during other personal care activities. Spanning the 7-month period prior to admission, he required forceful emergency restraint on 162 occasions.

On admission to JRC, M's behaviours were characterised as aggressive (hitting, kicking, aggressive posturing, spitting on others and making verbal threats), *health dangerous* (head banging, hitting self and inducing vomiting), *major disruptive* (yelling), non-compliant (refusing to a three-step direction and refusing physical prompting) and destructive (banging, throwing and breaking objects). Figure 3 shows the frequency of M's dangerous behaviours over a 12-year period. After approval and initiation of GED, his dangerous behaviours decreased significantly. However, after approximately 2 months, he appeared to habituate to GED and his behaviours began to accelerate. GED was discontinued, and the approval process for the stronger GED-4 was started. During the time off GED prior to GED-4, mechanical restraints were again required throughout the day to maintain safety.

After approval, GED-4 was first used if needed in brief treatment sessions (up to 15 min) designed to teach and maintain a new behaviour that was incompatible with his aggressive behaviour and SIB. Specifically, because M's most frequent responses were striking his face and hitting others, he was taught to place his hands in 'hand holsters' at his sides. When M's hands entered the holsters, his fingers activated a micro switch causing mounted green LED lights to illuminate and reinforcement ensued (eg, access to superhero movies). In the event that M removed his hands from the holsters, the LED light colour changed to red, a tone sounded, reinforcement ceased and GED-4 was administered. M learnt this incompatible behaviour in 18 progressively longer (10 s–15 min) treatment sessions. In total, he required only 2 GED-4 applications among all the training sessions combined to learn the new behaviour that was incompatible with hitting.

Subsequently, the brief treatment sessions were discontinued, and M wore a GED-4 device 24 hours/day. His programme was designed such that if he engaged in hitting behaviour, he received a GED-4 application and was required to complete a treatment session of 10–15 min controlling his hands using the holster protocol as described earlier. This procedure reduced M's aggressive, health dangerous, destructive, major disruptive and non-compliant behaviours to a mean rate of 1.18 per month for 34 months. Subsequently, two forms of fading ensued: GED device fading and topography fading. GED device fading involved removing all GED devices for progressively increasing periods of time. If GED targeted topographies that recurred during device fading, the protocol was suspended and

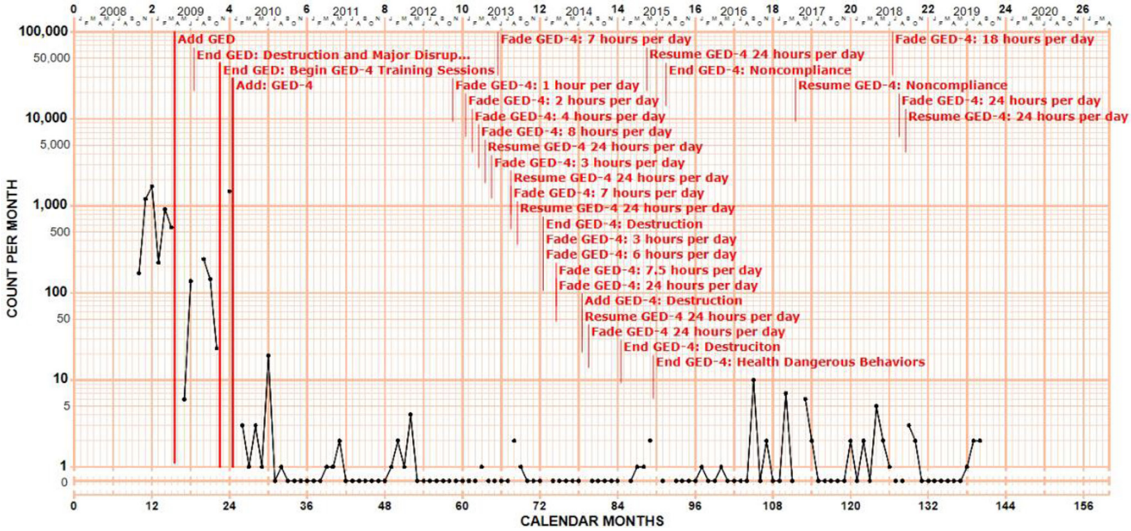

Figure 3 Monthly frequency of Miron's aggressive, destructive, health dangerous and non-compliant behaviours before and after the introduction of GED and subsequently, GED-4, and various stages of fading. GED, graduated electronic decelerator.

resumed at a later date. Topography fading involved systematically removing GED as a consequence for specific problem behaviours. For M, over 62 months of device and topography fading, GED was able to be removed as a consequence for the categories of health dangerous, destructive and non-compliance, and his problem behaviours were reduced to a mean monthly frequency of 0.76.

In M's case, GED was initially partially successful but quickly lost efficacy. When GED was removed, his problem behaviours returned to pre-GED levels immediately. However, once GED-4 was combined with a protocol designed to teach M an incompatible behaviour that was maintained with a GED-4 contingency, M's problem behaviours decreased to near zero. Categories of problem behaviours that were previously treated with GED-4 no longer required applications. M was eventually able to refrain from GED-4 targeted behaviours without wearing the device. However, it has been necessary to occasionally reinstate the GED-4 contingency as a precaution in the event of re-emergence of a specific behaviour category.

Pattern 4: J

J is a 21-year-old woman with ASD and ID and a normal neurological exam. Because of frequent tantrums, aggression and SIBs, she attended specialised day programmes beginning at 5 years old. Although she was assigned a 1:1 staff, she frequently became aggressive if others attempted to intervene in her SIB, and her parents were often called to pull her from that day's activities because of her violent behaviours. Over the years, she received comprehensive behavioural intervention, including differential reinforcement, extinction, alternative response training and antecedent interventions. She was unsuccessfully treated with numerous medications, including aripiprazole, risperidone, ziprasidone, clonidine and amphetamine/dextroamphetamine. Over the course of 10 months prior to admission, she required emergency restraint on 99 occasions and injured others numerous times. All of the residential programmes to which she was referred rejected her.

After arriving at JRC and prior to the initiation of GED treatment, J's problem behaviours were characterised as aggressive (hitting, pushing, scratching, pinching, grabbing, kicking, pulling hair, biting, head butting and throwing objects at others), health dangerous (biting self, eating inedible objects, pulling her own hair, forcefully throwing self on the floor, head banging and faecal smearing), major disruptive (smearing saliva on others, disrobing, throwing food and yelling/screaming), non-compliant (refusing three-step directions and refusing physical prompting) and destructive (throwing, ripping and banging objects, and standing on or slamming body against furniture).

As with the other patients, J's problem behaviours were dramatically reduced with the initiation of GED. Prior to the introduction of treatment, her problem behaviours occurred at a mean monthly rate of 1165.13. After GED was introduced, they decreased to 14.07 per month for 42 months (figure 4). GED was then progressively faded and discontinued. In the absence of the GED device, her problem behaviours increased to a mean monthly frequency of 30.2; however, the intensity of the behaviours remained low and could be managed with behavioural interventions. She required emergency restraint on only two occasions over 83 months after GED discontinuation. In J's case, the addition of the GED, combined with other procedures, was curative in that GED was removed entirely and dangerous self-injurious and assaultive behaviours did not recur. J is one of many patients whose problem behaviours were permanently reduced to low manageable levels.

OUTCOME AND FOLLOW-UP

Figure 5 shows the effect of adding GED in a multiple baseline across participants' display. The charts for each participant were reordered by GED start date. The initial introduction of GED resulted in an immediate deceleration in the frequency of the treated problem behaviours. This replication in treatment effect was seen across virtually all of the participants within the 173-subject cohort.

DISCUSSION

The summary data presented here replicate past findings showing the introduction of the GED dramatically reduces the frequency of problem behaviours. Here we describe the four most frequently seen patterns of response with application of GED as demonstrated by representative patients with ASD and ID with treatment refractory self-injurious and assaultive behaviours. For pattern 1 (P), the introduction of GED was remarkably effective; however, GED was *prosthetic* in that it could not be discontinued without recurrence of problem behaviours. For pattern 2 (L), GED was also remarkably effective in reducing the frequency

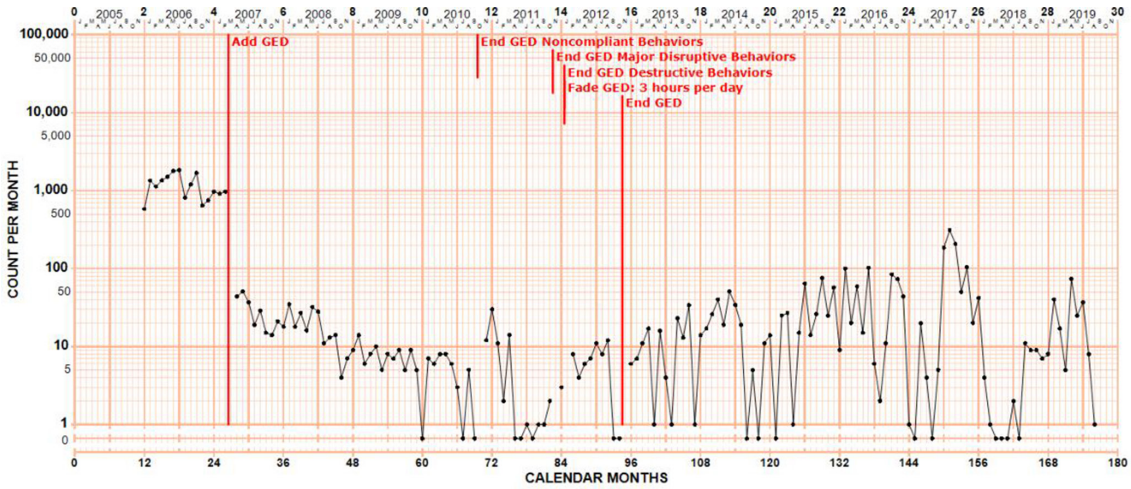

Figure 4 Monthly frequency of Jennifer's aggressive, destructive, health dangerous and non-compliant behaviours before GED, during various stages of fading and after GED discontinuation. GED, graduated electronic decelerator.

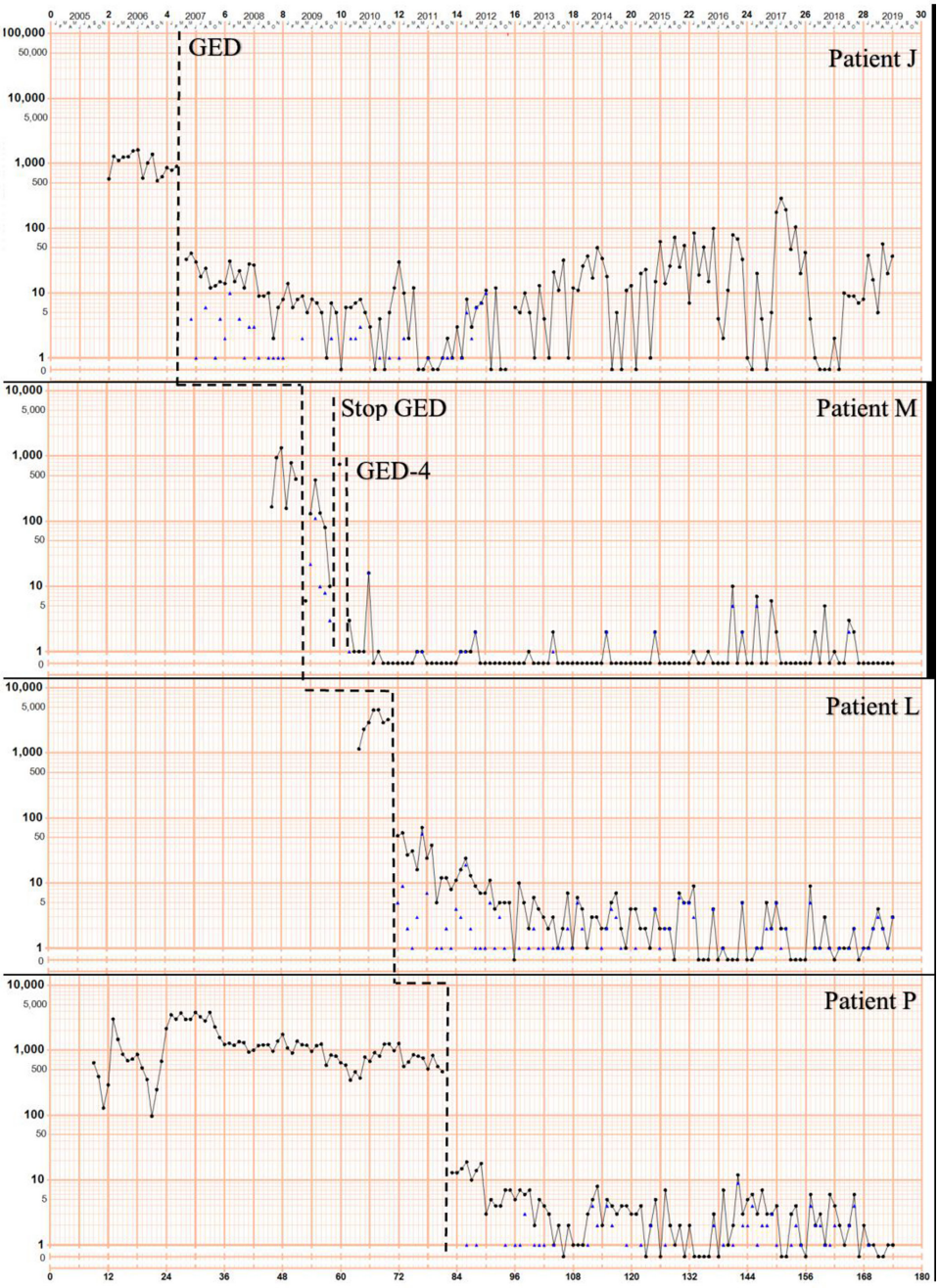

Figure 5 Multiple baseline across participant display of all four participants organised by GED start date. Note that M received two start dates, one for GED and another for GED-4. GED, graduated electronic decelerator.

of destructive behaviour. L required GED over the long term (105 months) as well, but he was able to control his behaviours for various periods of time with the absence of a GED device. For pattern 3 (M), problem behaviours improved initially when GED was added. However, GED lost efficacy and the GED-4 (a stronger stimulus) was required to reduce the frequency of his aggressive behaviours. This response is consistent with the findings of Williams *et al*[8] in which a stronger stimulus was required to reduce problem behaviours. M underwent a 9-month period of GED-4 fading, and he continues to require the availability of GED-4 but receives infrequent applications. For pattern 4 (J), GED successfully eliminated severe problem behaviours and was withdrawn without a major acceleration or relapse. GED in such cases is curative in that problem behaviours are reduced and remain at a low frequency with lower intensity after the treatment is discontinued.

Over 20 years of experience, we estimate that approximately 35% of the patients treated with GED have similar responses seen in pattern 1 (P) in that fading has yet to be achieved. Approximately 20% are similar to patterns 2 (L) and 3 (M) collectively in that they have tolerated some degree of fading but have yet to dispense with the treatment altogether. Remarkably, approximately 27% of all patients have had similar responses to pattern 4 (J) in that GED was removed entirely and not reintroduced. Finally, for 18%, a determination could not be made because the treatment was terminated for a non-clinical reason.

In all cases, GED or GED-4 was required over the long-term to maintain benefit (68–115 months). The results presented here

Table 1 Pros and cons of GED treatment

Pros	Cons
► Immediately eliminates or significantly reduces targeted behaviour. ► Eliminates or significantly reduces the need for restraint, protective equipment and PRN psychotropic medications. ► Precise limits on intensity and duration (dosing) to ensure safety and efficacy. ► Does not interfere with ongoing activities. ► Reduces or eliminates the need for physical contact with a patient who is exhibiting dangerous behaviours. ► Often associated with positive side effects: reductions in untreated problem behaviours; increases in laughing and smiling; less distressed when upset; calmer. ► Increases the amount of time the patient can participate in leisure and educational activities. ► Treatment can be implemented across environments, allowing patients to safely visit their home and enter the community.	► Causes temporary pain. ► Patient must wear/carry the equipment (battery, device and electrode). ► Treatment may be prosthetic in nature; that is, patient may need to continuously wear the device to maintain benefits. ► May evoke avoidance responses and anxiety between the onset of the behaviour and GED application. ► Requires comprehensive treatment monitoring systems (eg, cameras and supervision of staff). ► Negative public perception of the treatment. ► Extensive administrative resources are typically needed to satisfy all safeguards.

The Food and Drug Administration (FDA) issued a ban on allelectrical stimulation devices in 2020. The JRC Parents Association and JRCpetitioned the FDA for a stay of action in relation to the ban and have filedan appeal of the ban with the United States Court of Appeals for the Districtof Columbia. In response, the FDA issued a partial stay allowing patientsalready using ESDs (e.g. the GED) to continue such use.
GED, graduated electronic decelerator; PRN, per registered nurse.

support the notion that skin shock can be efficacious years after the introduction of treatment. The extent to which the treatment can be faded varied across participants. P could not tolerate even momentary fading. On the other hand, J was able to dispense with the treatment altogether after 68 months. The other participants (L and M) were able to be faded from the GED for periods ranging from hours to months; however, both patients required GED or GED-4 to be available in order to maintain low rates of problem behaviours. The use of skin shock in general has been criticised based on the premise that it only suppresses behaviour and that removal of the skin shock contingency will result in a return of the problem behaviour. While this is true in some cases, one must consider the nature of the problem. CSS is only considered for extraordinarily severe and treatment refractory problem behaviours that have caused extreme harm and continue to pose serious threat. In such cases, a treatment that reduces or eliminates such behaviours is highly valued. As with some patients receiving GED, many treatments for illness or dysfunction in medicine are prosthetic in nature as well. For example, treatments that must be maintained to manage or prevent relapse of symptoms include insulin for diabetes, antiarrhythmic and antihypertensive drugs for cardiovascular disease, proton pump inhibitors for reflux disease, corrective eyewear, psychopharmacological interventions and various behavioural interventions.

The risk/benefit associated with skin shock (see table 1) must be weighed against the risk/benefit of other treatments and that of taking no action. In all four examples presented here, the introduction of GED resulted in major improvements in quality of life by significantly reducing or eliminating the need for various forms of restraint and protective equipment as well as psychoactive drugs invariably with adverse effects. Patients with treatment refractory, severe behaviour disorders have few treatment options. The accepted course of treatment in most facilities includes continual mechanical restraint, psychopharmacological interventions with iatrogenic comorbidity, and repeated trials of ineffective or unproven treatment approaches, all of which have been ineffective for this subpopulation of patients. Furthermore, the healthcare cost burden for individuals with chronic and demanding care needs must be recognised. An alternative course of action is the discriminant and regulated use of CSS (eg, GED), which has repeatedly been shown to be safe and effective and can eliminate the risk of harm to the patient and those who interact with the patient.

Learning points

- ► A graduated electronic decelerator (GED) is a contingent skin shock intervention that can be incorporated into the treatment plan in a very small subgroup of patients with violent behavioural disorders refractory to all other interventions and after exhaustive procedural, legal and ethical deliberation.
- ► The patients presented here did not respond to all known behavioural and pharmacological interventions over years of treatment in multiple facilities. Many, if not most, facilities reject such patients because of the liability they present. It is then necessary for the patients to return to their families, which are even less skilled and capable of containing violent outbreaks.
- ► GED is a treatment option that has been shown over many years with a large patient cohort to result in immediate deceleration of dangerous behaviour and, in most cases, elimination of the need for restraints and psychoactive medications.
- ► Despite unequivocal evidence supporting its effectiveness, the use of GED to regulate the neural processing leading to violence by those without adequate cognitive function to control their actions continues to be a topic of active debate.
- ► The authors maintain that individuals should not be denied their right to effective treatment for health-threatening and life-threating mental disabilities.

Contributors MC conceived and designed the investigation, cowrote the manuscript, polished and approved the final version, and accepts accountability for all aspects of the work. NB contributed to the design of the study provided access to data, revised and approved the final publishable version of the paper, and is also accountable for all aspects of the work. GY compiled and organised the data, composed the early drafts of the manuscript, approved the final version and holds herself accountable for all aspects of the work.

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Competing interests None declared.

Patient consent for publication Parental/guardian consent obtained.

Ethics approval This retrospective case study protocol was approved by the Massachusetts Department of Developmental Services Research Review Committee. Participants were selected based on their specific responses to the

graduated electronic decelerator, and informed consent was obtained from their guardians.

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