Biomedicine

Daniel Pendick reports from Baltimore at the annual meeting of the American Society of Nephrology

Rest for the weary dialysis patient

People who suffer total kidney failure can prolong their lives with regular hemodialysis — a mechanical filtering technique that cleanses the blood of waste products and toxins. But this life-saving treatment also produces debilitating side effects. For example, many dialysis patients are constantly jarred from sleep by brief episodes of interrupted breathing, called sleep apnea, and involuntary muscle twitching.

Now, nephrologist Robert L. Benz has shown that a small bedside respirator can offer significant relief to dialysis patients desperately seeking a good night's sleep.

Benz, medical director of the Haverford Dialysis Unit at Lankenau Hospital in Wynnewood, Pa., first tried to treat his patients with sleeping pills. When this proved unsuccessful, he enlisted eight dialysis patients in a sleep study and observed the relentless nocturnal disquiet responsible for their lack of energy and mental alertness during the day.

These patients experienced anywhere from 7.5 to 140 episodes of sleep apnea per hour, Benz explains, and their calf muscles twitched an average of four times per minute. These events momentarily awakened the study participants throughout the night, depriving them of restorative deep sleep.

Even more troubling, especially for patients with heart or lung conditions, is the oxygen starvation caused by sleep apnea. In the worst case, this can cause erratic heart rhythms or even cardiac arrest, Benz notes.

In many of these patients, he explains, sleep apnea traces to the autonomic nervous system in the brain stem. Nitrogen wastes that accumulate in the bodies of dialysis patients may impair this part of the brain, causing interruptions in breathing and involuntary muscle movements, he speculates.

Although the full physiological explanation for sleep disorder in dialysis patients awaits discovery, Benz' therapy has proved effective. Called nasal continuous positive airway pressure (NCPAP), it is essentially a small respirator that assists and stimulates regular breathing throughout the night.

Among his eight study participants, the average incidence of sleep apnea fell from 64.4 episodes per hour to six. Oxygen concentrations in the patients' bloodstreams increased over 10 percent. And most important, says Benz, the patients felt rested the next day.

Potassium hazard seen in AIDS drug

Physicians often administer large doses of the drug trimethoprim (TMP) to combat pneumocystis carinii pneumonia, a common opportunistic infection in AIDS patients. TMP, however, can also elevate potassium in the blood, creating a condition called hyperkalemia. As many as 53 percent of hospitalized AIDS patients treated with TMP develop mild to moderate hyperkalemia.

Researchers Michael J. Choi, Thomas R. Kleyman, and Pedro C. Fernandez of the Veterans Administration Medical Center in Philadelphia report that they have discovered the cellular mechanism that causes this side effect. But more important clinically, they have observed an AIDS patient treated with TMP whose hyperkalemia reached the point of "medical emergency," says Choi.

This case should alert physicians to the possible life-threatening consequences of using massive doses of TMP to treat pneumocystis carinii pneumonia, he suggests.

TMP does not generally elevate potassium concentrations to harmful levels. But a significant number of AIDS patients already suffer hyperkalemia caused by kidney failure or hormone deficiencies. For these patients, treatment with TMP could boost the potassium in their blood to dangerous levels, causing heart cells to fire erratically and even bringing on cardiac arrhythmia, Choi says.

Physics

Brightness waves in cloudy liquids

Deflected by a host of microscopic globules of fat and protein, light traveling through a glass of milk constantly changes direction. Such light scattering makes it difficult to view objects completely immersed in the liquid.

Until recently, researchers tended to look upon light scattering in liquids as a nuisance. But this attitude has changed with the growing realization that even the randomly scattered, or diffuse, light emerging from a cloudy liquid carries recoverable information about what's inside the liquid (SN: 4/20/91, p.248).

Now researchers have uncovered a new scattered-light phenomenon that shows potential as the basis for a medical imaging technique. Physicist Arjun G. Yodh and his collaborators at the University of Pennsylvania in Philadelphia report their findings in the Nov. 2 PHYSICAL REVIEW LETTERS.

The researchers achieve this effect by sending a modulated laser beam, which rises and falls in brightness at a certain rate, through a cloudy liquid. The resulting chain of dark and light patches, produced by the collective effects of randomly scattered photons of light, behaves like an ordinary wave with a characteristic wavelength as it travels through the liquid. That wavelength depends on the modulation frequency and the type of liquid involved.

"It's really rather surprising that you can generate this kind of wave in a diffusive system," Yodh says.

The researchers have demonstrated experimentally that a brightness wave can be refracted. In other words, when the wave passes at an oblique angle from one cloudy liquid to another — for example, from whole milk into skim milk — its direction changes in accordance with the same laws that govern the passage of sound or light waves from one medium into another. In this case, however, it's not the 816-nanometer wavelength of the incoming laser light but the much longer, 10-centimeter wavelength of the resulting brightness wave that's important.

"We also showed that if you have a curved boundary, you can focus these brightness wave fronts," Yodh remarks.

To find out what information they can glean about what's inside a milky liquid, the researchers are now studying how brightness waves are affected by lumps and other obstructions in the liquid. "In practical biomedical scenarios, we will be looking for distortions of these wave fronts as a result of absorptive and dispersive inhomogeneities within objects such as the human breast," the researchers note.

Such an imaging technique would represent a potentially attractive alternative to an approach based on the capture of only those few photons that manage to get through a cloudy liquid without being scattered widely (SN: 5/25/91, p.325).

Heavy neutrino down and out

The verdict on the existence of a heavy neutrino with the unexpectedly high mass of 17 kiloelectron-volts has now turned sharply negative (SN: 4/27/91, p.260; 5/2/92, p.302). In August, several groups of researchers at the International Conference on High Energy Physics, held in Dallas, presented impressive data that appeared to rule out the particle's existence. Those negative findings prompted Andrew Hime, now at the Los Alamos (N.M.) National Laboratory, to reexamine the experiments he and a colleague had performed at the University of Oxford in England — experiments that had provided some of the best evidence favoring the existence of a heavyweight neutrino.

Hime now reports that he has found the glitch in the Oxford experiment that accounts for their spurious result. Errors in counting electrons, combined with the effects of aluminum baffles used to channel electrons, distorted the data just enough to suggest the heavyweight's presence.