

## In cats and dogs with traumatic diaphragmatic rupture, does surgical timing affect outcome?

A Knowledge Summary by

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### PICO question

In cats and dogs with traumatic diaphragmatic rupture undergoing herniorrhaphy does surgical timing affect outcome?

### Clinical bottom line

### Category of research question

Prognosis

### The number and type of study designs reviewed

Ten studies were critically appraised. All of these were retrospective case series

### Strength of evidence

Zero

### Outcomes reported

Overall, there is not sufficient evidence reporting if timing of surgical intervention has an effect on the mortality rate in dogs and cats with traumatic diaphragmatic rupture. Mortality rate was 6.8–50% in all cases

### Conclusion

There is no statistically significant information available with only several retrospective studies published that are a low quality of evidence. Clinical practice can be reviewed based upon current evidence assessing timing of herniorrhaphy of traumatic diaphragmatic rupture. However, there are no clear recommendations and future studies are warranted

### [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 2 year old female neutered domestic short-hair presents 30 minutes after being hit by a car. On presentation the cat is dyspnoeic and tachycardic at 250 bpm with poor peripheral pulses. On thoracic auscultation heart sounds are dull on the left side and displaced caudodorsally on the right side. The abdomen feels 'empty' on palpation. Thoracic radiography and ultrasonography reveal the presence of a diaphragmatic rupture. The cat requires surgical repair of the diaphragm. Is the cat more likely to survive if herniorrhaphy is performed immediately, or if medical stabilisation is performed for 24 hours prior to surgery?

## The evidence

Evidence is lacking about the outcome of cats and dogs with traumatic diaphragmatic ruptures. There are few studies that assess outcome based on time from presentation to surgery. This may be due to many of these cases presenting to and being surgically repaired by their primary veterinarian. The papers discussed show no statistical correlation between length of time from presentation to surgery and survival to discharge. Clinical practice can be reviewed based upon current evidence; however, there are no clear recommendations and future studies are warranted. There are currently no prospective studies published, these may find a more significant outcome as less variables may be present.

## Summary of the evidence

Wilson et al. (1971)	
<b>Population:</b>	Dogs and cats with diaphragmatic hernia admitted to the College of Veterinary Medicine at Ohio State University (USA) from January 1959 to December 1969.
<b>Sample size:</b>	116 cases: 94 dogs and 22 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"><li>• 113 dogs and cats had surgery attempted, three animals died or were euthanised prior to surgical intervention.</li><li>• All animals were diagnosed based on thoracic radiographs.</li><li>• Type of diaphragmatic tear and herniated organs were noted.</li></ul>
<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	<ul style="list-style-type: none"><li>• Survival during hospitalisation.</li><li>• Time from suspected trauma to surgery was recorded.</li><li>• Follow-up time postoperatively varied.</li></ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"><li>• Time from suspected trauma to surgery was from immediately following trauma to 6 years later (mean 109 days).</li><li>• Most hernias were traumatic. 11 animals had congenital hernias, in 16 cases the cause was unknown.</li><li>• 76/116 (65.4%) animals survived to discharge from hospital.</li><li>• One animal was dead on arrival and two were euthanised prior to surgery</li><li>• 19/116 (16.8%) animals died prior to surgery – of these most hernias were present for 1 hour to 2 weeks prior to surgery.</li><li>• 6/116 (5.1%) animals died during surgery.</li><li>• 14/116 (12.1%) animals died postoperatively – 12/14 (85.7%) died within 24 hours of surgery.</li></ul>
<b>Limitations:</b>	<ul style="list-style-type: none"><li>• Single-centre study.</li><li>• Retrospective study.</li><li>• No statistical analysis or discussion of results.</li><li>• No discussion of stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li><li>• Since the paper was written, surgical, anaesthetic and medical management is likely to have changed a lot. Clinical management, and therefore outcome of cases may be different in current practice.</li></ul>

Garson et al. (1980)	
<b>Population:</b>	Dogs and cats with traumatic diaphragmatic hernia admitted to Glasgow University Veterinary School (UK) between January 1972 and August 1978.
<b>Sample size:</b>	56 cases: 23 dogs and 33 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>• 53 dogs and cats underwent surgery, three dogs died prior to anaesthesia for herniorrhaphy.</li> <li>• All animals diagnosed based on thoracic radiographs.</li> <li>• Anaesthetic protocols and supportive treatment varied.</li> <li>• Midline celiotomy performed in all cases, two cases had lateral thoracotomy.</li> <li>• Type of diaphragmatic tear and herniated organs noted.</li> <li>• In cats evacuation of pneumothorax at the end of surgery was performed by maximally expanding lungs prior to tying of a purse string suture in the diaphragmatic tear. In dogs a chest drain was placed.</li> </ul>
<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	<ul style="list-style-type: none"> <li>• Duration of clinical signs and signalment of each case recorded.</li> <li>• Follow-up time postoperatively varied.</li> <li>• Discussed reasons patients had not survived to discharge.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>• 27/53 (50.9%) animals died or were euthanised.</li> <li>• Most deaths occurred within 24 hours postoperatively, mostly due to pneumothorax.</li> <li>• Time from admission to surgery was not recorded.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Single-centre study.</li> <li>• Retrospective study.</li> <li>• No statistical analysis or discussion of results.</li> <li>• No discussion over time from presentation to surgery.</li> <li>• Some findings discussed as 'unremarkable', however these findings not presented and no statistical analysis performed.</li> <li>• Did not discuss method of diagnosis of the diaphragmatic rupture or the pathology leading to death or euthanasia.</li> <li>• Varied stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li> <li>• Since the paper was written, surgical, anaesthetic and medical management is likely to have changed a lot. Clinical management, and therefore outcome of cases may be different in current practice.</li> </ul>

Schmiedt et al. (2003)	
<b>Population:</b>	Cats that had surgical repair of traumatic diaphragmatic hernia at the University of Tennessee and University of Georgia College of Veterinary Medicine (USA) between 1991–2001.
<b>Sample size:</b>	34 cats

<b>Intervention details:</b>	All cats underwent surgical repair of diaphragmatic rupture.
<b>Study design:</b>	Retrospective multi-centre case series
<b>Outcome studied:</b>	<ul style="list-style-type: none"> <li>• Cause of hernia, breed, age, sex, clinical signs, duration of hernia, location of diaphragmatic tear, organs herniated, level of training of veterinarian performing the surgery, placement of thoracic drain after surgery, postoperative complications, time to discharge were recorded.</li> <li>• Duration of hernia was subjectively assessed as time from traumatic event to surgical repair.</li> <li>• Long-term follow-up was obtained by telephone interview with the owner or referring veterinary surgeon or by review of medical records.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>• There was no significant difference in mortality rates in cats that had diaphragmatic hernia for 0–24 hours (7/34 (20.6%) cats), 1–7 days (17/34 (50%) cats) or &gt;7 days (10/34 (29.4%) cats) from trauma to repair.</li> <li>• Mortality rate during hospitalisation was 6/34 (17.6%) cats.</li> <li>• Postoperative cardiac or respiratory arrest occurred in 5/34 (14.7%) cats within 48 hours postoperatively.</li> <li>• Mean duration of traumatic diaphragmatic hernia was 17.6 days.</li> <li>• Concurrent injuries were present in 8/34 (23.5%) of cats, mortality was significantly greater in these cats.</li> <li>• Long-term follow up available in 17/34 (50%) of cats, mean duration was 3.28 ± 2.28 years. 10/14 (71.4%) cats were healthy, one cat had dyspnoea after strenuous exercise. 3/14 (21.4%) cats were dead, one was euthanised due to urinary incontinence, one due to nasal haemorrhage, one had an unknown cause of death.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Retrospective study.</li> <li>• Cases collected over long time period (1991–2001), surgical procedures and medical management may have changed within this time.</li> <li>• Varied stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li> <li>• Length of follow-up was variable and 17/34 (50%) cases were lost to long-term follow-up.</li> </ul>

<b>Minihan et al. (2004)</b>	
<b>Population:</b>	<ul style="list-style-type: none"> <li>• Cats and dogs that underwent surgical repair of a chronic traumatic diaphragmatic hernia at Tufts University School of Veterinary Medicine or Angell Memorial Animal Hospital (USA) between 1987 and 1996.</li> <li>• Diagnosis made by thoracic radiography in 48 animals, 10 animals had thoracic ultrasonography.</li> <li>• Cases were considered chronic with: <ul style="list-style-type: none"> <li>○ A history of known trauma, and clinical signs (coughing, tachypnoea, dyspnoea, vomiting, weight loss) for at least 2 weeks prior to surgery; OR</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>○ Obvious signs of chronicity at surgery (body wall bruising, absence of haemothorax or haemoabdomen, presence of adhesions or fibrosis at hernia margins).</li> </ul>
<b>Sample size:</b>	50 cases: 34 dogs and 16 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>• Anaesthetic protocol varied, all cases were mechanically ventilated.</li> <li>• All animals underwent exploratory laparotomy, 14/50 (28%) also underwent partial median sternotomy.</li> </ul>
<b>Study design:</b>	Retrospective multi-centre case series
<b>Outcome studied:</b>	<ul style="list-style-type: none"> <li>• Duration and type of clinical signs, initial clinical exam findings and time from trauma to surgery were recorded.</li> <li>• Postoperative complications were recorded.</li> <li>• Follow-up time was variable, with long-term follow-up available in 34 cases.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>• Duration of clinical signs was 1 day to 7 years.</li> <li>• Time from trauma to surgical correction was 2 weeks to 84 months (mean 14.5 months).</li> <li>• 43/50 (86%) of animals survived to discharge.</li> <li>• 2/50 (4%) of animals died or were euthanised during surgery.</li> <li>• 5/50 (10%) of animals died or were euthanised postoperatively during hospitalisation.</li> <li>• 30/43 (70%) of animals were alive at long-term follow-up with no clinical signs related to the diaphragmatic hernia (mean 47 months). 3/43 (7%) of animals had died or were euthanised at long-term follow-up (mean 56 months), the remainder were lost to follow-up.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Retrospective study.</li> <li>• Cases collected over long time period (1987–1996), surgical procedures and medical management may have changed within this time.</li> <li>• Varied stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li> <li>• Groups outcome of all animals with diaphragmatic hernias over 14 days, does not discuss outcome of different length of clinical signs.</li> </ul>

<b>Gibson et al. (2005)</b>	
<b>Population:</b>	Dogs and cats undergoing surgical repair of traumatic diaphragmatic hernia within 24 hours of admission to Ontario Veterinary Clinic, University of Guelph (Canada), between January 1990 to December 2002.
<b>Sample size:</b>	92 cases: 63 dogs and 29 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>• Cases underwent surgical repair of diaphragmatic rupture.</li> <li>• All cases underwent repair via a midline celiotomy and were mechanically ventilated throughout the procedure.</li> </ul>

<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	<p>To examine the effect of timing of surgical intervention on perioperative survival rate.</p> <ul style="list-style-type: none"> <li>Intervention timing was objectively classified by: <ul style="list-style-type: none"> <li>Time from trauma to admission</li> <li>Time from trauma to surgery</li> <li>Time from admission to surgery</li> </ul> </li> </ul> <p>This was then categorised as early intervention (&lt;24 hours) or late (&gt;24 hours).</p> <ul style="list-style-type: none"> <li>Survival classified as discharge from hospital. Grouped as alive or dead. Euthanised animals were included in the dead group.</li> <li>Cases with time from trauma to admission &lt;14 days were considered acute.</li> <li>Cases with time from trauma to admission &gt;14 days were considered chronic.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>82/92 (89.1%) dogs and cats survived to discharge.</li> <li>84/92 (91.3%) dogs and cats received surgery within 24 hours of admission.</li> <li>Perioperative survival was not significantly associated with time from trauma to admission (admitted &lt;24 hours vs &gt;24 hours after trauma).</li> <li>Perioperative survival was not significantly associated with time from trauma to surgery (undergoing surgery &lt;24 hours vs &gt;24 hours after trauma).</li> <li>Perioperative survival was not significantly associated with time from admission to surgery (undergoing surgery &lt;24 hours vs &gt;24 hours after admission).</li> <li>Survival to discharge was not associated with time from trauma to admission, time from trauma to surgery or time from admission to surgery.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>Retrospective study.</li> <li>Single-centre study.</li> <li>Cases collected over a long time period (1990–2002), surgical procedures and medical management may have changed within this time.</li> <li>Poor control group (animals undergoing surgery &gt;24 hours after admission).</li> <li>Did not present data or discuss findings of animals undergoing surgery &gt;24 hours after admission.</li> <li>Did not discuss how diaphragmatic hernia was diagnosed.</li> <li>Varied stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li> </ul>

#### Ozer et al. (2007)

<b>Population:</b>	<ul style="list-style-type: none"> <li>Cats undergoing diaphragmatic herniorrhaphy as treatment for suspected traumatic diaphragmatic hernia at Istanbul University Faculty of Veterinary Medicine (Turkey).</li> <li>Diagnosis made by positive contrast celigraphy.</li> </ul>
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<b>Sample size:</b>	44 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>All animals underwent general anaesthesia with a standard protocol of gaseous induction via face mask with isoflurane and positive pressure ventilation. A midline celiotomy was performed for diaphragmatic herniorrhaphy.</li> <li>Postoperative plain radiographs were obtained for all cats.</li> </ul>
<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	Age, sex, breed, concurrent orthopaedic and soft tissue injuries, radiographic changes, biochemical abnormalities, duration of anaesthesia and surgery, organs herniated, location of rupture on the diaphragm, perioperative complications were recorded.
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>Perioperative survival rate was 41/44 (93.2%).</li> <li>All deaths that occurred 3/44 (6.8%), were perioperative.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>Retrospective study.</li> <li>Single-centre.</li> <li>Only perioperative survival is discussed, it is not clear what percentage of cats survived to discharge from hospital.</li> <li>Stabilisation of cases is not discussed.</li> <li>The type of positive pressure ventilation that was used is not stated. If manually ventilated there would be varied volume and pressure given with each breath.</li> <li>Anaesthetic length is not discussed.</li> <li>The time frame that cases were collected over was not recorded.</li> </ul>

<b>Besalti et al. (2011)</b>	
<b>Population:</b>	<ul style="list-style-type: none"> <li>Cats undergoing diaphragmatic herniorrhaphy as treatment for traumatic diaphragmatic hernia at Ankara University, Faculty of Veterinary Medicine (Turkey), between May 2002 and April 2010.</li> <li>Diagnosis made by radiography, with some cases requiring celigraphy or a barium swallow study for the confirmation of diagnosis.</li> </ul>
<b>Sample size:</b>	52 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>Acute diaphragmatic rupture was defined as the suspected trauma occurring &lt;14 days prior to surgery.</li> <li>Chronic diaphragmatic rupture was defined as the suspected trauma occurring &gt;14 days prior to surgery.</li> <li>All cats received prophylactic cephalosporin and dexamethasone prior to surgery.</li> <li>They all received standard protocols for general anaesthesia, mechanical ventilation, and midline celiotomy for diaphragmatic herniorrhaphy.</li> <li>All cats were prescribed ketoprofen for 3 days postoperatively.</li> </ul>
<b>Study design:</b>	Retrospective single-centre case series



<b>Outcome studied:</b>	<ul style="list-style-type: none"> <li>Age, sex, timing from suspected trauma to presentation, clinical signs, concurrent injuries, location of diaphragmatic tear, organs herniated, perioperative and postoperative complications were recorded.</li> <li>Survival was classified as survival to discharge.</li> <li>Follow-up was performed in all cats to assess rate of recurrence within the first 10 days postoperatively.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>82.7% (43/52) of cases survived to discharge.</li> <li>Acute diaphragmatic hernia occurred in 31/52 (59.6%) cats; mortality rate was 5/31 (16.1%).</li> <li>Chronic diaphragmatic rupture occurred in 21/52 cats (40.4%); mortality rate was 4/21 (19%).</li> <li>Of the cases that died, 4/9 (44.4%) occurred intraoperatively and 5/9 (55.6%) occurred postoperatively (within 5 hours after surgery).</li> <li>When assessing location of diaphragmatic tear, death occurred in 4/7 (57%) of cases with a centrally located tear, 1/2 (50%) of cases with tears in multiple locations, 2/9 (22%) with ventrally located tears, 2/13 (15%) with left sided tear. No cases with a right sided tear died.</li> <li>8/9 (33.3%) non-survivors had multiple organs herniated into the thorax.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>Retrospective study.</li> <li>Single-centre.</li> <li>Pre-operative stabilisation and postoperative care were not discussed.</li> <li>Although it is discussed that cases were more likely to not survive based on location of tear and having multiple organs herniated, it is a small number of cases and therefore not possible to assess causation.</li> </ul>

<b>Igna et al. (2014)</b>	
<b>Population:</b>	<ul style="list-style-type: none"> <li>Cats and dogs undergoing diaphragmatic herniorrhaphy as treatment for traumatic diaphragmatic hernia at the Faculty of Veterinary Medicine Timișoara (Romania), between 2001 and 2013.</li> <li>Diagnosis made by thoracic radiography and/or confirmed at surgery.</li> </ul>
<b>Sample size:</b>	<ul style="list-style-type: none"> <li>43 cases: 17 cats and 26 dogs.</li> <li>All dogs and 13/17 (76.5%) of cats had traumatic diaphragmatic rupture.</li> <li>Three cats had a peritoneopericardial hernia and one cat had a pleuroperitoneal hernia.</li> </ul>
<b>Intervention details:</b>	All animals underwent general anaesthesia, manual or mechanical ventilation, and midline celiotomy for diaphragmatic herniorrhaphy. Four cases required a partial median sternotomy.
<b>Study design:</b>	Retrospective single-centre case series

<b>Outcome studied:</b>	Age, sex, concurrent orthopaedic and soft tissue injuries, clinical signs, organs herniated, timing from trauma to surgery, organs herniated, type of diaphragmatic tear and location, survival to discharge.
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>• 32/43 (74.4%) of cases received surgical intervention within 24 hours of trauma.</li> <li>• Survival to discharge was 38/43 (88.4%) cases.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>• Retrospective study.</li> <li>• Single-centre study.</li> <li>• Cases collected over a long time period (2001–2013), surgical procedures and medical management may have changed within this time.</li> <li>• Stabilisation, surgical technique, anaesthetic protocol and postoperative management are not discussed.</li> <li>• Some cases were manually ventilated, varied volume and pressure would be given each breath.</li> <li>• Survival is described for all cases. There is no differentiation between the outcome of traumatic versus congenital diaphragmatic hernias. This is a limitation as cases with traumatic hernias may present with concurrent injuries which may affect patient stability and outcome.</li> </ul>

Legallet et al. (2017)	
<b>Population:</b>	Cats and dogs undergoing diaphragmatic herniorrhaphy as treatment for traumatic diaphragmatic hernia at Texas A&M Veterinary Teaching Hospital (USA) between 1 October 2001 and 31 April 2014.
<b>Sample size:</b>	96 cases: 17 cats and 79 dogs
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>• Diagnosis made by thoracic radiography and ultrasonography and confirmed at surgery.</li> <li>• All animals underwent general anaesthesia, manual ventilation, and midline celiotomy for diaphragmatic herniorrhaphy.</li> </ul>
<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	<ul style="list-style-type: none"> <li>• Age, sex, SpO<sub>2</sub> (oxygen saturation), blood lactate at presentation, concurrent orthopaedic and soft tissue injuries, duration of anaesthesia and surgery, organs herniated, additional surgical procedures performed during herniorrhaphy, perioperative and postoperative complications were recorded.</li> <li>• Intervention timing was objectively classified by: <ul style="list-style-type: none"> <li>○ Time from trauma to admission</li> <li>○ Time from trauma to surgery</li> <li>○ Time from admission to surgery</li> </ul> </li> <li>• Acute diaphragmatic hernias were present for &lt;14 days duration.</li> <li>• Chronic diaphragmatic hernias were present for &gt;14 days duration.</li> </ul>

	<ul style="list-style-type: none"> <li>Animals grouped into survival to discharge or death during hospitalisation, including euthanised animals.</li> </ul>
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>Time between trauma and admission, trauma and surgery, and admission to surgery did not affect survival.</li> <li>Perioperative survival rate was 78/96 (81.3%) (15/17 (88.2%) cats and 63/79 (79.8%) dogs).</li> <li>In acute cases 10/12 (83.3%) cats and 38/48 (79.2%) dogs survived to discharge.</li> <li>In chronic cases 5/5 (100%) cats and 25/31 (80.6%) dogs survived to discharge.</li> <li>Animals that were oxygen dependent prior to surgery had a 5 times higher likelihood of mortality.</li> <li>Animals with concurrent soft tissue injuries had a 4.3 times higher likelihood of mortality.</li> <li>Animals with concurrent orthopaedic and soft tissue injuries had a 7.3 times higher likelihood of mortality.</li> <li>Increased anaesthetic and surgical time, due to concurrent orthopaedic and soft tissue injuries, was associated with higher mortality rates.</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>Retrospective study.</li> <li>Single-centre study.</li> <li>Cases collected over a long time period (2001–2014), surgical procedures and medical management may have changed within this time.</li> <li>Varied stabilisation, surgical technique, anaesthetic protocol and postoperative management.</li> <li>All cases manually ventilated, varied volume and pressure would be given each breath.</li> <li>Many animals underwent other procedures at the same time as diaphragmatic herniorrhaphy, including elective procedures such as neutering and portosystemic shunt ligation. This likely affected outcome by increasing anaesthetic length.</li> </ul>

<b>Yayingül et al. (2019)</b>	
<b>Population:</b>	<ul style="list-style-type: none"> <li>Cats undergoing diaphragmatic herniorrhaphy as treatment for traumatic diaphragmatic hernia at Adnan Menderes University, Faculty of Veterinary Medicine (Turkey), between 2016 and 2017.</li> <li>Diagnosis made by thoracic radiography, positive contrast celigraphy was performed in one case.</li> </ul>
<b>Sample size:</b>	15 cats
<b>Intervention details:</b>	<ul style="list-style-type: none"> <li>All animals were admitted to the intensive care unit and received oxygen therapy and prophylactic antibiotics for 24 hours prior to surgery.</li> <li>They all received standard protocols for general anaesthesia, manual ventilation, and midline celiotomy for diaphragmatic herniorrhaphy.</li> </ul>

	<ul style="list-style-type: none"> <li>All cases remained hospitalised for 3 days postoperatively. During this time, they all received oxygen therapy, methylprednisolone and salbutamol via nebulisation.</li> <li>All cats were prescribed cefazolin for 1 week postoperatively.</li> </ul>
<b>Study design:</b>	Retrospective single-centre case series
<b>Outcome studied:</b>	Age, sex, body weight, timing from suspected trauma to presentation, clinical signs, radiographic findings, biochemical changes, location of diaphragmatic tear, organs herniated, perioperative and postoperative complications were recorded.
<b>Main findings: (relevant to PICO question):</b>	<ul style="list-style-type: none"> <li>Four cases died perioperatively; all of these had lung lacerations and pleural effusion.</li> <li>Mortality rate was 4/15 (26.7%).</li> </ul>
<b>Limitations:</b>	<ul style="list-style-type: none"> <li>Retrospective study.</li> <li>Single-centre study.</li> <li>No discussion over timing from presentation to surgical intervention.</li> </ul>

### Appraisal, application and reflection

Overall, there is low quality of evidence assessing if performing herniorrhaphy within 24 hours of presentation affects the outcome of cats and dogs with traumatic diaphragmatic hernia. In the studies that assessed the time between trauma or hospital admission and surgical repair the timing of herniorrhaphy was not associated with survival to hospital discharge (Gibson et al., 2005; Legallet et al., 2017; and Schmiedt et al., 2003).

In one study assessing surgical repair of chronic diaphragmatic hernia, defined as being present for over 2 weeks prior to surgical repair, in-hospital mortality was 7/50 (14%) (Minihan et al., 2004). Another study found no difference in mortality in cats undergoing surgical repair within 24 hours, 1–7 days or over 7 days since trauma, with overall mortality of 6/34 (17.6%) (Schmiedt et al., 2003). Overall mortality is variable, with the lowest reported rate 3/44 (6.8%) (Ozer et al., 2007). The highest reported mortality rate was 27/53 (50.9%) (Garson et al., 1980); survival in this population was markedly worse than the cases in the remainder of the studies. This may reflect a change in approach to case management and treatment options available since publication. However, another older publication reported a mortality rate similar to more recent studies (Wilson et al., 1971).

The published data are retrospective studies with many clinical variables, with differences in individual disease severity and case management (Besalti et al., 2011; Garson et al., 1980; Gibson et al., 2005; Igna et al., 2014; Legallet et al., 2017; Minihan et al., 2004; Ozer et al., 2007; Schmiedt et al., 2003; Wilson et al., 1971; and Yaygingül et al., 2019). Varied disease severity is to be expected in this condition as it has a traumatic aetiology, and many cases presented with concurrent soft tissue and orthopaedic injuries. Multiple injuries were associated with outcome in two studies (Legallet et al., 2017; and Schmiedt et al., 2003), with an increase in mortality of these patients. Animals with concurrent injuries that underwent herniorrhaphy also had other surgical procedures performed under the same general anaesthesia. Several also had elective procedures performed, such as neutering. Increased anaesthesia time was linked with an increase in mortality (Legallet et al., 2017). In the same study, animals that required oxygen supplementation prior to surgery were less likely to survive. These findings suggest that systemic disease severity is associated with outcome in cats and dogs with traumatic diaphragmatic rupture.

Variables not assessed was the association between number and type of organs herniated into the thorax or the location of diaphragmatic tear and outcome. These were not linked to the PICO question to assess the timing of surgical intervention, therefore were not investigated as part of this review.

In conclusion, in reviewing the available literature, there is no evidence to support that time to surgical intervention is associated with outcome in cats and dogs with traumatic diaphragmatic rupture.

## Methodology Section

Search Strategy	
Databases searched and dates covered:	CAB Abstracts 1973–2021 Week 31 PubMed 1966–2021 Week 31
Search terms:	CAB Abstracts and PubMed: <ol style="list-style-type: none"> <li>1. dog OR dogs OR canine OR cat OR cats OR feline</li> <li>2. diaphragm*</li> <li>3. hernia OR hernia OR rupture OR tear OR injury</li> <li>4. outcome* OR prognosis* OR survival* OR mortality*</li> <li>5. 1 and 2 and 3 and 4</li> </ol>
Dates searches performed:	03 Aug 2021

Exclusion / Inclusion Criteria	
Exclusion:	Not relevant, foreign, case reports, abstracts, reviews, book chapters, repeat of same relevant result within search
Inclusion:	Relevant journal articles, accessed through University of Glasgow library

Search Outcome									
Database	Number of results	Excluded – Not relevant	Excluded – Foreign (without translation to English)	Excluded – Case report	Excluded – Review	Excluded – Congress proceedings (abstract only)	Excluded – Book chapter	Excluded – Repeated result in same search	Total relevant papers
CAB Abstracts	229	188	3	12	11	3	1	1	10
PubMed	83	68	1	7	1	0	0	0	6
Total relevant papers when duplicates removed									10

## CONFLICT OF INTEREST

The author declares no conflict of interest.

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