ROCKY MOUNTAIN SUNSCREEN
HIGH ALTITUDE TESTING

I. High Altitude Setting- Vail, Colorado

BACKGROUND

The requirements of a sunscreen lotion are vastly different at high altitude compared to sea-level. Factors such as sun intensity, drastic temperature differentials between morning and afternoon, and dry skin due to low humidity all affect the ability of a sunscreen to perform at high altitude.

UV intensities increase with altitude because objects are physically closer to the sun. In general, intensity increases at a rate of 6% per 1000 ft. above sea level for the same latitude. For example, at 5000 ft. the sun is 30% stronger than at sea level. At 10,000 ft., the sun's intensity increases by 60%. At very high altitudes, the sun's characteristics also change due to the thinning of the atmosphere.

At 10,000 ft. above sea level, in extreme summer weather, the temperature may be as low as 30° F with snow and 60 – 70 mph winds. More typically, the temperature ranges from 50° F in the morning to 90° F or higher in the afternoon. Rain showers and/or thunderstorms, however, can cause temperatures to plummet in mid-day.

Due to these extreme temperature fluctuations, many people must apply sunscreen in the morning and immediately cover it with clothing until temperatures warm. This is a potential problem because clothing can absorb the sunscreen. Sitting in a chair or car compounds the problem because clothing can rub more vigorously against the skin, forcing the sunscreen into the clothes. Once the temperature has risen and clothing is removed, the skin may not contain enough sunscreen to provide adequate protection, resulting in "patchwork quilt" sunburn pattern (depending on sun intensity and exposure).

Low humidity is common in the western United States. Dry, flaky skin is therefore a problem. Dry skin burns more easily and is more prone to long-term skin damage than skin that is moderately moist. Dry skin appears to absorb sunscreens faster and deeper than moist skin, and does not hold the product on the surface as well. The potency of many sunscreens would decrease rapidly under these conditions.

PURPOSE

The purpose of this study was to prove that Rocky Mountain Sunscreen's SPF 30 could withstand the rigors of use at high altitude. Thirty-one (31) people were monitored per Testing Protocol PR028C over a 4-day period in July, 2000, under real-world conditions to determine if the SPF 30 sunscreen performed effectively at high altitude.

TESTING

Vail, Colorado: Elevation 8,000 – 10,000 ft.

On July 24 and 25, 2000, a total of nine (9) children and eleven (11) adults at the Gold Peak Children's Center in Vail, Colorado volunteered to be monitored during their activities while wearing Rocky Mountain Sunscreen's SPF 30. Typically, the children arrived at the Center between 7:00 – 9:00am, and spent their day participating in a wide variety of indoor and outdoor activities. Often times, the part of the day they spent in the sun was during the peak sun intensity hours between 10:00am – 3:00pm. In order to prevent the children from receiving extraordinary amounts of UV radiation, they were not kept out in the direct sunlight for more than a few hours each day.

All skin types were observed- from "Always tans, Never burns" to "Always burns, Never tans". Weather conditions varied from overcast skies with temperatures in the mid 70s to sunny, cloudless skies with temperatures in the upper 80s. Humidity levels averaged near 30%.

Sunscreen was applied between 7:15am and 9:15am each day, and was closely monitored by RMS staff. Since counselors normally help the children with their sunscreen application, assistance was provided to the children during this study. Sunscreen was not re-applied during the day. Each person wore a UV monitor and was graded and photographed each morning and afternoon in order to evaluate their UV radiation exposure. RMS' *Reflectance Analyzer* assisted in evaluating dry skin conditions and was used to gather skin baselines and *in vivo* sunscreen data.

Activities observed during this study included hiking on Vail Mountain, playing at a park, and paddling boats across a lake.

Keystone, Colorado: Elevation 9,000 – 11,000 ft.

On July 26-27, 2000, a total of eleven (11) golf course maintenance employees at the Keystone Golf Course volunteered to be monitored during their normal daily activities while wearing Rocky Mountain Sunscreen's SPF 30. These employees spent most of their workday on the greens in the direct sunlight during the peak sun intensity hours between 10:00am – 3:00pm. The volunteers for this study typically began work at 7:00am, and applied their sunscreen before going out on to the golf course for the day. The temperature was quite cool in the early morning hours (30° - 50° F), so most employees wore jackets or sweatshirts over their sunscreen until temperatures warmed.

A wide variety of skin types were observed- from "Always tans, Never burns" to "Burns, then tans". No one reported having skin that "Always burns, Never tans". Weather conditions varied from overcast skies with temperatures in the lower 60s to sunny, cloudless skies with temperatures in the 90s. Humidity levels averaged near 25%.

Sunscreen application took place from 6:10am – 6:45am, and was closely monitored by RMS staff. It was not re-applied during the day. Each person wore a UV monitor and was graded and photographed each morning and afternoon in order to evaluate their UV radiation exposure. RMS' *Reflectance Analyzer* assisted in evaluating dry skin conditions and was used to gather skin baselines and *in vivo* sunscreen data.

Because the temperature during the early morning hours was quite cool, employees wore jackets or sweatshirts over their sunscreen and UV monitors until temperatures warmed. They were instructed to wait 20-30 minutes after sunscreen application before putting on clothing. The UV monitors were not exposed to sunlight until later in the morning, when temperatures warmed. This should not have affected the study results, however, because the majority of their skin was also protected by the clothing.

Activities observed during the 2 day test period included lawn maintenance (mowing and weeding), re-grooming sand traps, relocating green holes, and repairing sprinklers.

RESULTS

The amount of UV radiation exposure received on the monitors was reported as a MED (Minimal Erythemal Dose). A MED is defined as the amount of UV radiation exposure that is required to cause a minimal color change on unprotected skin. If skin darkens to twice the minimum observable color change, it has received 2 MEDS of UV radiation. If skin darkens to three times the minimum observable color change, it has received 3 MEDS of UV radiation, etc…

No subjects received a sunburn while participating in this study as indicated by the daily grading reports and photographs. Over the 2 day test period, the children and counselors at the Gold Peak Children's Center were exposed to as many as 3.78 MED. Results from the counselors were not included in the study results due to incomplete data. The golf course employees who were forced to wear jackets for approximately 3 hours after applying sunscreen received as many as 6.2 MED over the 2 days of the study, and did not receive a sunburn.

RMS' *Reflectance Analyzer* indicated that a portion of the participants retained considerably less sunscreen than in other studies. Further investigation revealed that these individuals suffered from severely dry, flaky skin. The sunscreen, a moisturizing product, was quickly absorbed into the extremely dry, deeper layers of skin. The sunscreen was not optically visible on the skin's surface, but still remained effective. These participants were exposed to as many as 3.33 MED and still did not receive a sunburn.

CONCLUSIONS

Rocky Mountain Sunscreen's SPF 30 was effective in preventing sunburn at high altitude. No one, including those suffering from dry, flaky skin received a sunburn during the 4 days of testing. The sunscreen did not rub off or absorb into clothing- it maintained its effectiveness throughout the day.