An Electrostatic Discharge (ESD) Control Program for Children with Cochlear Implants

Mary D. McGinnis
John Tracy Clinic, Los Angeles, CA

The increasing presence in educational programs of infants and young children with cochlear implants mandates that professionals become knowledgeable about electrostatic discharge (ESD), so that they can provide a safe educational environment for children. An ESD-control program is presented that is practical and inexpensive for most educational situations. An ESD inservice module for parents and professionals is also presented.

Introduction

Cochlear implantation has become an increasingly common option for children with profound hearing loss (Moore and Teagle, 2002). Children with implants can be found in all types of programs, from residential to special day classes, and in all types of placements, including classrooms that use sign language, Cued Speech, or auditory-oral methods, as well as in the mainstream (Geers, 2002).

Professionals in these programs are now expected to be familiar with implant issues. The basic knowledge regarding implants grows at a fast pace, and currently includes understanding candidacy, surgery, and habilitation, as well as troubleshooting. The issue of ESD has received little attention, and, in fact, implant manufacturers do not request implant centers to report ESD events (Geoff Fernald, personal communication, March 2003). ESD has significant implications for children with implants, however, and professionals need to be aware of the steps they can take to design an ESD-control program for their educational environments, as well as the types of information they need to provide to parents and other professionals about ESD.

There are thousands of families successfully dealing with the day-to-day issues of wearing implants. Parents acquire information on these issues from their implant centers, their school professionals, and other parents, as evidenced by the questions and advice posted daily on the internet listservs, such as *CI Circle*, designed for parents of children with implants. Parents wrestle with decisions somewhat differently when their child has an implant. Issues include everything from how to wear the device, decisions regarding if and/or how to participate in sports, and how to deal with the issue of ESD.

Discussion of these issues is not meant to alarm parents of children with implants, or to deter parents from considering an implant for their child, but simply to provide information so they can make informed decisions. In raising awareness concerning ESD, parents and professionals become knowledgeable enough about ESD to survey their environments and situations for possible ESD risks, and to take simple corrective action to prevent damage to their children's processors or implants.

ESD and Cochlear Implants

ESD is the sudden discharge of static electricity, which most people associate with the shock or spark they feel when touching a doorknob or pulling apart socks in a clothes dryer. The little lightning bolt that is ESD can create voltages over a large range. ESD can damage sensitive electronic equipment, including cochlear implants (Cochlear Corporation, 2002). ESD is an everyday occurrence, which may go unnoticed, since charges may be small. Though some people are more sensitive to feeling shocks than others, we typically become aware of an ESD shock when the charge reaches about 2000-4000 volts (Smallwood, 2002).

For our purposes, we need to know that ESD can be caused by the contact and parting of two surfaces, such as the soles of shoes walking across a carpet (about 15,000-25,000 volts left on a person's body), or a latex balloon coming into contact with hair (about 20,000 volts). ESD can also result from the electric field generated by cathode ray tubes (CRTs) of computer monitors and TV screens (about 25,000 volts 1 inch or so from the TV screen).

Figure 1. ESD created by walking across a carpet (15,000-25,000 volts) (Courtesy Kirk Olsen, JPL/NASA)

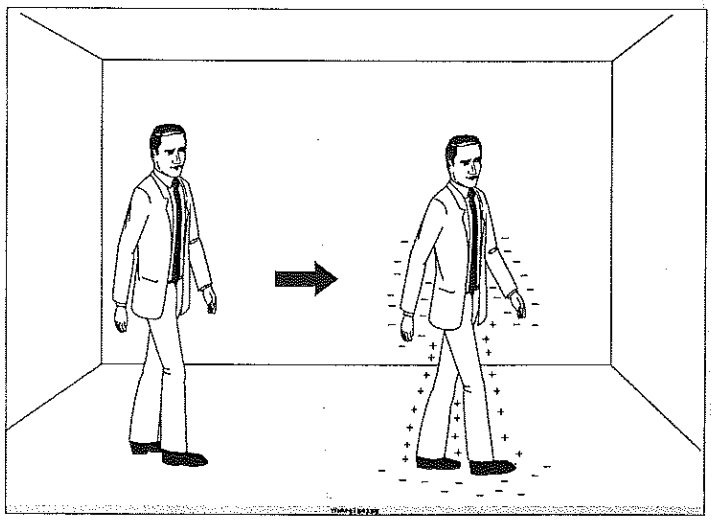


Figure 2. ESD created by a TV screen (25,000-30,000 volts) (Courtesy Kirk Olsen, JPL/NASA)

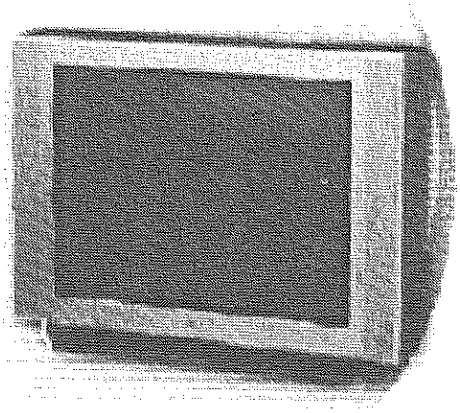
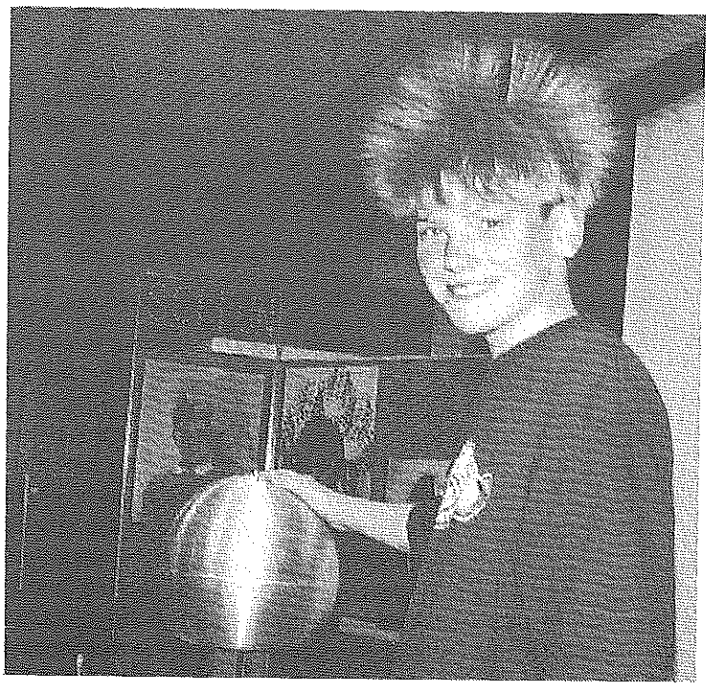


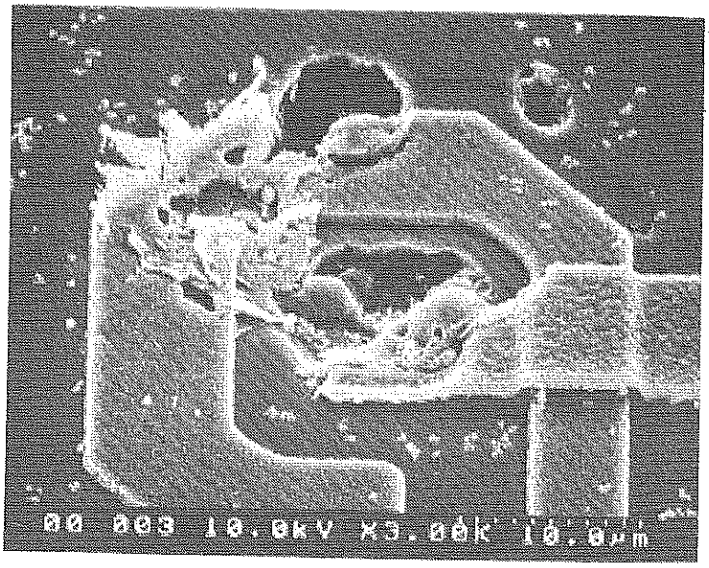
Figure 3. ESD created by a Van de Graaf generator (200,000+ volts). (Courtesy SCI-FUN: The Scottish Science Technology Roadshow)



The human body is one of the most significant sources of ESD in the environment. One principle of ESD is that discharges may occur if there is a different charge between two people. If two people are unequally charged, they will "share" (equalize) electrons when they touch. This inequality of charge between bodies, and the tendency of electrons to "share" so that each body is charged equally, may result in a zap of voltage into any part of the cochlear implant.

Electronic devices, including cochlear implants (both the internal and external devices), are susceptible to damage from ESD. You may have felt a shock when handing the disk from your digital camera to someone, only to find later that all your photos were gone because of corruption from ESD. Electrostatic discharge can cause minor corruption of the implant programs, resulting in nonstandard maps which require remapping. Further damage to the speech processor's integrated circuits from ESD may require replacing the speech processor. Internal device failure, which is extremely rare from ESD, particularly with the newer implant models, requires another surgery. New implant models in general are designed to be more resistant to ESD.

Figure 4. Memory chip from Galileo spacecraft zapped 3 times by a person charged to 8000 volts (Courtesy Kirk Olsen, JPL/NASA)



There are currently three companies that manufacture cochlear implants for children, including Advanced Bionics, Cochlear Corporation and Med-El. At John Tracy Clinic, we have had more experience with the implants manufactured by Advanced Bionics and Cochlear Corporation, and most of the experience we have is based on the body processors. We have had less experience working with the Med-El, and with BTEs of all manufacturers. All three manufacturers have designed their devices with ESD protection in mind, and each company recommends taking similar precautions to protect their devices from possible ESD damage (Advanced Bionics Corporation, 2001; Cochlear Corporation, 2002, Med-El Corporation, 2002). ESD-protective recommendations are available from each manufacturer in the user's guide, and a collection of user's guides for each implant that you deal with is essential to begin designing an ESD-control program.

There are no published specifications from any of the three implant manufacturers on how much voltage from ESD any implant can withstand. Cochlear implants are Class III medical devices, and as such, are tested for minimum resistance to ESD--6,000 volts for direct and indirect contact, and 8,000 volts for air discharge. (IEC standard #60601, 1993). Unfortunately, there is no sure way to judge "safe" levels of ESD in your own environment, since each situation varies from moment to moment, depending on factors including, but not limited to the relative humidity in an area, what types of materials and activities are involved, and the surface area over which the charge accumulates (McGinnis & Olsen, 1999). The nature of ESD is such that each little micro-climate can create its own ESD potentials. Sliding down a plastic slide may not cause an ESD event one time, and yet another time it will. Since ESD is a very complicated phenomenon, the best rule to follow is: It's easier to avoid situations that typically cause ESD, than to search for a particular "number of volts" when defining what is a "safe" level for ESD.

Though you may not have any physical evidence that an ESD event has occurred in your environment, the first indication of an ESD event may be a child's reaction. Children's reactions to ESD events vary, depending on the type of event, the type of damage done, and the child's personality, listening experience, and language level. Children may suddenly report hearing no sound at all, or hearing a loud sound, or hearing an uncomfortable noise. Their responses to auditory stimuli may change suddenly, or slowly over time. Children's behavior may change suddenly. The child may become clingy, confused, or frustrated, or the child may act out. Sometimes children may give no immediate indication of any problems, but may become less vocal or unresponsive.

If the child does not provide information indicating that an ESD event may have occurred, the device itself may indicate an ESD event. One or more of the programs on a processor may be erased or corrupted. If the implant has an LED screen, all icons may appear, indicating: "see audiologist." The device may continually emit a warning signal, despite all troubleshooting efforts. The device may shut down, or you may not be able to call up the program corrupted by ESD. The user manual for each device may be checked for specific information on how the device indicates an ESD event.

Though it may seem that sending a child to the audiologist to have his program reinstalled is a small inconvenience, being without hearing for any amount of time can have emotional repercussions for the child, as noted above, as well as the parent. Parents' reactions to their child's sudden loss of hearing because of an ESD event can bring back the devastation they felt during their child's initial diagnosis, particularly if the wait between not hearing and hearing again is a long one. A wait may occur because of distance from the implant center, or waiting for a new processor in the mail. Parents may require counseling during the time the child is without hearing, particularly if the child is very auditory and has come to depend on his hearing.

The ESD-Control Program at John Tracy Clinic

John Tracy Clinic serves families of children with hearing loss from birth to age six in two programs on site, including a parent-infant program, a preschool program for local families during the academic year, and a preschool program for international families during the summer. With the advent of cochlear implantation in children as young as, and younger than 12 months of age, the risk of an ESD event occurring on the John Tracy Clinic campus rose because of the normal behaviors of young children. One toddler's play, for example, involved crawling on the synthetic carpet in the parent-infant room, all the while rubbing his hair on the carpet. One toddler loved to run through the mall with his tennis shoes, then roll on the carpeted areas. These are normal behaviors for a young child, but risky behaviors for ESD. The toddler in the mall lost all his maps. Rather than attempting to stop children from engaging in normal play activities, we wanted to find a way to minimize the risk of ESD damage to the child's device while at John Tracy Clinic, and at home, by providing families with practical steps they could take.

We embarked on a fact-finding mission to ascertain what measures could be undertaken to protect children from ESD at the Clinic. After a year-long search for information on ESD and ESD-control measures from cochlear implant engineers and various companies who manufactured ESD-control products, the Clinic asked two ESD-control experts from the Jet Propulsion Laboratory/National Aeronautics and Space Administration (JPL/NASA) in Pasadena, California to perform an ESD audit at the Clinic. One engineer was an expert regarding ESD on earth, the other was an expert on ESD in space. They pinpointed areas of risk, and provided basic information regarding the nature of ESD, as well as practical, inexpensive solutions to minimize ESD.

Using an ESD field meter, they measured charges on children as they went about their normal activities throughout the day (Table 1). The children walked, crawled, rolled, scooted, and ran on the synthetic carpet. They slid their bodies in, on, and out of plastic chairs and tables. They slid down the slides. They touched the TV screen while watching a video. They threw trash in the plastic trashcans lined with plastic bags. They slept on the plastic nap mats. They reached over to a classmate to put the headpiece back on the classmate's head. They played dress-up with plastic fireman and policeman hats and costumes. They touched the monitor while working on the computer.

Table 1. Situations That Have Caused ESD Events Where One or All Programs Have Been Lost or Corrupted

1.	Touching TV screen while TV was on
2.	Retrieving toy from plastic trash bag
3.	Sliding down plastic slide once
4.	Playing in nylon tent
5.	Jumping on moon bounce
6.	Jumping on trampoline
7.	Balloon batted on head
8.	Balloon-animal hat placed on head

We found out that all of these activities carry a potential risk of ESD damage, some more than others. We also found out that there are practical and inexpensive ways to lessen the risk of an ESD event. Based on the information we learned from the audit, an ESD-control program was designed that includes the points in Table 2.

Table 2. ESD-Control Program

1.	Control the physical environment
2.	Educate the staff
3.	Educate the parents
4.	Educate the children
5.	Educate other professionals

Control the Physical Environment

Several options were investigated to find a way to control static. One option was to place humidifiers throughout the clinic in order to raise the relative humidity. Another was to carpet the entire clinic with anti-static carpeting, which is carpeting with conductive carbon inside each fiber. These options were not feasible, since they were costly and introduced other problems, such as the noise from the humidifiers. Staticide, the simplest, cheapest solution, also turned out to be the best solution.

Flooring

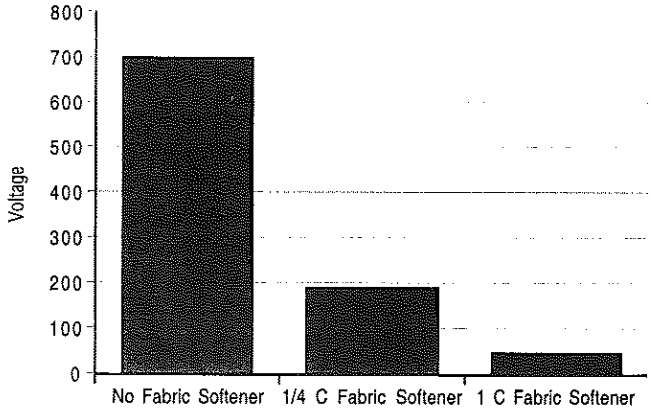
Carpets, which, for acoustic reasons, cover most floors at the John Tracy Clinic, are sprayed every three months with ACL Staticide®. This staticide is non-toxic, nonflammable, and biodegradable. (Resources are listed in Appendix A.) Staticide is the most effective preventive measure undertaken, as it covers most of the behaviors in which children are involved. Every room is sprayed with staticide, since individuals with implants, who include children, graduate students, faculty, staff, and visitors, venture into every room in the clinic. We do not spray diluted fabric softener because it quickly makes the rugs gummy. Nor do we use the static spray available at grocery stores, because it shouldn't be inhaled. The effects of staticide on ESD are illustrated in Figure 5.

All bathrooms and kitchens in the clinic are tiled, either with linoleum or ceramic tile. The children's bathrooms, which are tiled with linoleum, have large anti-static mats, which also prevent children from slipping on wet surfaces.

Classroom Furniture, Toys, and Materials

Plastic furniture was replaced by wood or wood-product furniture wherever possible. On days when the relative humidity is 30% or below, all furniture is wiped down with fabric softener sheets. Fortunately, our original built-in cabinets are solid wood, and during our recent new construction, we insisted on solid wood construction, rather than the popular plastic-laminate wood products.

Figure 5. Effects of Fabric Softener on ESD Voltage



Plastic nap mats are wiped down with fabric softener sheets (preferably unscented), and covered with 100% cotton sheets washed in fabric softener or dried with a softener dryer sheet. Before being wiped with a fabric softener sheet, our plastic nap mats measured at about 10,000 volts when rubbed with a fleece jacket, and 1000 volts after being wiped with a fabric softener sheet.

All large plastic toys were removed from the preschool, such as the ride-on toys for toddlers and nylon tunnels. The plastic ride-on toys were replaced with wooden versions. The plastic slides that originally came with our large outdoor play sets had previously been replaced with metal slides, and then covered with shade structures to keep the metal cool.

All plastic dramatic play hats were covered inside with cloth that was infused with fabric softener, and plastic costumes were replaced with cloth costumes treated with fabric softener (either washed, wiped, or sprayed).

The large trash bags lining the large trash cans were a significant risk, since the preschool children tended to lean down into the trash cans that rose to their shoulders, unwittingly rubbing against the two plastic surfaces. Measured voltages reached 25,000 volts. Large metal trash cans replaced the plastic cans.

We no longer use latex gloves for diaper changes, since many times the gloves would become impromptu latex balloons, which are high ESD risks. We now use food-handler gloves, which are available in quantity from discount food stores. Use of these gloves also helps us avoid sensitizing children with latent latex allergies, something that we have experienced, since many of our children have allergies already, and have had exposure to latex through surgery.

Electronic Equipment

The TV was identified as one of the highest risk areas, with 20,000 to 30,000 volts of charge. The monitor is kept on a tall media cart, and children are taught to stay three feet away from all sides of the cart, since the charge emitted can be the same from every side of the TV, but the electric field strength is reduced as you move away. The children are taught not to touch the screen.

A large, grounded, anti-static glass shield was used to cover the TV in the parent lounge, where families play with their children. Another TV sits inside a custom-made cabinet, behind a glass door with a child safety lock on it.

The classroom computers are placed on wooden computer tables, and anti-static mats are placed under the monitor, CPU, mouse, keyboard, and printer. This is overly cautious, but was done because it is inexpensive, and was recommended by Cochlear Corporation's ESD booklet. The anti-static shields were removed from the screens, since the ESD audit revealed that they created more electrical charge than the monitor without the shield. According to the JPL/NASA ESD-control experts, most newer computer CRT-type monitors do not produce much static at all, and the LCD displays are even lower since they contain no CRT. The recommendation to use an anti-static shield on the monitor is the one guideline specified by implant companies that we do not follow, based on the information we received from our ESD audit.

ESD Monitoring Equipment

Since the relative humidity is a prime factor in whether or not there is a risk of ESD, we have a hygrometer hung on the main hall wall, with a line indicating 30%. On days when the relative humidity is 30% or below, red signs indicating "ESD Alert" are placed at the doorways to each classroom and under the hygrometer. Days of low relative humidity usually occur when there is cool, dry weather, usually November to March in southern California.

We purchased an ESD field meter, which costs around $400. It is a simple device to use. A button turns it on, another sets the device to zero, and when held within one inch of a surface, the meter measures the voltage on that surface. It is a very useful tool when demonstrating to parents the voltage on their child's fleece nap blanket, for example.

Educate the Staff, Parents, Children, and Other Professionals

Staff and parents are educated through classes on manufacturer's recommendations for ESD safety issues, including car seats, balloons, trampolines, parachutes, and plastic ball pits and slides. Common misconceptions are dispelled (Table 3). We recommend having fabric softener sheets in the car, purse, or diaper bag, as well as a small spray bottle of staticide. Routine use of fabric softener when washing children's clothes, and avoiding synthetic clothes is recommended. Some materials, such as nylon, cannot be made safe even by washing or wiping with a fabric softener.

Parents have been a valuable source of information for us, as well, sharing their experiences with ESD on a daily basis, and alerting us to areas we might not have pinpointed. Parents have noted situations that may not be specifically mentioned in the literature, but, by their nature, are akin to those same risks. So, for example, nylon play tents, large plastic playhouses, and moon bounces pose similar risks. Airplane cabins are low humidity, and static-prone. One of our parents who is a frequent flyer wipes the airline seats down with a fabric softener sheet, since her son's hair instantly begins rising upon entering a plane, serving as her personal ESD field meter. One mother switched to leather-soled shoes for her preschooler, since his tennis shoes appeared to make the difference between whether or not his processor was affected by an ESD event.

Table 3. ESD Myths

1. You can be ESD-safe if you clap your hands at the bottom of a plastic slide before getting off.
   There is no way to ground yourself while sliding on a plastic slide.
2. You can wear your processor, and still be ESD-safe on a plastic slide, if you just turn it off.
3. You can wear your processor, and turn it "on," and still be ESD-safe on a moon bounce, if you take the headpiece off your head.
   Whether the processor is turned on or off, or whether the headpiece is on or off the head does not prevent ESD.
4. You can slide down a plastic slide wearing your implant if you don't do it too many times.
   Because you don't know what kind of charge the slide might already have accumulated from the child ahead of you, an ESD event could occur even with your first slide.
5. You can wear the processor in an anti-static baggie and slide down a slide.
   On body-worn processors, the long cable, which must come through the baggie, can become charged and carry the charge down to the processor.
6. My child plays on plastic slides and ball pits, and has never had an ESD event, so he never will.
   Many factors conspire to create ESD events, including the relative humidity, the type of activity, the types of

Besides staticide, educating parents, staff, and children about how to avoid causing ESD events themselves is one of our most important ESD-control strategies. Since the human body is one of the primary sources of ESD, we teach the "touch skin-to-skin first" rule. The rule describes the way we teach people to approach a child with an implant, whether it is to check or adjust the device, to take it off or put it on, or to replace the headpiece if it comes off the child's head. Touching the child's hand with your hand before you touch the implant helps reduce charge you may have collected in approaching the child. As two bodies approach each other, some charge may be dissipated in the small spark between them, and both parties are still charged even after contact, but once the skin-to-skin contact is made and kept, both people are charged to the same amount, and discharge of a zap into the cochlear implant is less likely.

ESD In-service for Parents or Professionals

The following inservice module may change depending on what materials you have on hand to demonstrate the concepts. The main concepts covered are the same, no matter what materials are available. A list of ESD-control materials used at the clinic can be found in Table 4.

Table 4. ESD-Control Program Materials Used at John Tracy Clinic (See appendix for resource list)

1. Hygrometer,
2. "ESD Alert" signs for days below 30% relative humidity
3. ESD meter
4. ACL Staticide (small spray bottles, & gallon bottles in garden sprayer),
5. Fabric softener sheets
6. Metal trash cans (used with plastic liners)
7. Wooden children's furniture, including computer tables
8. Wooden toys wherever possible
9. Non-latex gloves for diapering
10. Anti-static mats on linoleum-tiled bathroom floors
11. Anti-static mats under static-generating equipment (computers, printers)
12. Small static-dissipative mats in cochlear implant storage cubbies
13. Anti-static plastic ziploc baggies for water play
14. Barrier for TVs (installation out of reach, or cabinet with glass door)
15. Wooden playhouse furniture
16. Cloth dress-up clothes (preferably cotton)
17. Cloth-linings sewn in plastic dress-up hats
18. Wooden ride-on wheel toys for toddlers
19. Metal tricycles for preschoolers
20. Metal slides
21. Canvas shades over metal slides to keep them cool
22. Appropriate holders for implants so cords are under clothing/ next to skin
23. Cotton sheets for plastic nap mats
24. ESD information from each cochlear implant manufacturer

The following demonstrations (Tables 5-10) are used to illustrate what ESD is, how staticide can decrease ESD risk, and what practical steps can be taken to control ESD.

Table 5. Demonstration 1: Explanation of ESD: Share the Charge

1. Holding a popsicle stick with 1000 volts written on it, walk across the carpet toward a volunteer, who is holding a popsicle stick with 1000 volts written on it.
2. As you walk, collect popsicle sticks along the way (two sticks with 8,000 volts written on each) totaling 16,000.
3. As you approach the volunteer, reach out to touch him.
4. Pretend to feel a spark of static electricity, and "share" your electrons, so both of you have an equal number, or a total of 9,000 each.

Table 6. Demonstration 2: Voltage from Latex Balloon or Plastic Trash Bag Rubbed on Hair

1. Measure voltage with ESD meter
2. Feel voltage by rubbing balloon/bag on arm and feeling hairs rise
3. Repeat after wiping balloon/bag with fabric softener sheet

Table 7. Demonstration 3: Voltage from TV

1. Measure voltage with ESD meter
2. Feel voltage by holding arm close to TV (small effect even when TV is off if inches from screen, and large effect, even sparks, with arm close to TV as TV is turned on)
3. See effect of voltage by smoothing small piece of paper on screen to see if it "sticks" (even "sticks" when TV is off)
4. Hear static on battery-operated radio tuned to AM station (affected even when TV is off if radio is within inches, and up to 3 feet away when TV is on)
5. Note: Fabric softener sheet will not work on TV, because the static is produced by the device CRT

Table 8. Demonstration 4: Voltage from Newer vs. Older Computer Screen

1. Very low reading vs. higher reading with ESD meter
2. No effect vs. small effect on arm hairs
3. No effect vs. small effect by rubbing paper on screen
4. No effect vs. strong effect of static with battery-operated radio tuned to AM station
5. Note: Fabric softener sheet will not work on monitor, because the static is produced by the device CRT.

Table 9. Demonstration 5: Voltage from Plastic Nap Mat Rubbed with Fleece Jacket (Simulates Clothing)

1. Measure voltage with ESD meter
2. Feel voltage by holding arm close to mat immediately after rubbing
3. Repeat after wiping mat with fabric softener sheet

Table 10. Demonstration 6: Voltage from Small Whiteboard (to Simulate Laminated Furniture) Rubbed with Fleece Jacket

1. Measure voltage with ESD meter
2. See effect of voltage by smoothing small piece of paper on board
3. Repeat after wiping whiteboard with fabric softener sheet

Once parents have received the initial information on ESD through parent education classes, they are reminded through routine ESD precautions taken on the John Tracy Clinic campus. During days of low humidity, the "ESD Alert" sign posted by the hygrometer alerts parents to ESD, and they observe staff measuring ESD with the ESD field meter on those days to identify materials that may carry risky ESD charges. ESD-control measures are modeled for the parents, including how to approach a child by touching skin-to-skin first before touching the implant. Parents receive a memo at the beginning of the low humidity season in October, reminding them of things that may cause ESD, such as Halloween costumes, and informing them of ways to avoid ESD.

ESD is a technical topic that is not often easy for parents to immediately comprehend. It takes many discussions, experiences, and frequent modeling to help them understand the concept of ESD, how it works, where it occurs, and how to take precautionary action against ESD. A summary of practical things parents can do is given in Table 11.

Table 11. Practical Things You Can Do

1.	Educate yourself, your family, and your child's teachers about ESD
2.	Know where ESD occurs, and how to avoid it
3.	If you can't avoid ESD, take off the implant
4.	Avoid synthetic materials and wool
5.	Wash clothes in fabric softener
6.	Rinse hair with anti-static rinse (for frizzy hair)
7.	Carry fabric softener sheets with you
8.	Use staticide on carpets, car seats, etc.
9.	Learn how to ground yourself
10.	Touch skin-to-skin first!

Conclusions

It is the choice of each family, of course, whether or not they choose to follow our recommendations. Families do vary on the level of ESD precautions they take outside the clinic. One of our families wears nothing but cotton clothing, while another has a ball pit in her home. Sometimes, information doesn't mean as much as personal experience. One family doesn't realize that ESD events could disrupt her child's life after experiencing several days of not hearing because of two ESD events in one month. Our goal is not to police parents, but to provide families with the necessary tools to make their own informed decisions and choices, and to maintain an ESD-safe environment at the clinic.

Current information regarding the ESD-resistance of the newer BTE cochlear implants is promising. They appear to be more ESD-resistant than existing body processors. Meanwhile, manufacturers continue to improve body processor designs to be even more ESD-resistant, with new models coming out soon, proving their commitment to creating child-safe and ESD-resistant implants.

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This article was prepared with the highest regard for accurate information. However, information contained in this article should not be used as a substitute for instructions from the cochlear implant manufacturers. Neither Mary McGinnis nor John Tracy Clinic assumes responsibility for the use or misuse of information provided. Please contact individual implant companies for specific information regarding ESD-protection designs and recommendations for protecting devices from ESD. The mention of products used at John Tracy Clinic does not indicate an endorsement.

Appendix A.

Static-Control Resources

The following resources list where to obtain further information about ESD and ESD products:

ACL Staticide®: www.aclstaticide.com or 800 782-8420

Advanced Bionics Corporation: www.advancedbionics.com or 800 678-2575

Back to Basics Toys (wood toys): 800 356-5360, some of their products at www.amazon.com

Cochlear Corporation: www.cochlear.com or 800 523-5798

Community Playthings (wooden furniture): www.communityplaythings.com or 800 777-4244

Component Playgrounds (metal slides): www.componentplaygrounds.com or 877 530-0222

EIDE (shade covers): www.eideindustries.com or 800 422-6827

Electrostatic Discharge Association: www.esda.org or 315 339-6937

Frontline (anti-static mats for computers, CI storage) www.frontlinesales.com or 800 538-4555

I Hear That! (CI shirts with pockets): stacie4566@cs.com or 714 672-9228

Med-El Corporation: www.medel.com or 888-MED EL CI (633-3524)

National Bag Company (anti-static baggies): www.nationalbag.com or 800 247-6000

WASSCO (ESD meter): www.wassco.com or 800 4WASSCO