VETERINARY EVIDENCE
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Insufficient evidence intraperitoneal fluid is equivalent or superior to intravenous fluid therapy in dehydrated calves

A Knowledge Summary by

Allan Gunn BVM&S, MANZCVS, DACT, MRCVS [1*]
Timothy Crawshaw BVetMed, MSc [1]
Victoria Brookes BVM&S, MANZCVS, PhD, MRCVS [1]

[1] School of Animal and Veterinary Sciences, Charles Sturt University, Wagga Wagga, NSW, Australia & Graham Centre for Agricultural Innovation, (NSW DPI and CSU), Pugsley Place, Wagga Wagga, Australia
[*] Corresponding Author (algunn@csu.edu.au)

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Reviewed by: **Virginia Sherwin (MA, VetMB, MVM Dip., ECBHM, MRCVS)and Dai Grove-White (BVSc, MSc, DBR, PhD, DECBHM, FRCVS)**
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KNOWLEDGE SUMMARY

PICO question
In calves <14 days old which are moderately to severely dehydrated (5–9%) or acidaemic (base excess -5 to -15 mM), does intraperitoneal fluid therapy result in comparable or superior clinical improvement when compared to intravenous fluid therapy?

Clinical bottom line
Category of research question
Treatment
The number and type of study designs reviewed
Two papers were critically reviewed (one randomised clinical trial and one case series)
Strength of evidence
Weak evidence relevant to the topic question
Outcomes reported
Statistically significant differences were not found between treatment groups (administration of intravenous fluids [n = 27] or intra-peritoneal fluids [n = 28]) in the clinical trial, and findings relevant to the topic question were not reported in the case series of 18 calves
Conclusion
These studies provide insufficient evidence that intraperitoneal (IP) fluid is comparable to, or provides superior clinical improvement, when compared to intravenous (IV) fluid therapy in moderately to severely dehydrated (5–9 %) or acidaemic calves (base excess -5 to -15 mM) aged < 14 days of age

How to apply this evidence in practice
The application of evidence into practice should take into account multiple factors, not limited to: individual clinical expertise, patient's circumstances and owners' values, country, location or clinic where you work, the individual case in front of you, the availability of therapies and resources.
Knowledge Summaries are a resource to help reinforce or inform decision making. They do not override the responsibility or judgement of the practitioner to do what is best for the animal in their care.

Clinical Scenario

A group of diarrhoeic calves <14 days old are presented for clinical examination and treatment. The calves are in differing stages of dehydration and mentation. Fluid therapy is indicated. In mildly affected calves, oral rehydration therapy will probably suffice, whilst the moderately to severely affected calves will require parenteral intravenous fluid therapy, and potentially supplementary bicarbonate to treat acidaemia. Intravenous fluid therapy can be time consuming and expensive. In moderately dehydrated or acidaemic calves, would intraperitoneal fluid administration be as least as clinically beneficial as intravenous fluid therapy?

The evidence

Two studies were identified in which IP fluid was administered to dehydrated calves. Koenig et al. (1995) describe a randomised controlled trial in which 55 calves received either IP or IV fluid. Correction of dehydration and acidaemia was not assessed; instead, longer-term impacts (weight gain and survival) were measured. Significant differences were not detected between treatment groups, but sample size was likely too small to provide sufficient power. The second study is a case series in which some calves were administered IP fluids (McSherry & Ginyer, 1954). An association between fluid therapy and clinical outcomes was not investigated.
Therefore, these studies do not provide evidence that IP fluids lead to comparable or superior clinical improvement when compared to IV fluid therapy in moderately to severely dehydrated or acidaemic calves.

Summary of the evidence

Koenig, Holmberg, Medeiros, & Guterbock (1995)	
Population:	Male Holstein calves aged 1–16 days with clinical dehydration (6–8 %) and an inability to suck, resident on a Californian calf ranch
Sample size:	55 calves

Intervention details:	• Calves were randomly assigned to two treatment groups:
	  ○ IV fluid treatment group (n = 27)
	  ○ IP fluid treatment group (n = 28).
	• The same warmed commercial electrolyte solution (unknown composition) was administered to all calves in both groups.
	• The same calculation (kg x estimated dehydration [%]) was used to determine volume of fluid administration to all calves in both groups

Study design:	Experimental, randomised, controlled trial
Outcome studied:	• Weight gain to 28 days post-treatment (kg, objective). • Survival rates to 60 days post-treatment (count, objective). • Pathological changes to the peritoneum of all calves that died to 60 days post-treatment (observation, subjective). • Primary reason for death in all calves that died to 60 days post-treatment (count, objective; primary reason for death, potentially subjective).
Main findings: (relevant to PICO question):	• Weight gain was 0.9 kg greater in the IV treated group than the IP group. This finding is not statistically significant. • Four more calves survived in the IV treated group than in the IP treated group. Days to death and the number that survived in each group is not provided. A finding of no statistical difference between group survival rates is reported. • No difference in pathological changes to the peritoneum was observed between groups. • The primary causes of death are not described and the significance of differences between the groups was not determined.

Limitations:	Study design and reporting: • Treatments were not blinded. • Results are summarised and lack sufficient detail to evaluate survival, pathological changes to the peritoneum and causes of death associated with treatment groups. • Methods for statistical analysis and values for significance are not described for the main outcomes. • Short-term clinical effect on dehydration and acidaemia was not assessed. Power analysis: • Effect size needs to be large (Cohen's d = 0.78) to detect significant differences between groups of the sizes in this study. • Therefore, the study is likely underpowered to detect whether a difference of 0.9 kg is a significant weight difference between these groups. Mean and standard deviation of weights of each group are not provided to fully assess this. • Similarly, insufficient data are provided to assess power of survival analysis. Assessment of bias: • Confounding: Although the calves were randomised between groups, the distribution of important variables between groups is not described. Therefore, potential confounding cannot be assessed. Confounders could include treatment prior to parenteral fluid administration, age, and levels of pretreatment dehydration and blood parameters. • Selection: Peritoneal changes were determined only on postmortem examination, and not in surviving animals. • Measurement: Treatments were not blinded. Cognitive bias could have occurred when making subjective assessments such as peritoneal changes and primary causes of death.

McSherry & Grinyer (1954)	
Population:	Jersey, Shorthorn and Holstein Friesian calves with diarrhoea, admitted to the Ambulatory Clinic of the Ontario Veterinary College, Canada. Median age was 12.5 days (range 7–90 days). Sex was not specified.
Sample size:	18 calves (Jersey = 7, Shorthorn = 7, Holstein Friesian = 4)
Intervention details:	• Antibiotics including penicillin, streptomycin and unspecified antibiotics, administered pre- or during clinic admission (reportedly administered to nine calves). • Unspecified chemotherapeutic agents (reported in three calves) • Oral electrolyte solution – composition not described and administered to an unspecified number of calves.

	• Parenteral electrolyte solution with or without dextrose (5–6 %) – reportedly administered to eight calves (one calf received IV fluids, one calf received IP fluids. The route of administration was not specified in six calves). Composition of electrolyte fluid is provided in the manuscript.
Study design:	Case series
Outcome studied:	• Clinical course of hospitalised calves with diarrhoea (objective and subjective measurements). • Repeated objective measurements of selected blood electrolytes (HCO_3, Cl, Na, K, Ca), pH, sugar and haematocrit in admitted calves. Sampling interval ranged from 1–4 days.
Main findings: (relevant to PICO question):	None that were relevant to the PICO
Limitations:	• No associations are assessed or described between interventions and clinical signs or blood parameters. • The paper does not fully describe when and how calves were administered the electrolyte solution. • There is no rationale given as to why a stated volume of electrolyte solution was administered to any given calf.

Appraisal, application and reflection

Although intraperitoneal fluid therapy for dehydrated calves has been suggested as equivalent, of greater benefit or of less benefit than other methods of fluid administration, or potentially harmful, these suggestions are not evidence-based.

For example, Roussel (1983) proposed that IP fluid administration was equivalent to oral fluid therapy if dehydration was <8 %. Vermunt (1994) supported this opinion, stating that IV fluids should be administered if dehydration is >8%. Reasons suggested for equivalency or of greater benefit than other methods of fluid administration include the potential for administration of large volumes (Lewis & Phillips, 1971) and that IP administration might be a useful method to deliver fluids to the interstitial and intracellular compartments of young animals (Edwards & Williams, 1972).

In contrast, Radostits (1965) suggested that IP fluid therapy was not beneficial, but stated that this might be due to administration of insufficient volume, and Watt (1967) proposed that it was unsuitable due to the risk of adhesions. Phillips (1985) commented that there were good reasons that IP fluids were not commonly used (without further discussion), and Dickson (1987) recommended that only IV fluids were of benefit in severely dehydrated calves because IP absorption was ineffective. This was reiterated by Michell (1988) who stated that there is no real alternative to IV fluid administration for severe dehydration. More recently, Constable (2003) and González-Montaña et al. (2017) also mention the potential use of IP fluids in cattle and highlight similar risks.

Only two studies were found which claimed to assess intraperitoneal fluid administration of electrolyte solutions to treat dehydration in calves (Koenig et al., 1995 and McSherry & Grinyer, 1954). In the study by Koenig et al. (1995), authors assessed outcomes in calves at 28 and 60 days post-treatment with IP or IV fluids between 1–16 days old. Although they suggested that IP fluid administration was useful to treat dehydration in young calves (several Californian calf ranches were using this method to administer fluids) this evidence was not presented because it was not the focus of their study. In the study by McSherry & Grinyer (1954), the

authors presented clinical and haematological findings from a series of cases in which dehydrated calves were treated with combinations of antibiotics and oral, IP and IV fluids. The clinical benefit of IP fluids relative to IV fluids was not assessed. Importantly, the two studies presented here also did not provide evidence that IP fluid administration does not cause harm (for example, peritonitis).

Overall, we found that there is no evidence to support the use of IP fluids to treat moderate to severe dehydration and acidaemia in calves. Given the lower expected non-clinical costs of IP fluids relative to IV fluids (labour and time) we suggest studies to investigate the safety and clinical benefits of IP fluid administration in calves for this purpose are needed. We propose that IP fluids might be used earlier than intravenous fluid therapy in dehydrated acidaemic calves due to the lower non-clinical costs.

Methodology Section

Search Strategy	
Databases searched and dates covered:	CAB Abstracts on OVID Platform (1973 – Week 27 2018) Scopus
Search terms:	CAB Abstracts: 1. (fluid therapy or rehydration therapy or intraperitoneal or intra-peritoneal or transabdominal or intra-abdominal or intraabdominal or parenteral or intravenous injection or iv injection).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes] 2. (calf or calv*).mp.[mp=abstract, title, original title, broad terms, heading words, identifiers, cabibodes] 3. dehydrat* or diarrh*).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabibodes] 4. 1 and 2 and 3 5. Restrict to the English language Scopus: (TITLE-ABS-KEY("fluid therapy" OR "rehydration therapy" OR intraperitoneal OR intra-peritoneal OR transabdominal OR intra-abdominal OR intraabdominal OR parenteral OR "intravenous injection" OR "iv injection")) AND (TITLE-ABS-KEY(calf OR calve*)) AND (TITLE-ABS-KEY(diarrh* OR dehydrat*)) Article references: If intra-peritoneal fluid administration was mentioned within reviewed articles, the cited references were also included.
Dates searches performed:	18/07/2018

Exclusion / Inclusion Criteria	
Exclusion:	No mention of intraperitoneal fluid therapy/administration in the title or abstract OR no survey or study occurred. Literature in languages other than English.
Inclusion:	A survey or study in which calves were treated with intraperitoneal administration of an electrolyte solution.

Search Outcome

Database	Number of results	Excluded – Duplicated in both searches, so removed	Excluded – No mention of intraperitoneal fluid administration in the title or abstract	Excluded – No study carried out	Total relevant papers
CAB Abstracts on OVID Platform	323	0	312	11	0
Scopus	182	103	79	0	0
Cited references from included searched articles	2	0	0	0	2
Total relevant papers when duplicates removed					**2**

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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