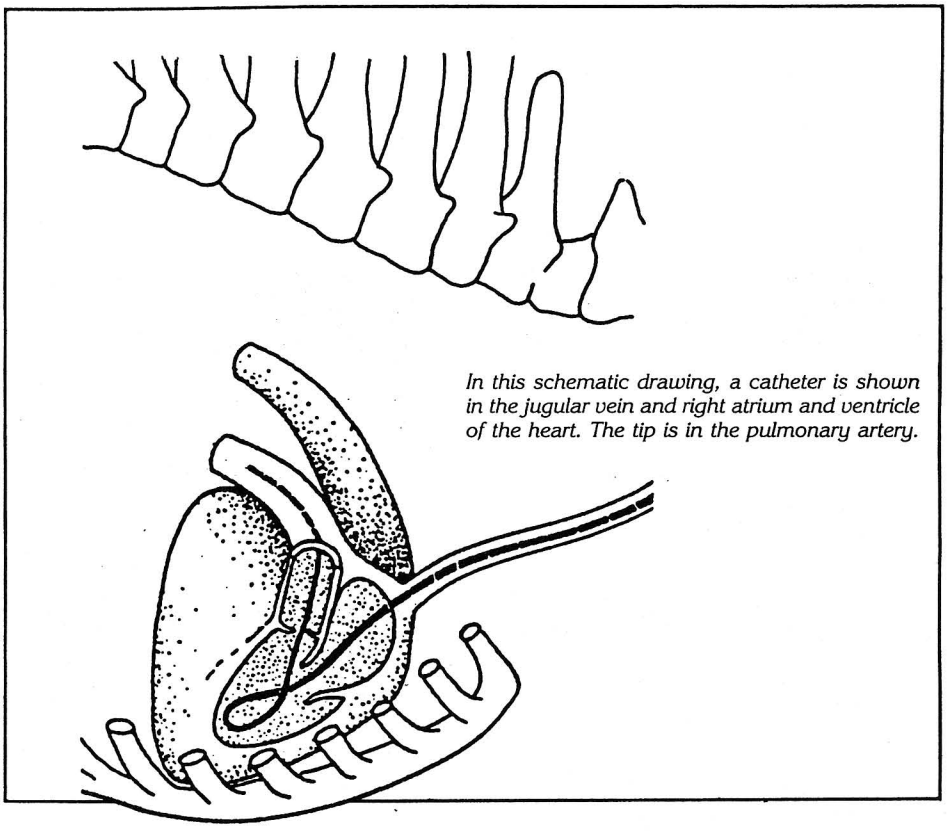
PAP Measurements
A Management Tool for High Country Cattlemen

by R.M. Teegarden, DVM



In this schematic drawing, a catheter is shown in the jugular vein and right atrium and ventricle of the heart. The tip is in the pulmonary artery.

Cattlemen in the Colorado mountains often have serious losses from high mountain disease, more commonly called brisket disease. In the spring, on Colorado ranches located at altitudes of 7,000 feet and above, there are approximately 310,000 bulls, cows, heifers and calves. In the summer, they graze mountain ranges from 7,000 to above 10,000 feet. High mountain disease and other conditions contributing to congestive right heart failure will claim up to 12 percent (an average of 0.5 to 2 percent) of the suckling calves and a number of the older animals. Some cattlemen have reduced their losses through the use of pulmonary arterial pressure (PAP) measurements.

Powderhorn rancher Stan Smock, one of the first to use PAP measurements in an attempt to eliminate high mountain disease, recalls his experience and the results: "Basically, we have an Angus herd. Our home ranch is located at 8,000 feet and we graze on ranges up to 10,000 feet. In 1970, '71 and '72, our calf crop at weaning averaged 84 percent. We knew high mountain disease was a serious problem for us on the summer range. In '72, we began taking PAP measurements on all bulls we used. Since then, we have improved our herd management in a number of ways, but I think PAP measurements on our bulls have been the most influential in improving our calf survival. We now wean a 96 to 98 percent calf crop. It's difficult to know how much of our losses before '73 were due to high mountain disease, but I think it's safe to say it was around nine to 10 percent. Now, it's under 0.1 percent. High mountain disease is no longer a problem for us. However, we continue to buy bulls with low PAPs or buy them subject to test."

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Pulmonary arterial pressures above normal are indicative of pulmonary hypertension, the forerunner of high mountain disease and other forms of congestive right heart failure. Some cattle have an exaggerated response to low atmospheric oxygen, which can lead to high mountain disease. Low oxygen content of the air at high altitudes causes muscle cells around the small arteries in the lungs to contract. The resulting reduced inside diameter of the arteries increases resistance to the flow of blood. The right side of the heart works harder to force the blood through the arteries. As a result, there is a corresponding rise in pressure, which can be measured in the pulmonary artery. If the cattle move to higher altitudes, the vessels constrict further, increasing the heart's work load. The heart may no longer be able to compensate for the increased work load. If not, it fails. With congestive right heart failure, fluid collects in body tissues, being most apparent in the brisket and along the underline. (Hence the name brisket disease.) The jugular vein is generally enlarged and the enlargement is frequently accompanied by a jugular pulse.

The jugular pulse indicates the heart has dilated preventing complete closure of the valve between the right atrium and ventricle, and blood is pumped back through the valve. If the animal remains at high altitude without treatment, death occurs.

PAP measurement

To measure the pressure in the pulmonary artery, an animal is confined in a chute equipped with a stanchion-type head catch. A 13-gauge needle is inserted through the skin of the neck and

into the jugular vein. A sterile, three-foot catheter (outside diameter, .067 inches) containing sterile solution is guided through the needle and into the vein. At this point, the other end of the catheter is attached to a transducer. The tip located in the vein is then passed with the flow of blood, down the vein through the chambers in the right side of the heart, first the atrium, then the ventricle and then into the pulmonary artery.

The transducer converts the fluid pulse in the catheter to an electronic signal, and wave forms pass across the screen on a pressure monitor, an electronic instrument. When wave forms characteristic of the pulmonary artery appear on the screen, the catheter is held in place. The average pressure appears on the monitor's L.E.D. digital read out and is recorded (in mm of mercury). The catheter is then withdrawn. If conditions for working cattle are optimum, this process takes approximately five minutes, meaning it is possible to take measurements on as many as 95 to 100 cattle in an eight-hour period.

Differences important

All cattle when moved from low to high altitudes, in time, develop a significant rise in their PAP. A normal PAP at 3,000-5,000 feet is about 25 to 35 mm of mercury. Most cattle at high altitude develop only moderate pulmonary hypertension with PAPs from 35 to 45 mm of mercury. Some, however, may develop severe pulmonary hypertension with measurements greater than 60 mm of mercury. (The frequency of high PAPs varies from herd to herd.) Cattle with high PAPs are subject to developing congestive right heart failure, which is responsible for fluid appearing in the brisket and other signs associated with high mountain disease.

Strong evidence indicates that susceptibility to severe pulmonary hypertension at higher altitudes is a heritable trait in cattle. This knowledge has led to the use of PAP measurements in screening new sires for use at the higher altitudes. However, two factors must be considered in the interpretation of PAP measurements: 1. PAPs taken after an animal has been at high altitude for two to three months are the most informative because they reflect the degree of susceptibility to altitude induced pulmonary hypertension. 2. PAPs taken at low altitude are less informative because presently there is no practical way to identify which animals will develop high PAPs when serving at the higher altitudes.

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The following four general principles or guidelines are suggested for interpretation of PAPs taken at low altitude, that is, less than about 5,000 feet: 1. Normal range is about 25 to 35 mm of mercury. 2. Animals with the lowest PAPs are probably less likely to develop high PAPs when taken to higher altitude. 3. Animals with higher PAPs should be considered more susceptible to high mountain disease. 4. Animals with PAPs greater than 45 to 50 mm of mercury should probably not be moved to high altitude.

A selection tool

Change has been rapid in the cattle industry during the last two decades. It

has been accompanied by increased competition, efforts to intensify important traits in cattle, and the acceptance of A.I. and cross breeding. Seed stock producers at high altitudes have been forced to consider breeding stock and semen from states where altitudes are near sea level, and where resistance of cattle to the adverse effects of high altitude or low atmospheric oxygen could not be determined.

The Reed Cattle Company of Sanford, Colo., found themselves in this dilemma. Angus breeder Othell Reed relates his experiences. "After taking PAP measurements on our sale bulls and replacement heifers, the records indicated that high PAPs were more prevalent among the offspring of some A.I. sires. We wondered if we could identify A.I. sires which would produce groups of calves resistant to high mountain disease before we bred them to our registered cows. To find out, we took PAP measurements on our commercial cows and inseminated the 'low cows' to A.I. sires we wanted to use in the purebred herd. We took PAP measurements on the calves from those matings in the fall of '83. From the results and a statistical analysis, the CSU Research Center in Gunnison and our ranch came up with these conclusions. If we used bull number 1, PAP measurements on 95 percent of his calves should range from 30 to 36 mm of mercury, which appealed to us. For comparison, 95 percent of calves produced by bull number 7 should have PAPs ranging from 40 to 65 mm of mercury. This information reinforced our belief in the heritability of resistance to high mountain disease. It also reinforced our confidence in PAP measurements as a management tool in our program."

Clarence Martin, manager of the V Heart Ranch near Sanford also believes in the value of PAP measurements.

"Since '79, we haven't purchased a bull that wasn't PAP tested. Testing has reduced the amount of brisket disease for us and the registered breeders are real good about doing it. However, I don't think we can PAP test the bulls and eliminate all our difficulties, because I know there are a bunch of other things that contribute to the problem."

Other problems

It is important to understand that brisket disease, a term used to describe cattle showing signs of congestive right heart failure, can be induced by a variety of causes. Respiratory diseases, anemia, effects of physical exertion, and heart defects are among the conditions commonly adding to the effects of low oxygen tension. Acting independently, the effects of low atmospheric oxygen may not be adequate to cause failure, but when complicated by the addition of just one or more conditions, may increase the heart's work load beyond its ability to respond. The outcome is congestive right heart failure.

High mountain disease is a form of congestive right heart failure brought about specifically in animals reacting adversely to low atmospheric oxygen. A tolerance for low atmospheric oxygen is essential if cattle are to be productive at high altitudes. PAP measurements have proven effective in detecting the level of tolerance. Understanding the complex nature of congestive right heart failure, ranchers in the high country can reduce its prevalence by applying appropriate management practices. AJ

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