Treatment Duration Variability in 80 mAmp*min Devices
Michael Johnson M.D.

Self-contained iontophoresis patches deliver a calibrated charge over a predetermined treatment period. Each patch requires a method of timing the treatment. The timing technology of 2001 consisted of depleting of a battery **(*IontoPatch*).** The battery is either charge calibrated or has a shunt resistor. In 2009 a new iontophoresis technology was introduced using a microprocessor to precisely determine the treatment time (***ActivaPatch 2.5***). Each of these iontophoresis patches are labeled to deliver an average 80 mAmp*min dosage over a specified treatment period detailed in the instructions for use. Examples of iontophoresis patches using both types of timing technologies were tested:

- **ActivaPatch IntelliDose 2.5** is an iontophoresis patch specified to output an average of 80 mAmp*min over a treatment period of 2.5 hours
- **Travanti *IontoPatch 80*** is a iontophoresis patch designed to output an average 80 mAmp*min dosage over an average 14-hour treatment period.
- **Travanti *IontoPatch STAT*** is an iontophoresis patch designed to output an average 80 mAmp*min dosage over an average treatment period of 4 hours.

Accuracy and repeatability of the treatment duration is compared for these iontophoresis patches. These iontophoresis patches were evaluated using an industry standard testing protocol[1]. A sample of 38 patches were tested for each type of device. All patches were sampled from at least two lots. Average skin resistance was approximated as 10 K ohm. End of treatment was defined relative to the mean Voltage over the treatment period across all 38 samples[2]

Results

The time duration until OFF was measured for each of the iontophoresis patches. The manufacturer's specified duration was compared to the measured duration (mean range, standard deviation).

Iontphoresis Patch	Specified Duration	Mean Duration	Range	Standard Deviation
ActivaPatch 2.5	2.5 hours	152 min (2.53 hours)	149-158 min (2.5-2.6 hour)	2 min
IontoPatch STAT	4 hours	242 min (4.03 hours)	62-299 min (1-5 hours)	46 min
IontoPatch 80	14 hours	756 min (12.6 hours)	82-1360 min (1.4-22.7 hour)	358 min

Table 1: ***Battery depletion and microprocessor timing*** *compared for three 80 mAmp*min iontophoresis patches. The treatment duration for the ActivaPatch 2.5, IontoPatch STAT and IontoPatch 80 are shown. Mean value is for 38 determinations.*

The microprocessor controlled ***ActivaPatch 2.5*** calculated treatment durations were by a large margin the most precise and repeatable. The mean duration was 2.53 hours, with 2.5 hours specified. The range of ***ActivaPatch 2.5*** durations was very narrow with just 9 minutes of difference between all samples.

The battery depletion devices (***IontoPatch STAT, IontoPatch 80***) were notable for wide dispersion of the treatment durations. The ***IontoPatch STAT*** average duration of 4.03 hours was close to the specified 4 hours. The variability of duration was very large with a range of 1 to 5 hours. The standard deviation of 46 minutes was 20% of the mean. The ***IontoPatch 80*** had an average duration

of 12.6 hours, close to the specified 14 hours. The variability of duration was very large with a range of 1.4 to 22 hours. The standard deviation of 358 was 47% of the mean.

In the worst case, a patient might wear an ***IontoPatch STAT*** for three extra hours after the battery had depleted. The patient might wear an ***IontoPatch 80*** for twelve extra hours after the battery had depleted. This extra wear time represents patient inconvenience and potential for skin irritation by the adhesive in sensitive individuals.

Conclusions

Significant differences in average treatment duration were observed across the tested iontophoresis patches.

The microprocessor controlled device (***ActivaPatch 2.5***) treatment durations were the most repeatable with a range of only 9 minutes across all 38 tested devices.

The battery-depletion controlled devices (***IontoPatch STAT, IontoPatch 80***) were notable for wide dispersion of the treatment durations. The ***IontoPatch STAT*** had treatment durations with a wide range from1 to 5 hours. The standard deviation of 46 minutes was 20% of the mean. The ***IontoPatch 80*** had an average duration of 12.6 hours, close to the specified 14 hours. The variability of duration was very large with a range of 1.4 to 22 hours. The standard deviation was 47% of the mean, compared to the ***ActivaPatch 2.5*** with a standard deviation of 1% of the mean.

The ***ActivaPatch 2.5*** microprocessor allows for increased timing accuracy. It also allows for increased communication with the patient. End of dose is signaled by an LED sequence and shut off, allowing the user to remove the patch as soon as the treatment is finished, reducing skin irritation from adhesives. Using a microprocessor also makes possible impedance measurements throughout the treatment. If the patch separates from the skin, another LED sequence signals high impedance. This adds to safety, as high impedance is associated with the possibility of skin burns.

The timing variability of the battery depletion devices impacts the accuracy of the total dose delivery. Total dose depends on rate of charge delivery (current) and the time over which the current is applied (treatment duration). Previously, using the same methodology, it was found that the battery depletion devices also had a large variability in total dose delivered. The ***IontoPatch STAT*** delivered a mean of 58 mA*min (range 33.6 to 63.4 mA*min). The ***IontoPatch 80*** delivered a mean of 33.7 mAmp*min (range 7.4 to 51.5 mA*min). Both of these battery depletion devices under-delivered as they are specified to deliver 80 mAmp*min. Practitioners of iontophoresis therapy should keep in mind that some types of iontophoresis patches under-deliver the dosage of drug. Some brands of patches deliver less than half of the specified dosage.

1. **Methods of measurement:** The test system has been used for FDA dosage validation and is the basis for 510k performance testing for the last two decades. Two silver plates (2" x 2", 99.9% pure) were connected by a 10 Kohm resistor. Iontophoresis patches were placed so that positive and negative electrodes were separated on hydrated Delstar hydropolymer, adherent to each of the silver plates. The iontophoresis patches were hydrated with a 0.9% saline solution according to supplied instructions. The delivery electrode was filled with the prescribed amount of Dexamethasone Sodium Phosphate (4mg/ml). A digital data logger (Agilent 34970A) was used to measure voltage and current every minute.

2. **Method to define OFF:** The duration of each patch requires a definition of OFF. The mean Voltage over the specified treatment period was used as the threshold. When the Voltage trajectory dropped below the mean Voltage, the patch was considered OFF. This is a consistent endpoint for all types of patches. Using the mean Voltage as a threshold tends to underestimate the treatment duration. This favors the "battery depletion" patches as the treatment period with significant current generation often extends well beyond the specified treatment period.

3. **Footnotes:**