



Anaesthetic Monitoring in Small Animal Practice.

Primary aim: To continually satisfy the attendant staff that the anaesthetised animal is maintained within all normal homeostatic mechanisms.

Because of the state of anaesthesia some of the homeostatic mechanisms have been lost and the responsibility of maintaining the patients body within the normal boundaries lies with us.

E.g. In a conscious animal if blood oxygen saturation levels fall there will be an increase in respiratory rate and depth as well as an increase in heart rate to improve lung perfusion. In the anaesthetised patient there is no such response to falling blood oxygen levels and so we must ensure that the respiratory rate and exchange mechanism is such that O₂ levels do not fall.

When people talk about anaesthetic monitoring they are invariably talking about anaesthetic monitoring equipment. There is no doubt that such equipment can be very helpful but only if the basics of manual observation and interpretation are firmly understood. As an addition to this foundation of knowledge, monitoring equipment comes into its own and can save time money and most importantly lives. Without the basic monitoring skills then such equipment is at best a waste of money and at worst life-threatening. However in addition to this it must be noted that there is little point in careful monitoring if the person monitoring the anaesthetic does not know how to respond to any crises that arise.

The purpose of this talk: Is to give you information on what to look for and how to respond when monitoring an anaesthetic.

The other main point I would like to get across is that absolute values have little place in the real world. It is fine to look up a textbook that shows the respiratory rate of a rabbit is 40. But this refers to it at rest. Your rabbit is going to be stressed under anaesthetic and on the receiving end of noxious stimuli. Expect it to be 60 or more. But what is more important than absolute values is the trend. In all the examples I give I will rarely give absolute values since it is the trend that is important. E.g. two anaesthetised cats for spaying. One could have a post-induction heart rate of 190 the other, 110. Neither is cause for concern as long as the rate settles. In fact the rate of 110 rising to 170 would worry me more than the rate of 190 staying there or only falling to 180.

Example:

ECG monitor used to monitor a bitch. Due to a poor lead connection mains interference starts to affect the reading and increases the apparent heart rate which is then displayed on the screen. Seeing this as an increase in heart rate the attendant nurse increases the concentration of volatile agent to deepen



the anaesthetic with no response. If this continues an anaesthetic death is the inevitable result. What the nurse should have done is:

- 1) Check the ecg connections or the ecg display
- 2) Checked the heart rate by stethoscope/pulse or direct palpation and identified that there was no actual change in patient status.

i.e. the nurse must verify and validate the apparent problem. And that cannot be done unless they are familiar with basic monitoring techniques.

Quick review of what can be monitored

1) What can you monitor?

- | | |
|------------------------------|--|
| a) Heart rate: | I) By Femoral or lingual pulse
II) By auscultation / direct palpation
III) By ECG
IV) By Pulse-Oximetry
V) By blood Pressure cuff/ |
| b) Respiratory rate: | I) By Chest Movement
II) By rebreathing bag
III) By respiratory monitor |
| c) Body temperature: | I) Serial rectal readings
II) Temperature monitor |
| d) Oxygen Saturation: | I) Mucous membrane/tongue colour
II) Colour of spilt blood
III) Pulse Oximeter
IV) Gas analysis |
| e) Cardiac output: | I) Capillary refill time - beware
II) Doppler flow |
| f) Blood pressure | I) Indwelling arterial line
II) Oscillometric technique
III) Doppler combined with pressure cuff. |
| g) End tidal CO2 | I) Capnograph |
| g) Conscious reflexes | I) Palpebral reflex
II) Foot withdrawal reflex |



Note: The above can be monitored by an observant nurse without the aid of any equipment with the exception of blood pressure and end tidal CO₂. Also note that for most of them you are looking for a positive result with the exception of the conscious reflexes which will only be apparent when consciousness returns.

2) Failures in monitoring techniques

Monitoring methods fail because the information they give is misinterpreted. Very rarely is the information actually false. Therefore the biggest hurdle to overcome is that of misinterpretation.

Manual observation. If you look back at the previous slides you will see that there is very little room for error when the observations are manual.

The exceptions are:

a) Capillary refill time: A poor capillary refill time does not necessarily mean a poor CO. It is more likely to be due to peripheral vasodilation and or shock.

b) Obtaining the heart rate of an obese dog or cat can be difficult by palpation.

c) Conscious reflexes: These must be interpreted with caution in diseased and shocked animals. E.g. a very shocked bitch with a pyometra may not respond to normal stimulation.

Therefore when a problem is encountered these basically foolproof observations need to be made to confirm a problem.

Monitoring equipment

As mentioned before the equipment rarely ever fails and what information it presents to you is therefore correct. However the information that the equipment is working on may be completely wrong. In the example earlier with the bitch spay the ecg monitor had not failed but the information it displayed was wrong. The ecg machine is designed to pick up the tiny ecg signals on the skin of the patient. If an electrode is not connected to the skin it can pick up the tiny radiated electrical signals from mains equipment and misinterpret them as ecg signals.

There is no point in monitoring of any kind if you can't deal with the crisis that the results of this monitoring indicate.

Therefore I propose to set out some guidelines for dealing with real monitoring emergencies.



1) Variations in heart rate

A steadily increasing heart rate: A fast heart rate is not necessarily a cause for concern but a heart rate that was 100 and is now 160 and rising is of concern. If the rate as reported is from a monitor then **VERIFY IT** and then **LOOK FOR A CAUSE**.

How do you verify it? Pulse, stethoscope, palpation.

Possible causes: Pain, lightening anaesthetic, falling cardiac output – shock haemorrhage, adrenaline (local anaesthetics)

Having identified a cause then the response is indicated:

Pain or lightening of the anaesthetic- deepen the anaesthetic. The surgeon would probably be aware of the change in anaesthetic plane and confirm your findings. Using a pre-operative painkiller in these circumstances can reduce the need for such a deep anaesthetic.

Falling cardiac output: Look for and identify a possible source of haemorrhage. The situation is often enough to rule this out e.g. a dental or x-ray. Check the CRT. It may still be OK because the heart is compensating. If there is no haemorrhage it may be shock. Is the animal cold? If so warm it up. If you can measure it, is the blood pressure OK? – feel the pulse. Has it changed? If the pulse is weak and the animal is cold then get it on a warm drip and run the fluid in quickly. Get it on a heat pad.

Adrenaline: Many local anaesthetics contain adrenaline. If these are in use and there is no other obvious cause for the increase in heart rate then this may be the culprit.

A falling heart rate: Again a change from the norm is what is important. If this is reported by a monitor then **VERIFY IT** and **LOOK FOR A CAUSE**

Possible causes: Cardiac depression – too deep. Vagal stimulation. Heart arrhythmia. Listen to the heart and palpate the pulse at the same time.

Actions: Lighten anaesthetic. Atropine. Antiarrhythmics

2) Variations in respiratory rate

A rising respiratory rate: If this is reported by a monitor then **VERIFY IT** and **LOOK FOR A CAUSE**

How do you verify it? Observation of chest or breathing bag or by stethoscope.



Possible causes: Pain. Blocked anaesthetic circuit/et tube. Out of oxygen/oxygen turned off.

Actions: Ensure airway is patent. Deepen the anaesthetic.

A falling respiratory rate: If this is reported by a monitor then **VERIFY IT** and **LOOK FOR A CAUSE**

Possible causes: Deep anaesthetic.

Action: Lighten anaesthetic. IPPV.

3) Changes in oxygen saturation

Current thinking suggests that there is no problem with 100% oxygen saturation so the only alarm condition we are concerned with is a falling oxygen saturation.

You can still make some attempt to verify the reading. Reposition the probe. Look at spilt blood. If the spilt blood is a rich red and the monitor has a reading of 75% then I would doubt the reading. (Carbon Monoxide poisoning excepted).

Possible causes: Obstructed airway/anaesthetic circuit. Falling heart and or respiratory rate.

Actions: Check the airways and anaesthetic circuit. Check the breathing- rate and depth and act as above. Check the heart rate and act as above.

Remember that most of our intubated patients are run on 100 - 66% oxygen compared with 21 % in air so that by the time there is a fall in oxygen saturation levels marked physiological changes must have occurred and there are likely to be other indicators in addition to the low saturation level.

4) Changes in blood pressure

Blood pressure is influenced by two main factors: heart rate and apparent circulating blood volume. Therefore changes in blood pressure must derive from one or both of these factors.

A rise in blood pressure

This can only really be reported by a piece of equipment since we are incapable of assessing mean blood pressure. Our digits can only appreciate the pulse height or the difference between systolic and diastolic pressure. Therefore a blood pressure of 160/ 110 may well feel the same as a blood pressure of 130/80. However mean blood pressure can be semi-evaluated by



looking at the nature of bleeding from cut vessels. High blood pressure would produce increased bleeding and low blood pressure reduced bleeding. Does this fit with the blood pressure reading. Also is this a trend or a one-off? Take another reading and compare it with the last.

Possible causes: Tachycardia. Drip rates too high.

Actions: Identify and rectify the cause of the tachycardia. Slow the drip down

A fall in blood pressure

Much more likely than a rise in blood pressure.

Does this fit with the clinical picture? Look for signs of shock or haemorrhage - Pale mucous

Possible causes: Loss of circulating blood volume. Haemorrhage, shock. Reduced venous return due to surgery/surgeon. Bradycardia.

Actions: Arrest haemorrhage. Increase circulating blood volume - drip. Make sure surgeon is not pressing on vena-cava return. Attend to the possible causes of bradycardia.

Note that the ability to monitor blood pressure is very useful in the older patient especially those with CRF. Even if they have elevated blood pressures whilst conscious most will become hypotensive under anaesthesia. Dripping these patients during surgery can maintain kidney function and urine output. Drip rate can be titrated against the blood pressure readings. It can be surprising how much fluid you need to give even a cat to maintain blood pressures.

5) Changes in end-tidal CO₂

Not many practices will have end-tidal CO₂ but since it represents one of the few parameters that we cannot measure ourselves it is a valuable addition to anaesthetic monitoring. In normal patients end-tidal CO₂ is finely controlled and lies somewhere between 3 and 5%. Values above or below this may represent a problem but are likely to be related to previously discussed factors, notably increased or reduced respiratory rates. Other causes of changes in CO₂ elimination are outside the scope of this talk.

Note that in all of these alarm conditions the alarm has been raised not by an absolute value or rate but by a change in the trend of a parameter.



Monitoring in exotics is broadly similar to monitoring in cats and dogs. The basic observations are the same. However there are individual characteristics worth noting.

Rabbits:

OXYGEN: Whenever you think about anaesthetising rabbits use oxygen, even if it's only e.g. rompun/ketamine. Most rabbits have some degree of lung compromise either due to upper airway disease or bronchial disease or subclinical pasteurella pneumonia. Therefore for this reason monitoring of respiration is paramount in rabbits. Sternal recumbency is best if at all possible. If not then elevate the chest. If they are intubated (best) or you have a tight fitting mask then use an inline respiratory monitor. If not then use an oesophageal stethoscope or normal stethoscope. Respiration rates will vary with size and breed but as a rule of thumb expect an increase of 30% following induction. Look at the depth of respiration. Rapid short breaths mean poor gas exchange and are often associated with pain. Deal with the pain to improve respiration – pre-op painkillers.

Heart rates: A rabbit induced by mask with no pre-med. can be expected to have a heart rate somewhere between 200 and 300. This should fall to nearer 200 or below once the rabbit stabilises. Fat rabbits in dorsal recumbency may maintain this high rate due to compromises in venous return and hence cardiac output. Although heart rates are helpful nothing is as helpful as respiratory rate.

Pulse-Oximetry: If you've got it then use it. If the tongue isn't available then use: nipple, ear, skin fold and in some rabbits the footpads if non-pigmented. You may well be alarmed by the levels you get.

Without intubation dealing with problems when they arise is difficult and the most common problem is apnoea. In any event you can always: Supplement with oxygen, administer dopram (some give this as a pre-med.), alter recumbency position. If intubated you can additionally perform IPPV.

Ecg monitoring in rabbits: Rabbits often have tiny complexes and a standard lead II connection can give disappointing results with some monitors. Instead of a lead II connection use lead I. This often gives a better monitoring signal. You will probably need to pluck the hair to get a good connection and you may need a contact medium.

Body temperature: As with all the furies/exotics body temperature is v important. Monitor the anal temperature during the anaesthetic. Use heat pads, bubble wrap, blankets to maintain body temperature. Post-op recovery is markedly prolonged by hypothermia.



Guinea pigs, rats and hamsters:

Much of what has been said about rabbits applies to these. In all these dorsal recumbency causes marked problems. Elevate the chest if at all concerned. Rats have similar sub-clinical respiratory problems to rabbits. Painkillers help enormously to reduce the amount of gaseous anaesthetic needed. For procedures like lump removals and castrations use local anaesthetic (without adrenaline) to reduce the depth of anaesthesia required. These animals are not going to be intubated most of the time so it is even more important to prevent a respiratory problem developing. Keep an eye on the depth and rate of respiration by whatever means. Have dopram handy if you need it. Always use supplemental oxygen. Again the heart rate may be an indicator of impending problems. A falling heart rate is much more worrying than a rising one.

Pulse-Oximetry: This may cause you more problems than it solves. It can be very difficult to get a good reading in these species. A non-pigmented foot works well. However due to the tiny signals obtained monitor alerts are frequent and too much time can be spent adjusting the monitor where it would be better to concentrate on the animal.

Iguanas:

I have little experience with snakes or tortoises under anaesthetics so I can only really report on iguanas. These are not easy to monitor under anaesthesia and indeed anaesthesia itself is not straightforward. If at all possible intubate and be prepared to use IPPV. Because of this respiratory rate is of little help. Heart rate is helpful. Use an oesophageal stethoscope or an ecg using transcutaneous needles. Look for trends particularly a falling heart rate.

Note the following:

- 1) Always provide an external source of heat.
- 2) Remember that inspiration is a passive event in reptiles so do not wedge between sandbags as this can severely compromise lung function.
- 3) Apnoea is common. When monitoring by pulse-oximetry following induction with rapinivet SaO₂ can fall to below 50%!
- 4) Isoflurane is much safer than halothane in these species.

Local anaesthetics can help reduce the amount of gaseous anaesthetic required.



Birds:

Birds show a huge diversity of type from canaries to swans so it is difficult to generalise. However some standard principles for monitoring still apply. Watch the respiration. Look for depth and frequency variations. In these species it is often more helpful to combine heart rate observations with respiratory rate observations. A stethoscope is virtually useless for monitoring birds as the rate is so fast. A rate of 400 is not uncommon. The only way to follow trends in these birds is to use a heart rate monitor. Using a lead II connection does not give a good reading. Instead use a lead I connection - across the heart. Most ecg counting monitors will be confused by the strange complexes obtained with a lead II connection. Look for trends. Combine what you find with what you see. E.g. HR 400, respiratory rate 40 and no response to painful stimuli -OK. If this then becomes HR 450, respiratory rate 60 and still no response to stimuli then there is probably some cardiovascular or respiratory embarrassment. A pulse oximeter in these situations can be very helpful if the bird is large enough to support it.

If necessary, intubation is simple and IPPV can be used to improve the SaO₂. Remember the air sacs will become filled with gas and can take some time to empty giving unpredictable results when altering gaseous anaesthetic concentrations. If possible make any changes slowly. Maintain supplemental oxygen until consciousness returns and be prepared for birds going to sleep again as air sac gas gets re-circulated.

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