Review On Fluid Therapy For The Treatment Of Dehydration In Large Animals

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Summary: Fluid therapy is important for many medical conditions in veterinary patients and is indicated for the treatment of diseases that determine dehydration and electrolyte and acid base imbalances. The method provides vital support to sick animals and for many the simple act of rehydration with a high sodium fluid like lactated Ringer's solution vastly improves their potential for recovery. This review highlights the importance of fluid therapy in dehydrated animals and also points out basic considerations that need to be implemented during fluid administration with focus on route, type and amount of fluid administered to individual animal. Almost two-third of the total body water is intracellular fluid (ICF, water located in cells) and the remaining one-third is extracellular fluid (ECF, water that is outside of the cells). Maintaining body water and electrolyte concentration in cattle is a delicate balancing act involving many different organ systems with disruption of these homeostatic mechanisms potentially leading to the rapid development of life threatening imbalances. Fluid therapy corrects the present imbalances, the restoration of blood volume and adequate tissue perfusion and also used for the treatment of shock, different metabolic diseases and toxicities in animals. Fluids include crystalloids, synthetic colloids and biological fluids. Fluid therapy can also play a supportive role during anaesthetic and surgical procedures. The two major routes of fluid administration for systemic effect are Oral (enteral) and parenteral (systemic). Clinical status including improvement of hydration status, normalization of hypotension and improved perfusion parameters should be monitored frequently in patients receiving fluid therapy because administration rates may need to be adjusted.
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1. Introduction

Fluid therapy is commonly used in large animal practice and depending on the disease and its severity; fluids administered either enteral or parenteral may be warranted. Fluids include crystalloids, synthetic colloids and biological fluids (example: red blood cells, plasma and concentrated albumin transfusions) (Quesenberry *et al.,* 2003). The fluid therapy is indicated for the treatment of diseases that determine dehydration and electrolyte and acid base imbalances and therefore it is commonly used in ruminants' medicine, especially in calves. The goals of the replacement of fluids and electrolytes are the correction of present imbalances, the restoration of blood volume and adequate tissue perfusion and the treatment of shock, different metabolic diseases and toxicities in animals (Benson *et al*., 2000).

Fluid therapy can also play a supportive role during anaesthetic and surgical procedures. It is important to remember however, that fluid therapy is supportive and the underlying disease process that necessitated fluid therapy needs to be diagnosed and treated (Merry *et al*., 2010). There are a number of things that need to be considered when formulating a plan for fluid therapy in a patient for instance therapy should be planned and executed over 1-24 hours, to be determined by patient needs and your available resources. At the end of this planned period the physical and laboratory findings are reassessed and the next treatment period is planned (Lichtenberger, 2004).

Fluid therapy provides support to sick animals and for many simple act of rehydration with high sodium fluid like lactated Ringer's solution vastly improves their potential for recovery. In some situations however, a careless approach to fluid therapy stands to do more harm than benefits (Hartling *et al*., 2006).

Maintaining body water and electrolyte concentration in cattle is a delicate balancing act involving many different organ systems with disruption of these homeostatic mechanisms potentially leading to the rapid development of life threatening imbalances. The importance of fluid therapy in the treatment of dehydrated bovine patients has long been recognized with few radical breakthroughs in recent years. Therefore, this article

will review the principles of fluid therapy and its use in dehydrated large animals (Renney, 2010).

Fluid administration occurs via enteral and parenteral routes i.e. Fluid administration in all species is by enteral and parenteral routes and the aims of fluid therapy are rehydration, replacement of ongoing losses and maintenance (Martin *et al.,* 2005). In cattle oral and intravenous therapies predominate (intraosseous administration of fluid to calves has been demonstrated as an alternative; IP administration yields adhesions in cattle). In adult cattle use of a functioning intestinal tract is an important consideration for successful outcomes with economic constraints (Merry *et al*., 2010).

Emergency intravenous fluid therapy is often indicated but it is complicated by difficult venous access, physiologic diversity among many species of small mammals and a lack of research data regarding their response to therapy. In some cases the clinician must weigh the advantage of delivering fluids intravenously against the risk of life threatening stress that may result from emergency therapy (example: catheter placement). Some of the same monitoring protocols used to measure response to fluid therapy in traditional pets, such as arterial blood pressure measurement can be applied to small exotic mammals with some modifications (Castellani *et al*., 2010).

Fluid therapy forms a vital component of veterinary medicine being used either as a sole therapy or more commonly in combination with other therapies/treatments. The role of a properly managed fluid therapy plan is increasingly being recognized as a major contributing factor to the successful outcome in the treatment of many medical conditions especially for dehydration (Smarick *et al*., 2007).

Therefore the objectives of this paper are:

- To review the importance of rehydration in dehydrated animals.
- To understand the basic considerations of fluid administration.

2. Fluid Therapry

2.1. Indications of Fluid Therapy in Adult Ruminants

Obviously the most common indication for fluid therapy in adult ruminants is to correct dehydration that can occur as a sequella to any number of primary conditions. However, accurately predicting the degree of dehydration in adult ruminants is often difficult. A well designed study has been published demonstrating the eyeball recession and skin tent duration are the most accurate indicators of dehydration in neonatal calves and provides validation for estimating the percent dehydration based on extent of eyeball recession or duration of skin tent (Grove, 2007).

2.2. Patient Assessment

Careful assessment is needed to assess whether fluid therapy is required and if so, which treatment is optimal. While measuring packed cell volume (PCV), total carbon dioxide (CO_2), total plasma proteins and glucose levels allow a more accurate patient assessment in reality this can be impractical in the field situation therefore, estimations and rules of thumb are used. When assessing the level of dehydration, the degree of eyeball recession and skin tent duration provide good estimations. Severe dehydration is usually accompanied by other signs including cold extremities, weak pulse, dry mucous membranes and moderate to severe depression (Cheuvront *et al*., 2010).

Assessment of acid base status can prove more difficult in the field since the clinical signs are vagues and non specific for example: weakness, depression and ataxia. While metabolic acidosis's a consistent feature of neonatal diarrhoea and its severity depends on the causative agent, age of the calf and duration of the illness. There is no relationship between severity of dehydration and acidosis. Calves more than a week old are more likely to be severely acidosis than those less than seven days and as a general rule of thumb severely diarrhoeic calves under seven days of age can be assumed to have a base deficit or 10meq/L to 15meq/L and those older than seven days, 15meq/L to 20meq/L. However, there are variations between breed, with suckler calves appearing to be more susceptible to a severe acidosis than dairy calves and this should be taken into consideration (Castellani *et al*., 2010).

2.3. Purposes of Fluid Administration during the Perianesthetic Period

The importance of fluid therapy during the surgical and maintenance period in animals is: to replace insensible fluid losses (evaporation and diffusion), sensible fluid losses (blood loss and sweating) and also to maintain an adequate and effective blood volume, cardiac output, tissue perfusion and patency of an intravenous route of drug administration (Cheuvront *et al*., 2010).

2.4. Body Fluid Composition, Location and Percents in Animals

On average 60% of the body weight is due to water in the normal healthy animal. However, age, sex and nutritional status may cause this to vary. In young animals water content may be as much as 70 - 80%, while older animals may have water content that is 50 - 55% of their body weight. Almost 2/3 of the total body water is intracellular fluid (ICF, water located in cells) and the remaining 1/3 is extracellular fluid (ECF, water that is outside of the cells). Extracellular fluids can be further divided into intravascular or plasma water (water in the vascular space) (1/4 of the

ECF volume) and interstitial fluid (fluid that is present in the spaces between cells) (3/4 of the ECF volume). Transcellular fluid is found in very small amounts and is also considered an ECF fluid. Examples of transcellular fluids include cerebral spinal fluid, synovial fluid, plural fluid, peritoneal fluid, aqueous humor and gastrointestinal secretions (Fletcher *et al*., 2012).

The concentration of solutes in the ECF and ICF fluid compartments are strikingly different. ECF contains large quantities of sodium, calcium, chloride and bicarbonate with small amounts of potassium, phosphate, magnesium and protein. In ICF the distribution is reversed. The principles of electrolytes in ICF are potassium, phosphate and magnesium (Fletcher *et al*., 2012).

2.4.1. Normal body water distribution

The following points are the normal water distribution in the body such as: total body water: 60% of body weight, intracellular water: 40% of body weight, extracellular water (plasma water + interstitial water): 20% of body weight, interstitial water: 15 % of body weight, plasma water: 5 % of body weight, blood volume: 9 % of body weight (blood volume = plasma water + red blood cell volume) and inter compartmental distribution of water is maintained by hydrostatic, oncotic and osmotic forces. Daily water requirement is 1-3 ml/kg/hr (24-72 ml/kg/day), 50 ml x body weight (kg) provides rough estimate for daily requirement and requirements vary with age, environment and disease etc.

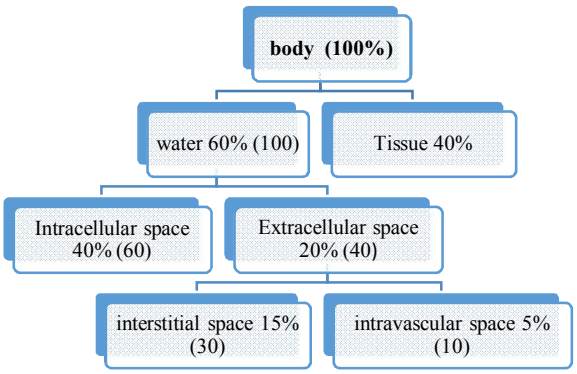

Figure* 1. Normal body water distribution *(source: Fletcher *et al*., 2012)

2.5. Changes in Fluid and Electrolyte Balance in Response to Disease Processes

It includes the following important points such as: may vary widely with species, hypovolemia is common, electrolyte changes are variable and the goal is to correct fluid and electrolyte imbalances before anesthesia. If possible changes in fluid and electrolyte balance in response to anesthesia many anesthetic agents produce vasodilation and hypotension relative hypovolemia results in alterations in sympathetic nervous system activity and the endocrine system, redistribution of blood flow with changes in vascular resistance, reduction in urinary flow rate, renal blood flow and glomerular filtration rate seen with withholding water (fasting), anesthetic drug effects and increased add levels and these effects can be eliminated or reduced by "filling the tank" with crystalloids (Mcgarvey *et al*., 2010).

2.6. Types of Fluids and Additives

Fluid therapy in the patient with vomiting and diarrhea can be complex. Animals may be presented with mild dehydration or may be profoundly hypovolemic. Patients may have a normal electrolyte and acid base status or have life threatening abnormalities. Each animal must therefore, be considered individually with careful attention paid to physical examination in addition to electrolyte and acid base status (Mcgarvey *et al*., 2010).

The composition of a balanced fluid (e.g., lactated Ringer's solution) resembles that of extracellular fluid (ECF) where as that of an unbalanced solution (e.g., normal saline) does not resembles ECF. Fluid preparations may be further classified as crystalloids and colloids. Crystalloids (e.g., 5% dextrose, 0.9% saline and lactated Ringer's solution) are solutions containing electrolyte and non electrolyte solutes capable of entering all body fluid compartments (Sawka *et al*., 2007). Crystalloid solutions expand the plasma compartment with equal effectiveness but, 2.5 to 3.0 times as much crystalloid solution must be given (compared with a colloid solution) because the crystalloid is distributed to other sites (e.g., interstitial compartment and intracellular compartment) (Cunha *et al*., 2010).

2.6.1. Crystalloids

Crystalloid solutions also can be classified as replacement or maintenance solutions. The composition of replacement solutions resembles that of ECF whereas maintenance solutions contain less sodium (40-60 mEq/L) and more potassium (15-30 mEq/L) than do replacement fluids. Most animals that require fluid therapy can be managed with a limited number of crystalloid and additive solutions. The most useful crystalloid solutions for routine use are a balanced replacement solution (e.g., lactated Ringer's solution), 0.9% saline, and 5% dextrose in water. Supplementation of crystalloid solutions with KCl may be necessary when body fluid losses have included large amounts of potassium (Dibartola and Bateman 2012).

Crystalloid solutions may be hypotonic, isotonic, or hypertonic. Animals with vomiting and diarrhea typically have isotonic or hypertonic fluid loss. Replacement isotonic fluids provide sodium and water

which correct volume and hydration deficits. Maintenance solutions contain a lower concentration of sodium and therefore it is not correct the volume and hydration deficits in animals with vomiting and diarrhea. Hypertonic saline (7.2% sodium chloride (NaCl)) draws fluid from the interstitium into the intravascular space and therefore should not be used in dehydrated patients. Hypertonic saline has limited use in animals with vomiting and diarrhea. Different crystalloid solutions have different concentrations of electrolytes and different buffers (Ong *et al*., 2011).

2.6.2. Colloids

Colloids are large molecular weight substances that normally are restricted to the plasma compartment and include plasma, dextrans and hydroxyethyl starch (hetastarch). Oncotic support can be achieved using natural or synthetic colloids. Synthetic colloids include gelatins, starches, and dextrans. Natural colloids include whole blood, fresh frozen plasma (FFP) and human albumin (HA) solutions (Cunha *et al*., 2010).

2.6.3. Blood products

Blood products including packed red blood cells (PRBCs) and FFP are rarely used in the treatment of vomiting and diarrhea.

2.7. Useful Formulas in Fluid Therapy

The purpose of fluid therapy is to increase tissue perfusion, repair fluid deficits, supply daily fluid needs and replace ongoing losses. The initial assessment of hydration determines the volume of fluid needed to correct the hydration deficit (replacement requirement). The hydration deficit is calculated as the percentage dehydration (estimated by physical examination) times the patient's body weight in kilograms. The resultant value is the fluid deficit in liters. During the rehydration phase of therapy, this volume is administered over 24 hours in conjunction with maintenance fluid requirements and replacement of ongoing or contemporary losses. (Merry *et al*., 2010).

Correction of dehydration (% dehydration (estimate) x Body weight (kg)), Maintenance (Adults: 60 ml/kg/day and Neonates: 70 ml/kg/day), Total amount of fluid to give (maintenance + replacement (% dehydration) + ongoing losses), Total bicarbonate deficit ((Base deficit x 0.3 x body weight (kg) = deficit in meq/l. To obtain deficit in grams, divide meq/12.), Commercial solutions are hypertonic: 5% and 8.4% NaHCO3. Isotonic bicarbonate is 1.3%)), To make isotonic bicarbonate (Add 13 gm NaHCO3 and 260 ml of 5% or 154 ml of 8.4% to each liter of sterile water.), Correction of metabolic acidosis (If blood pH <7.2 and Give of calculated deficit in 30 minutes and then rest over 12 hours) and Correction of potassium deficit: Body weight (kg) x 0.4 x deficit Potassium is an intracellular ion. Calculation of deficit based on serum concentration provides only an estimate for fluid supplementation. Maximum rate of administration: ≤0.5 meq/L), Hypertonic saline (4 ml/kg given during 5-10 minute period), Calculation of osmotic pressure (2[Na] (meq/L) + glucose/18 (mg/dl) + BUN/2.8 (mg/dl) = plasma osmotic pressure), Anion gap ($(Na^{+}+K^{+})$ and $(Cl^{-}+HCO3^{-})$=anion gap) and Calculating infusion rate ((Drops per minute = (total infusion volume (ml) x drops/ml) / infusion time (min)) (Yannopoulos *et al*., 2007).

2.8. Fluid Bags and Bottles

Figure 2. Fluid bags for Dehydratinganimals

Figure 3. Fluid infusion pumps (Source**:** Merry *et al*., 2010)

Small animals are much more prone to higher infusion than large animals due to their small size. The rate of fluid administration can be controlled simply by counting and adjusting the drip rate manually. However this method is prone to variation in flow rate

due to occlusion of the catheter, often as a result of the patient's limb position. A calf giving set provides 60 drops per ml (rather than the 20 drops per ml of a normal giving set). This allows for more accurate attainment of lower fluid rates. A calf burette includes a chamber from which the fluid is administered to the patient. This provides a very cheap method of physically limiting the volume of fluid that can be infused thus reducing the risk of accidental over infusion (Spandorfer *et al*., 2005).

3. Describing Level Of Dehydration Based On Physical Findings

Fluid loss from animals with vomiting and diarrhea can be severe, because large volumes of fluid are secreted and reabsorbed by the gastrointestinal tract. Approximately 2.5 L of fluid enters the duodenal lumen of a 20kg animal each day from diet and normal secretions and more than 98% of this fluid is reabsorbed. Fluid loss from gastrointestinal disorder thus can be extensive and together with decreased intake leads to progressive dehydration. Severe complications such as: hypovolemia may result. Clinical signs of dehydration can be subtle and the ability to detect dehydration based on physical examination depends on the age and nutritional status of the animal, acuteness of onset of the vomiting or diarrhea and any prior treatment. Table 1 provides guidelines for clinical assessment of dehydration (Ong *et al*., 2011).

Typical clinical signs result from a loss of interstitial fluid leading to a loss of tissue pliability and lubrication. Dehydration often can be detected first on examination of the mucous membranes. Assessment may be confounded by nausea induced hyper salivation. However, physical examination findings may include depression, dry or tacky mucous membranes and a prolonged skin tent. Clinicians must consider body condition score and age when assessing skin tent; subcutaneous fat provides greater lubrication than lean tissue (Plunkett and McMichael, 2008).

Table 1. Clinical assessment of estimated dehydration in animals

Clinical signs	Estimate of dehydration
Dry mucous membranes	5%
Reduced skin turgor	6%–8%
Mild hypo perfusion (tachycardia)	8%–10%
Moderate hypo perfusion (hypotension)	10%–12%
Severe hypo perfusion (collapse)	>12%

(Source**:** Ong *et al*., 2011)

Consequently, the top of the head and axillary region rather than the more commonly evaluated dorsal cervical region may provide more information about hydration status. When the eye of a normal animal is retropulsed, the nictitans should immediately slip back into place after release of the eye in healthy animals however, with the dehydrated animal the nictitans ''sticks'' to the globes and slides back more slowly. Clinical assessment of estimated dehydration in animals is expressed in Table 1. The most objective assessment of hydration status is body weight. Evaluation of this variable is most valuable when normal body weight can be documented on the same scale before the onset of fluid loss (Merry *et al*., 2010).

3.1. Diagnosing Dehydration

Body fluid balance is controlled by both physiological and behavioral actions. However, when there is lack of fluid availability, exposure to extreme environments or illness, inability to maintain fluid balance can seriously jeopardize health and the ability to perform. The terms euhydration, hypohydration and hyperhydration will be used. Euhydration defines a "normal," narrow fluctuation in body water content whereas the terms hypohydration and hyperhydration define respectively, a general deficit (hypohydration) and surfeit (hyperhydration) in body water content beyond normal. The term dehydration specifically defines the condition of hypertonic hypovolemia brought about by the net loss of hypotonic body fluids. Isotonic or hypotonic hypovolemia, manifest by large losses of solute and water is defined simply as hypovolemia (Mcgarvey *et al*., 2010).

3.2. Hydration Status in Animals

Animal hydration assessment is a key component for prevention and proper treatment of fluid and electrolyte imbalances. When fluids are limited, illness strikes or there is exposure to extreme environments, cumulative fluid deficits can threaten homeostasis, health and performance. Health is also threatened by fluid deficits which can increase the risk of serious heat illness and by fluid surfeits which increase the risk of hyponatremia (Mazzaferro *et al*., 2002).

Definitive hydration assessment requires monitoring of changes in hydration state. Although change can provide good diagnostic accuracy, it requires a valid baseline, control over confounding variables and serial measures. Large population heterogeneity explains in part why there are presently few hydration status markers that display potential for high nosological sensitivity from a more practical, single measure. Although Table 2 provides euhydration cut-off or thresholds for the most useful of hydration assessment measures, they too require considerable methodological control, expense and analytical expertise to be of practical use for day to

day hydration monitoring of athletic sojourners (Matthews and Barry, 2005).

Presently, there is no scientific consensus for how to best assess hydration status in a field setting. However, in most field settings the additive use of first morning body mass measurements in combination with some measure of first morning urine concentration and gross thirst perception provides a simple and inexpensive way to dichotomize euhydration from gross dehydration resulting from sweat loss and poor fluid intakes (Link *et al*., 2010).

Table 2. Biomarkers of hydration status

Measure	Practicality	Validity (Acute vs. Chronic Changes)	Euhydration Cut-Off
TBW	**Low**	**Acute and chronic**	**<2%**
Plasma			
Osmolarity	**Medium**	**Acute and chronic**	**<290 Osmolarity**
Urine			
Specific			
gravity	**High**	**Chronic**	**<1.020 g/mL**
Urine			
Osmolarity	**High**	**Chronic**	**<700 mOsmol**
Urine color	**High**	**Acute and chronic**	**<4**
***Body**			
Weight	**High**	**Acute and chronic**	**<1% change**

(Source: Link *et al*., 2010)

3.3. Dehydration and Pediatrics

Worldwide, diarrhea is the second most common cause of childhood mortality. Severe dehydration is a leading cause of death in children with acute diarrhea. WHO recommends Ringer's lactate (RL) and Normal saline (NS) for rapid intravenous rehydration in childhood diarrhea which is safe, well tolerated and is widely recommended (Santi *et al*., 2015).

Resuscitation with NS is associated with metabolic acidosis and hyperchloremia. When children with acute diarrhea and severe dehydration were treated with NS infusion, pH decreased despite clinical improvement in dehydration, as compared to a Polyelectrolyte solution. Worsening of acidosis

may have profound clinical implications as pH <7.20 may be associated with multi organ dysfunction. RL may independently improve pH in such cases, as lactate gets converted to bicarbonate *in vivo* (Hahn, 2012).

3.3.1. Intervention

Children with acute diarrhea and severe dehydration received either RL (RL-group) or NS (NS-group), 100 mL/kg over three or six hours. Children are reassessed after three or six hours. Rapid rehydration is repeated if severe dehydration persisted. Blood gas is done at baseline and repeated after signs of severe dehydration disappeared.

4. Routes Of Fluid Administrations

The routes of fluid administration for systemic effect may be divided into two major groups: Oral (enteral) and parenteral (systemic). When the gastrointestinal tract is by passed by injection or introduction into the lungs (inhalation). When the drug is effect is desired locally it is administered topically, that is on the skin (Jay and Webb, 2009).

4.1. Oral or Enteral Administration of Fluid

Oral ingestion is the most ancient method of fluid/drug administration, another organ where the substance or drug to be administered is placed is the rectum. The drug could be placed in the mouth under the tongue that is (subliquel). The drug could be administered directly into the stomach using intragastric tube (Hughes and Boag, 2006).

The oral route is the most physiologic. Fluids can be administered rapidly with minimal side effects. This route should not be used in the presence of vomiting. This route is also inadequate for animals that have had acute or extensive fluid losses. Fluid absorption is not sufficiently rapid via the oral route in those cases where the fluid loss has been extensive and blood flow inadequate. And this route includes some Advantages like: Safe, Sterility is no required and danger of acute drug reaction is minimal and some Disadvantages like: Ingestion of drug could cause gastric irritation, Nausea, Vomiting (in animals like dog, pig), Complexes formed with ingesta could prevent the drug absorption and the drug could be destroyed by low gastric pH or by the digestive and liver enzymes before entry into the circulation (Hall and German, 2005).

4.2. Parenteral Administration

Parenterally "par" means beyond "enteral" means intestinal. This is the route of administration of drug without crossing the intestinal mucosa. This is possible when the drug is directly into the blood or tissue fluid using needle and syringe. It is important to note that the man that leads to the introduction of the hypodermic needle and syringe is Alexander wood. The most important and most frequently used parenteral routes are I.V. (intravenous route), IM (intramuscular) route and SC (subcutaneous) route respectively. Other less frequent routes are: Tissue infiltration, Intra articular, Intradermal, Epidural, and Subaraclinord, Intra-arterial, Intrathecal, Intrathoracic, Intracardiac, Intramedullary, Intratesticular, Intralesional, Subconjuctival and Intramammary etc (Gonzalez *et al*., 2009).

4.2.1. Intravenous route (IV):

The drug is injected slowly; sometimes it could be infused rapidly as bodies. This method provides accurate and reliable dosage of drug directly into the circulation. It means that the bioavailability of drug is 100% when administered intravenously. This is the route of choice when vascular volume restoration is desired. This route is superior to all others with perhaps the exception of intraosseous. Fluid absorption is rapid. In addition to isotonic solutions, hyper and hypotonic solutions may be administered via this route. The rate and volume administered will vary from patient to patient based upon the desired endpoint. This route contain some advantages like: this route is often used in drug administration in life threatening situations, the drug would have rapid onset of action and irritating and non isotonic solutions can be administered intravenously, since the intima of the vein is insensitive and some disadvantages like: the drugs administered by this method have short duration of action, thrombophlebitis of veins, necrosis of adjoining tissue and severe adverse effect especially when organs such as liver, heart, brain are involved in toxicity (Fletcher *et al*., 2012).

4.2.2. Intramuscular (IM)

The drug is injected deep in the belly of a large skeletal muscle. The muscles that are usually used are detoid, triceps, Gluteus, Maximus, rectus and femurs depending on the species of animals. The muscle is less richly supplied with sensory nerves; hence injecting a drug IM is less painful (Dibartola, 2006).

The advantages of IM includes: It is convenient route in administering drugs in animals that are difficult to restrain. It is used in administering aqueous or oleaginous suspensions or solutions. Muscles are highly vasculorized thus, the drug could be absorbed haematologenously or through the lymphatic fluid. And the disadvantages of this route is: Intermuscular injection into fascia might lead to erratic absorption of the drug so, there is a possibility of improper deposition of drug preparation in nerves, fats and blood vessels or between muscle bundles in connective sheaths (Ely *et al*., 2010).

4.2.3. Subcutaneous (SC)

The drug is deposited in the loose subcutaneous tissue that is richly supplied with nerves but less vascular. The rate of absorption is slower than the intramuscular route. Fluids are usually administered in the subcutaneous tissues over the dorsal neck and cranial trunk. In the absences of vasoconstriction and hypovolemia the rate of absorption is approximately six to eight hours. Fluids should be administered at body temperature to decrease the discomfort to the patient and improve absorption. Only isotonic fluids should be administered by this route. Potassium supplementations approximately 40 meq/L may be added to the fluids. The rate and volume of administration will vary from patient to patient. Skin necrosis and infection are complications associated with this route of fluid administration. Some advantages of this route are: it is a good route of administration especially in skin infections and it is relatively safer than I.M. and I.V. Absorption is slower thus; it is a good route of a prolonged effect is to be achieved. And the disadvantage is if the drug is irritating it might cause the sloughing off of the skin epitheral tissue (Dibartola, 2006).

4.2.4. Intraosseous (IO)

Fluids are administered via the bone marrow. Like intravenous administration, fluid absorption is rapid. This route is indicated when it is difficult to gain venous access using standard techniques. This route is best used for the short term administration of fluids and or drugs. Fluid rates of 11 ml/min with gravity and 24 ml/min under 300 mm Hg pressure have been used to deliver the fluids (Cheuvront *et al*., 2010).

4.2.5. Intraperitoneal

Intraperitoneal administration is the administration of fluids into the peritoneal cavity. The rate of absorption from this route is roughly equivalent to the subcutaneous route. Peritonitis and intra abdominal abscess are potential complications associated with this route. Intraperitoneal administration does not offer any advantages over other routes. Therefore, it is reserved as a last resort. The pertitoneum possess a cavity that offers a large absorptive area for drugs. The perioneum is highly vascularized. This route is used in laboratory animals' administration and large animal practice for administration of large volumes of fluid. The injection is made via the sublumbarfossa and the Disadvantages is irritating compounds may produce peritonitis or adhesion (Cohn *et al*., 207).

4.2.6. Intra arterial route

Drugs and diagnostic agents are administered via this route. The diagnostic media e.g. (Contrast media in angiography) is injected directly into the artery. This is also of great use in treatment of limb malignancies and the advantages of this route is: The first pass and cleansing effects are by passed, bioavailability is 100%, it is one of great clinical value in administering anticancer drugs for example, in limb malignancies the drug is administered into the brachial artery or femoral artery and the Disadvantages are: Intra arterial injection requires great and expertise and its adverse effect there might be great danger (Castellani *et al*., 2010).

4.2.7. Intradermal

The drug is injected into the skin raising a bleb. This route is used in diagnosis of tuberculosis (tuberculin testing in cattle) and (allergen sensitivity testing) (Cheuvront *et al*., 2005).

4.2.8. Intra articular:

Intra articular injection of anti inflammatory preparation (e.g. sterioids) may be justified in some forms of lameness due to acute inflammation or trauma e.g. (swollen bursa or tendon sheath). Other routes of drug injection include intra medullary which is used for blood transfusion directly into the bone marrow. This is done inneonates when other is difficult (Casa *et al*., 2005).

5. Conclusion And Recommendations

Fluid therapy provides vital support to sick animals and for many, it is the simple act of rehydration with a high sodium fluid like lactated Ringer's solution that vastly improves their potential for recovery. Dehydration is a common outcome in many conditions in cattle. In cattle, fluid loss due to vomiting and diarrhea can be severe because large volumes of fluid are secreted and reabsorbed by the gastrointestinal tract i.e. fluid loss from gastrointestinal disorder thus can be extensive and together with decreased intake leads to progressive dehydration. Hydration assessment is a key component for prevention and proper treatment of fluid and electrolyte imbalances. However, in some situations a careless approach to fluid therapy stands to do more harm than benefits. Therefore, assessing clinical status of the animals including improvement of hydration status, normalization of hypotension and improved perfusion parameters should thoroughly be monitored in patients receiving fluid therapy as hasty fluid administration might worsen the situations of recipient animals. Based on the above conclusion the following recommendations are forwarded:

- Dehydrated animals due to various reasons especially those animals suffering from fluid loss should be treated with early rehydration.
- Antidiarrheal drugs, antibiotics and antiemetic therapy are indicated in dehydrated animals.
- Homemade oral rehydration solutions are discouraged since serious errors in formulation have occurred.
- Animals with mild to moderate dehydration should be treated under medical supervision with oral rehydration therapy rather than intravenous rehydration.
- Animals with severe dehydration should initially be treated with intravenous or intraosseous rehydration.

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