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Technical Tips: Electrode Application and Preventing Skin Breakdown Techniques

ABSTRACT. *The recording electrodes including their precise location, their ability to record during movements that can be intense during a convulsive seizure, and their capability to record for several days without causing skin breakdown are an integral part of long-term EEG recording. Many of the facets of EEG technology have changed dramatically with the introduction of digital EEG. But the electrode and the electrode/skin interface have not had many dramatic changes. The technologist still looks for ways to ensure correct electrode placement, good recording capabilities, and a patient with healthy skin when the electrodes are removed.*

This Technical Tips features ideas and experiences from several technologists. These technologists express suggestions and opinions which are accepted in Technical Tips.

They Are Not All Bald: Using the Pony-Tail Method Approach

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Within any profession there are difficulties and problems that arise from day to day. We are constantly searching for better ways to reduce stress and complete tasks faster and more efficiently. Preparing our patient's head for an EEG is one of the most important things we do as technologists. Without accurate measurement, skin preparation, and electrode placement an EEG will be full of unnecessary artifacts and technical mistakes. Using the ponytail method can be an extremely useful tool to help you, as a technologist, better prepare the patient for the test.

The time you spend to put your patient's hair into ponytails is time well spent. Skin preparation, electrode placement, and cleanup afterward are much easier when using this method. With hair clipped up, electrode sites are clearly visible (Figure 1). Any measurement errors are easily corrected, which is particularly important when new technologists or neurodiagnostics students are developing their skills at measurement and preparing for board examinations.

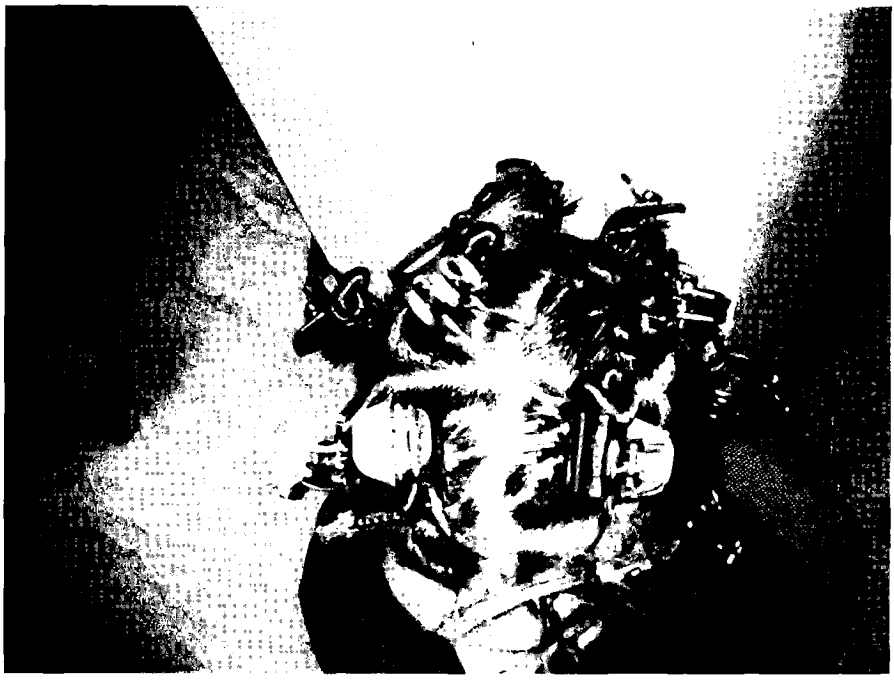

FIG. 1. The electrode sites are marked and easily visible for electrode placement.

There are many reasons for using the ponytail method. Not all of our patients are bald, although we may wish they were. Many of our patients will have longer hair and the ponytail methods allows EEG technologist to pull the patient's hair up and out of the way. This sectioning of the hair also allows for flat surfaces to apply electrodes more accurately. After ponytail placement, electrodes will no longer get lost in the patient's hair. In addition to the supplies that you are already using to measure the head, you will need a rattail comb, small rubber bands, and claw clips.

The best clips to use are claw clips (found at any general or drug store) or you may use small rubber bands. Some may prefer clips to rubber bands because bands can be time consuming and can pull hair; making a patient uncomfortable. Clips can be easily cleaned and reused and are relatively inexpensive to purchase.

Once you have your marks placed on the patient's head, you can begin the ponytail method. Making sure you have enough hair clips and/or rubber bands is important so that once you begin you do not have to leave your patient unattended. It is easiest to begin in the front separating the hair straight down the middle to clearly expose the line from nasion to inion. You will take a few minutes to gather and clip the hair in between electrode sites. For example, gather the hair between any four electrodes

such as Fz, Cz, F3, and C3. Once the hair is clipped up, the electrode site will be visible and it will be easy to see the parts in the hair. When the patient has hair that is too short to ponytail, twisting the hair and clipping it into a bun will be just as effective.

Once you have finished sectioning and clipping the patient's hair, you can begin electrode placement (Figure 2). It is helpful to make sure that the electrodes are placed on the scalp with the lead wire traveling toward the back of the head; this will keep electrode leads from falling to the side and out of the patient's face. To prevent dislodging electrodes when you are ready to apply the electrodes, apply posterior to anterior on the head beginning with O1 and O2.

Once all of the electrodes have been applied correctly you can then bundle and wrap the leads together in the back of the head (Figure 3). Bundling the leads will also help to eliminate electrical interference. You can easily bundle and wrap the wires with Coban™ or cohesive bandages. Once bundled, tape the leads to one side of the shoulder. You can record more confidently knowing the leads are not crushed or tangled behind your patient.

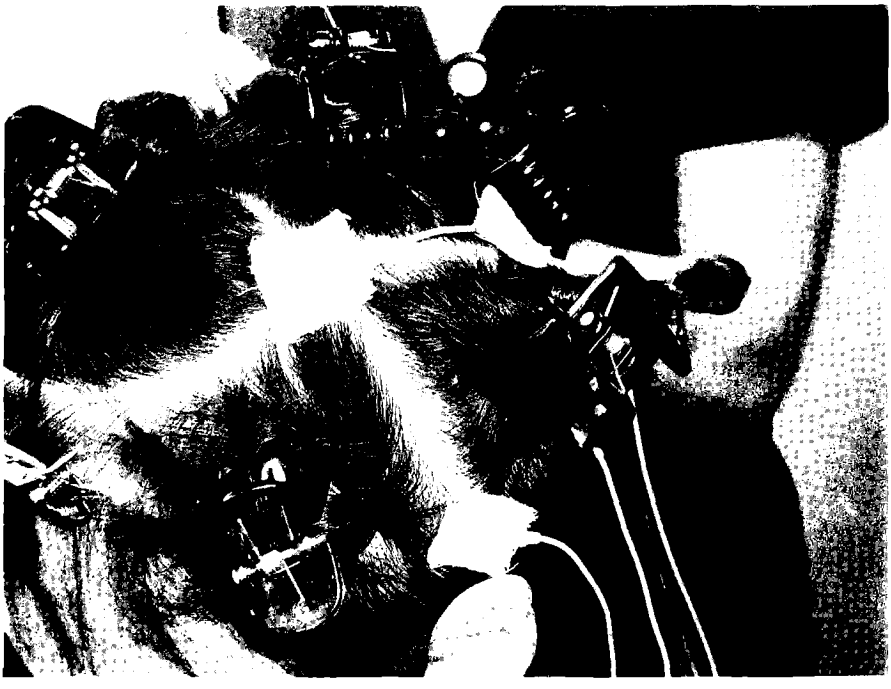

FIG. 2. Placement of the electrodes with the lead wires traveling towards the back of the patient's head.

FIG. 3. The full set of electrodes has been applied with clips holding the hair out of the way and all electrode wires coming off the back of the patient's head.

Electrode Application: Another Way to Attach Electrodes ... Without Collodion!

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For the past five years, I personally have been using this type of adhesive tape to apply electrodes for ambulatory EEG monitoring. The name of the product is Cover-Roll® Stretch Adhesive Gauze (Beiersdorf-Jobst, Inc., Hamburg, Germany). It

comes in 2 inches x 10 yards packages. As listed on the box, it is a hypoallergenic, air permeable, cross elastic, and non-woven adhesive bandage. This is the only brand I have tried and I swear by it. I know there are other brands out there, but this has proven itself to me and works just as well as collodion. Similar to a heat activated tape, this tape works with the body temperature keeping the adhesive sticky. As with anything, the more you use it, the more comfortable you become and the more efficient you will work.

The adhesive tape comes on a 10 yard roll. Cut the tape into smaller pieces that are 2 to 2½ inches in length. Just like applying electrodes with collodion, after measuring the head, use a small amount of skin prepping cleanser, scoop a nice amount of electrode paste into the electrode depending on how long the electrodes need to stay in place (use a bit more if monitoring for more than two days), and place the electrode onto head. Make sure the paste is laying directly on the scalp and that the surrounding hairs are laying flat and then take the 2 to 2½ inch piece of tape, peel off the backing paper cover, exposing the sticky side, lay the sticky side over top of the electrode. Making sure to center the tape over the electrode helps eliminate any potential lifting, which could cause popping artifacts. Holding that portion of the electrode and tape down, use your other hand to peel off the remaining paper covering of the tape, then press firmly over top the entire electrode (covering above tip of electrode, past the hub) (Figure 4). Ensure the entire electrode is covered. If it is not, add another piece of tape diagonally making sure to cover the biggest part of the electrode (Figure 5). As with most tapes, a little bit of heat makes the adhesive stickier, so once all electrodes are in place, I wrap the head with cotton gauze rolls. Between the head wrap and the patient's body temperature, the tape really sticks well.

FIG. 4. Securing an electrode with the adhesive tape.

FIG. 5. Notice how the electrodes on the forehead have tape place in the shape of a "T" or cross.

The most important challenge is making sure the hairs are laying a flat as possible or at least make sure of that once the tape is in place. If the patient has longer hair, take a strand of their hair and lay it over the piece of tape, kind of holding it down until the head wrap is in place. Because some people are active sleepers, tossing and turning all night, if the head wrap comes off, instruct the patient, not to remove the entire wrap; give them extra gauze and tape to add to what is already on their head. The electrodes really should not come off without using a remover, unless the patient actually pulls them off, and that can happen even with collodion.

After all the electrodes are in place, we secure the wires on top of the head using rolled cotton gauze (Figure 6). This keeps the wires out of reach from the patients as well as keeping the electrodes securely in place. We also offer bandannas to each of our patients so that they feel more comfortable walking out in public with this type of equipment on their heads (Figure 7).

Once the test is complete, remove the gauze wrap, then take some collodion remover (acetone not necessary), starting on one side saturate a piece of tape, move to the next electrode, until you get all the way around the head. By that time, where you first started saturating the tape, that piece of tape should pull off easily without pulling any hair with it. Remove each piece of tape then peel off the actual electrodes.

Make sure not to get any remover into the patient's eyes or mouth. Have the patient hold a wash cloth from his eyebrows and below (Figure 8). Simply spray a small amount of remover on the tape and electrode. Or pour a small amount of the remover on a 4 x 4 gauze pad then place directly on top of the piece of tape. Letting the remover dissolve the adhesive for a few seconds, move to the next electrode, and so on.

FIG. 6. Securing the wires on top of the patient's head using rolled cotton gauze.

FIG. 7. The patient has a bandanna over the cotton gauze as the technologist reviews the instructions for the ambulatory recording.

After getting around the entire head, gently peel off the pieces of tape starting on the piece you first started using the remover on. Once all the pieces of tape are off the hair and scalp, gently remove the electrodes. I then like to take a towel and really give a good head massage, absorbing the excess oil from the remover as well as any leftover paste. You should be able to easily comb through the hair. I instruct the

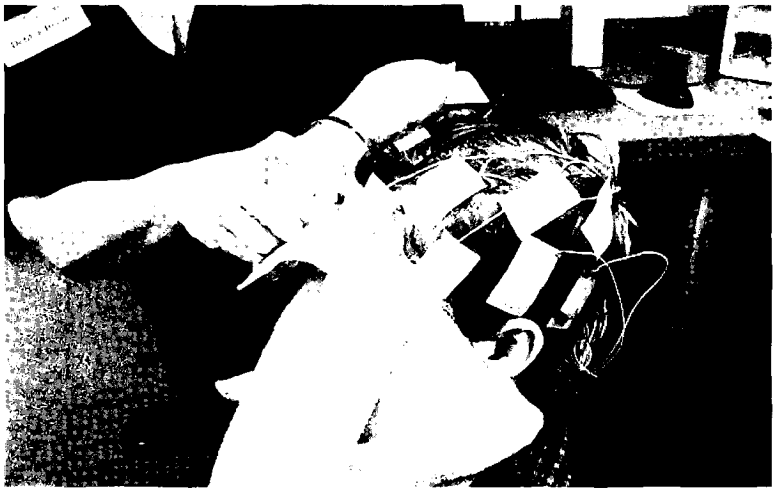

FIG. 8. Covering the patient's eyes and face during electrode removal.

patient to go home and wash as normal. There should be no residue like there is with collodion.

Your patients will be happy because there is no collodion residue left in the hair after electrode removal. And not only your patients but your co-workers will be most happy because there is no more collodion odor.

If you have any questions and wish to discuss this application process, please feel free to either email me or call me. I am so excited to share this method with everyone who has had hurdles to jump with collodion. In my opinion, collodion **was** the gold standard, now this is the 21st century way to attach electrodes – simple, easy, and yet effective.

An Alternative to Collodion

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In 1996, at the Westchester County Medical Center in Valhalla, New York, my coworker Yvonne Case and I were struggling with collodion application for long-term EEG/video monitoring of children. The difficulties of proper ventilation, applying and removing electrodes, and other problems accompanying collodion, especially skin breakdown in infants, led us to start using a relatively soft conductive paste as a conductor and a thicker one as the glue. The results were amazing!

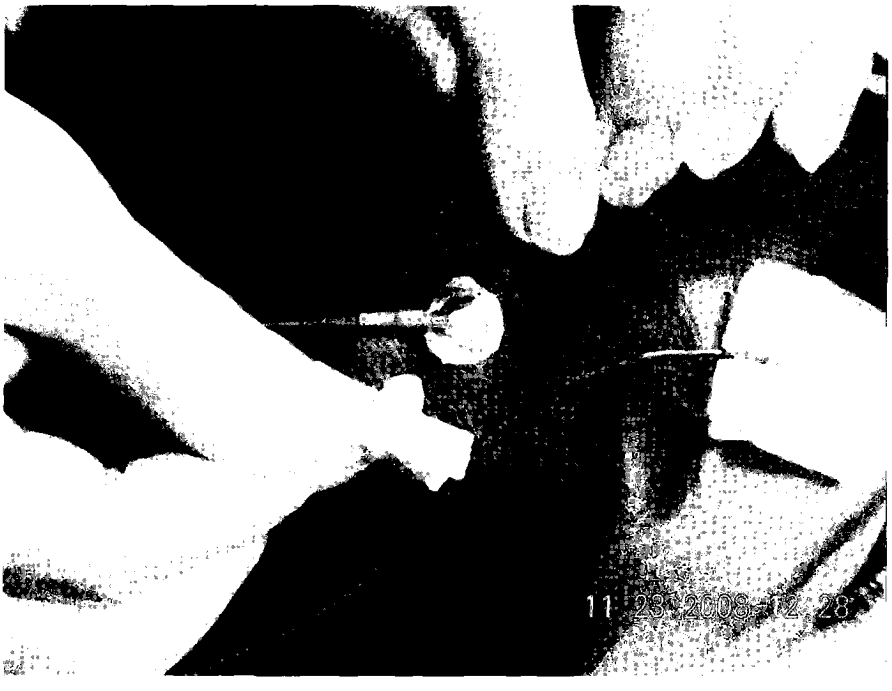

FIG. 9. EC2® Genuine Grass Electrode Cream on a small piece of gauze to be placed over the electrode.

Our procedure is as follows: Prepare the skin as usual. Cut gauze into 1 inch by 1 inch squares. Fill a 10 mm cup electrode with a conductive paste [we used Ten20® Conductive Paste (Weaver and Company, Aurora, CO, USA), but Elefix® (Nihon Kohden America, Foothill Ranch, CA, USA) could be used as well], just enough to fill the cup (as it will spread out beyond the edge a little when the electrode is applied, which is fine). Squeeze a bit of paste [we used EC2® Genuine Grass Electrode Cream (Grass Technologies, An Astro-Med, Inc. Subsidiary, West Warwick, RI, USA] on a gauze piece; just enough to cover the electrode (Figure 9). Hold down the gauze over the electrode for about 10 seconds. This method does not actually "*mix*" conductors since there is almost no contact between the two. One conductor is inside the electrode cup and the other conductor is on the outside and not serving any conductive function. The impedances of the electrodes should be less than 5,000 Ohms and balanced. After the impedances are found to be satisfactory, apply a piece of 3M™ Micropore™ Microporous Hypo-Allergenic Surgical Tape (3M™, St. Paul, MN, USA) over the electrodes on the forehead, the temples, and posterior temporal electrodes, e.g., F7, Fp1, Fp2, F8, T1, and T2 (Figure 10). Now you are ready to wrap

FIG. 10. Tape being placed over the frontal and temporal electrodes.

the head. We use two 4 inch self-adhering, conforming bandages. We wrap the head with the bandages and tape the head wrap for security and then place a net which is very convenient especially in children.

We have found this method to be fast, easy, and convenient with no collodion odor, no skin breakdown, and easy electrode removal with just water. We have monitored patient with all types of seizures, including up to three generalized tonic-clonic seizures, as well as during violent postictal states. The electrodes have remained secure. On uncooperative adults and autistic children, the electrodes have been stable with low impedances for three to four days without any repairs. On other occasions, two or three electrodes have been reapplied when impedances rose above 5,000 Ohms. These repairs were also quick and easy. This method is also for patients with an allergy to collodion as discussed in Maxine Wilson-Young's article "Technical Tips: Non-Collodion Long-Term EEG Monitoring Necessitated by an Allergy to Collodion" (Am J EEG Technol 1995; 35:303–304). I introduced this method to my colleagues in Dallas, Texas, Newport Beach, California, and Phoenix, Arizona with great acceptance by the technologists and the epileptologists.

Preventing Skin Breakdown at Fp1 and Fp2 Electrode Sites

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Under my leadership, we began using silver/silver chloride 3M™ Red Dot™ 2269T Neonatal Monitoring Electrodes (3M™, St. Paul, MN, USA) (Figure 11) for the frontal electrodes – Fp1 and Fp2 on adult and pediatric patients. We have observed a decrease in skin breakdown with improved patient comfort and satisfaction. We use the Red Dot™ electrodes as the full set of electrodes on neonates which have given us reliable, diagnostic electrographic results. Additionally, these electrodes are both flat and lightweight on the adult's, children's, and neonate's heads resulting in little or no skin breakdown.

We at Staten Island Hospital have initiated an effective way of wrapping loose electrodes together. When the application of electrodes is complete, we gather all the electrodes and hold them together with a plastic spiral cable (Figure 12) which is both comfortable for the patients and is less maintenance for the technologists. This plastic spiral cable is readily available at many retail office supply stores.

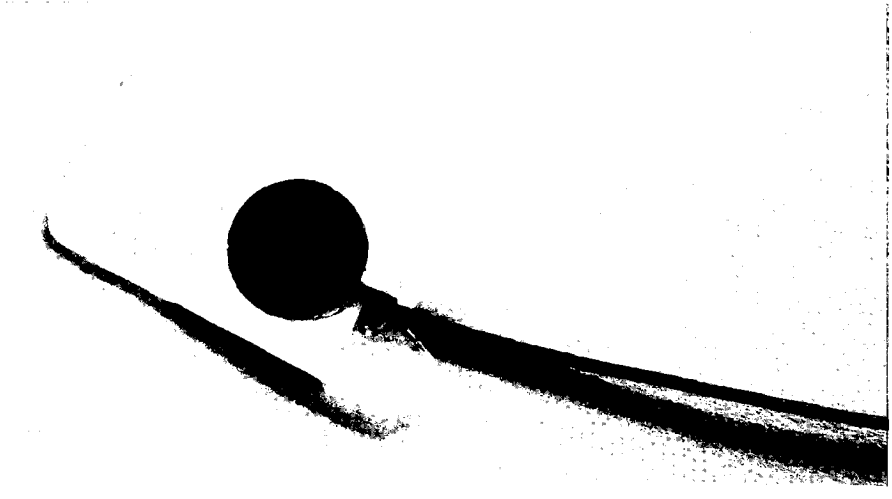

FIG. 11. The undersurface of a silver/silver chloride 3M™ Red Dot™ 2269T Neonatal Monitoring Electrode.

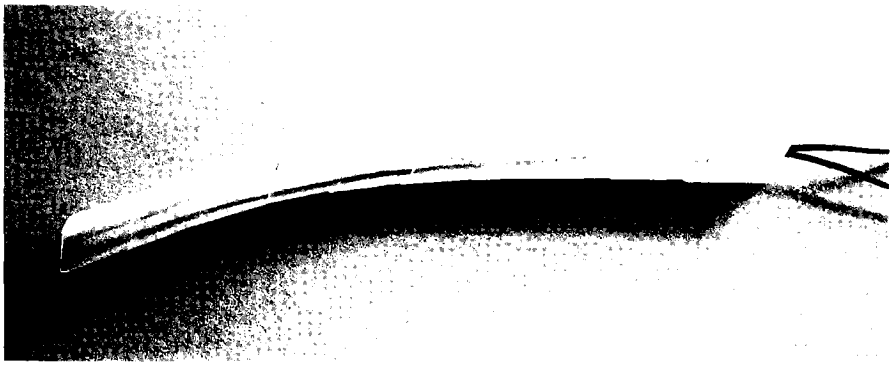

FIG. 12. Plastic spiral cable gathering the electrode wires.

Skin/Scalp Abrasions after Metal Electrode Application

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In the Laboratories of Epilepsy and Clinical Neurophysiology at Children's Hospital Boston, we have had an increased report of skin/scalp abrasions in our laboratory when metal electrode application were used and left on patients for 24 hours or more. These cases required nursing intervention. It is thought that after leaving the leads on for extended periods, pressure from the leads and metal to skin contact causes abrasions and bruising. These abrasions and bruising are especially prominent on the areas where the frontal leads were placed. These lesions are clearly visible to the naked eye and shaped like the electrodes.

The technologists at Children's Hospital Boston were asked by nursing, and management, to investigate the causes, and attempt to find a reasonable solution to this reoccurring problem, in an effort to improve patient care and safety. With some investigation, we found that the use of disposable electrodes may be of some help, since they are thinner, softer, and have a flat surface. We decided that this design aspect might lead to less pressure to the skin as compared to metal electrodes, therefore reducing skin abrasions.

We decided to place frontal electrodes on all patients with disposable electrodes for overnight recordings up to 72 hours. The rest of the International 10–20 System application was performed using gold plated silver/silver chloride electrodes. We performed over 100 electroencephalograms in a period of approximately three months time. The EEG types examined included 48 to 72 hour ambulatory EEGs, as well as bedside EEG recordings in the hospital on inpatients.

All 100 patients were carefully examined by trained technologists, looking for signs of skin abrasions or bruising, especially in the frontal area under the disposable electrodes. All patients returned without frontal area abrasions. Next, we examined the EEGs of all 100 patients, to see if there were any issues presented due to the change in metal type. Some recordings over 24 hours showed electrode drift in the frontal electrodes, where these disposables had been applied.

The electrode drift in the frontal electrodes led us to try an alternative product, known as HydroDot® SkinSavers (HydroDot®, Westford, MA, USA). These are small sticky pads, placed between the electrode and the skin. 50 patients were recorded using the HydroDot® SkinSavers. All 50 patients were carefully examined by trained technologists, looking for signs of skin abrasions or bruising, especially in the frontal area under the electrodes with the HydroDot® SkinSavers. All, but one patient, returned without frontal area abrasions. That one patient returned with a skin blister under the frontal leads, in the same shape of the skin savers. This patient was examined by the medical staff, and it was concluded that this was most likely an allergic reaction to the skin saver. Next, all EEGs were examined and there was no electrode drift.

Many of these patients were photographed for the purposes of documentation. In conclusion, disposable electrodes/skin savers placed on frontal areas will eliminate skin abrasions and bruising that is often seen during long-term EEG monitoring admissions.

Drinking Water to Prevent Skin Breakdown

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The Epilepsy Monitoring Unit (EMU) at St. Mary's opened in January 2008 and in the first year we experienced our fair share of skin issues. We attributed our patient's skin breakdown to overuse of the skin prep, the collodion, the tape, the marking pen, the room temperature, etc., but even after changing supplies and techniques, we continued to have skin issues. One week during that first year we had a patient who drank nothing but coffee – cup after cup – full carafes of coffee. When I took the first lead off at the end of the week, I saw the dreaded yellow/green puss, and after the patient showered, the skin was red and raw. From that point on, we started to look at the patients themselves as a possible cause for some of the skin issues we were seeing. Specifically, we noted that the patients who drank mostly soft drinks and/or coffee had more skin issues compared to the patients who drank water regularly. We made a point to remind our patients to drink more water, if their

diets allowed, and we began to see a drop in our incidents of skin breakdown. It was unbelievable that something as simple as drinking more water could help relieve such a painful problem.

Now when patients are admitted to the EMU and are being oriented to their room, they are asked to drink more water for the sake of their skin. Our standard procedure is to ask the patient to add an extra glass of water to their daily regimen if they are already water drinkers, and if they are not, add to a couple of glasses to their daily diet. Of course, nothing is 100% and we still have the occasional skin issue, but it is much less often and less severe.