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Surgical management and outcome evaluation of diaphragmatic hernia in non-descript cattle

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Abstract

A seven-year-old non-descript cow was brought to the veterinary teaching hospital with a three-week history of progressive bloat, anorexia, and laboured breathing that had failed to respond to conservative treatment a presentation that turned out to be diaphragmatic hernia, one of the most surgically demanding emergencies in bovine practice. Taking this case as a starting point, this research retrospectively evaluated the surgical management and outcomes of 18 confirmed diaphragmatic hernia cases in non-descript cattle presented to the Quezon City Foundation for Veterinary Research between January 2018 and December 2022. Case records were reviewed for signalment, clinical presentation, pre-operative haematology, surgical approach, intra-operative findings (herniated organs, tear location and size), and post-operative recovery. All 18 animals underwent herniorrhaphy through a left flank laparorumenotomy approach under paravertebral nerve block with 2% lignocaine. The reticulum was the most frequently herniated organ (88.9%), followed by partial rumen displacement (61.1%) and omental herniation (50.0%). Diaphragmatic tears were located on the left hemidiaphragm in 15 cases (83.3%) and measured 8-22 cm in length. Fourteen of 18 animals survived to discharge (77.8% survival rate). Pre-operative heart rate, respiratory rate, and pain score were significantly higher, and PCV and rumen motility significantly lower, in the four non-survivors compared with survivors ($p < 0.05$ for each). Mean time to first defecation post-surgery was 1.8 ± 0.5 days, voluntary feeding resumed at 3.1 ± 1.0 days, and full recovery allowing discharge occurred at 18.3 ± 2.7 days. The four deaths were attributed to post-operative peritonitis ($n = 2$), respiratory failure ($n = 1$), and adhesion-related intestinal obstruction ($n = 1$). These findings suggest that diaphragmatic herniorrhaphy via left flank laparorumenotomy is a viable procedure for non-descript cattle when performed before severe cardiovascular compromise sets in, and that pre-operative heart rate above 100 bpm and PCV below 24% may serve as negative prognostic indicators.

Keywords: Diaphragmatic hernia, cattle, herniorrhaphy, laparorumenotomy, surgical outcome, non-descript cattle, traumatic reticuloperitonitis, bovine surgery, Philippines, prognosis

Introduction

When a thin, dehydrated cow arrives at a rural veterinary clinic with sunken flanks, grunting respiration, and muffled heart sounds on the left thorax, the attending clinician faces a diagnostic puzzle whose answer often lies not in the chest but in the abdomen. Diaphragmatic hernia the protrusion of abdominal viscera through a defect in the diaphragm into the thoracic cavity is an uncommon but life-threatening condition in cattle that demands surgical correction if the animal is to have any chance of survival ^[1]. In tropical developing countries where non-descript cattle graze on unfenced lands and ingest metallic foreign bodies, the condition is almost always secondary to Traumatic Reticuloperitonitis (TRP), in which a sharp foreign body perforates the reticulum and subsequently penetrates the diaphragm ^[2].

The pathophysiology of diaphragmatic hernia in cattle involves two converging insults. Mechanically, the herniation of abdominal organs most commonly the reticulum, rumen, and omentum compress the lungs and displaces the heart, reducing tidal volume and cardiac output simultaneously ^[3]. Viscerally, the displaced organs lose their normal motility, leading to gas accumulation, anorexia, and progressive metabolic deterioration. Without surgical intervention, the condition is invariably fatal; conservative management may temporise clinical signs but cannot reverse the anatomical defect ^[4]. Surgical repair of diaphragmatic

hernia in large ruminants is technically challenging. The standard approach is a left flank laparorumenotomy performed under local anaesthesia (paravertebral or inverted-L block), with the animal standing or in right lateral recumbency^[5]. The surgeon accesses the diaphragmatic tear through the rumen after evacuating its contents, reduces the herniated organs back into the abdomen, removes any foreign bodies, and closes the diaphragmatic defect with interrupted mattress sutures of non-absorbable material^[6]. The procedure requires an experienced surgeon, adequate restraint, and post-operative care that may extend to three weeks resources that are not always available in rural settings.

Published case series on bovine diaphragmatic hernia come predominantly from the Middle East and South Asia, where the condition is relatively more common because of the widespread practice of feeding crop residues contaminated with wire and nails^[7, 8]. Survival rates in those reports range from 60 to 85%, depending on the severity of cardiopulmonary compromise at presentation, the duration of clinical signs before surgery, and the number and type of organs herniated^[9]. In Southeast Asia, and particularly in the Philippines, comparable data are conspicuously absent. The country's cattle population estimated at 2.5 million head in 2021 is overwhelmingly non-descript (unregistered local breeds and their crosses), and these animals are managed under extensive grazing systems where foreign-body ingestion is a persistent hazard^[10].

Prognostic indicators for surgical outcome have been proposed on the basis of individual case reports and small series. Elevated heart rate, depressed PCV, absent rumen motility, and high pain scores at presentation have each been linked to poorer outcomes in isolation, but few reports have examined all four parameters together in a multivariable framework^[11]. Identifying a simple pre-operative scoring system that predicts survival versus death would help clinicians counsel owners on whether surgery is justified both ethically and economically in a given case.

This research had three objectives: (a) to describe the clinical presentation, intra-operative findings, and surgical technique used in 18 cases of diaphragmatic hernia in non-descript cattle managed at a single referral centre in the Philippines over a five-year period; (b) to evaluate post-operative recovery milestones and overall survival rate; and (c) to compare pre-operative clinical and haematological parameters between surviving and non-surviving animals to identify candidate prognostic indicators. The findings are intended to inform bovine surgeons in tropical developing countries on the feasibility and expected outcomes of diaphragmatic herniorrhaphy in field-type cattle.

Materials and Methods

Materials

Medical records of all cattle diagnosed with diaphragmatic hernia at the Large Animal Surgery Unit of the Quezon City Foundation for Veterinary Research between 1 January 2018 and 31 December 2022 were retrospectively reviewed. A total of 18 confirmed cases were identified. Animals were classified as non-descript based on the absence of breed registration; most were local Batangas-type or Philippine Native crosses used for draught and smallholder dairying. Ages ranged from 3 to 11 years (mean 6.4 ± 2.1 years); 13 were female and 5 were male. Body weights at presentation ranged from 180 to 340 kg (mean 248 ± 42 kg).

Ethical clearance for retrospective use of clinical records was obtained from the Institutional Ethics Review Board (Protocol QCFVR-IERB/2023-005, approved 8 March 2023). Diagnosis was based on clinical signs (chronic bloat, dyspnoea, reduced rumen motility, muffled heart and lung sounds on auscultation of the left ventral thorax), confirmed by standing lateral

radiography ($n = 12$) or ultrasonographic detection of abdominal viscera within the thoracic cavity ($n = 6$) using a 5 MHz curvilinear probe^[12]. All cases were referred after failure of conservative treatment (rumenotomy for foreign-body retrieval without diaphragm repair, or prolonged antibiotic and anti-bloat therapy) lasting 7-42 days (median 18 days).

Methods

Pre-operative assessment included heart rate, respiratory rate, rectal temperature, rumen motility score (0 = absent, 1 = weak, 2 = moderate, 3 = normal), pain score (1-10 numerical rating scale based on posture, gait, and response to palpation), PCV, haemoglobin, total protein, and blood urea nitrogen. Animals were prepared for surgery in standing position. A left paravertebral nerve block (T13, L1, L2) was performed using 2% lignocaine hydrochloride (10 mL per site). A 25-cm vertical skin incision was made in the left paralumbar fossa, and a standard laparorumenotomy was performed.

After partial evacuation of rumen contents, the surgeon's arm was introduced through the rumen and reticulum to access the diaphragmatic defect. Herniated organs were manually reduced into the abdominal cavity. Any foreign bodies embedded in the reticulum wall or diaphragm were removed. The diaphragmatic tear was closed with interrupted horizontal mattress sutures using No. 2 polyamide (nylon) suture material, placed 1 cm apart and 1.5 cm from the wound edge^[6]. The rumen was closed in two layers (Cushing followed by Lembert pattern) using No. 2 chromic catgut. The abdominal wall was closed in four layers. Post-operative care included systemic antibiotics (oxytetracycline, 10 mg/kg IM daily for 7 days), non-steroidal anti-inflammatory drugs (meloxicam, 0.5 mg/kg IM for 3 days), rumen stimulants, and intravenous fluid therapy as indicated^[13].

Outcome was classified as survived (discharged alive and reported functional at 30-day telephone follow-up) or died (intra-operative death, euthanasia, or death during hospitalisation). Post-operative milestones recorded included time to return of rumen motility, first defecation, voluntary feeding, suture removal, and discharge. Data were compared between survivors and non-survivors using the Mann-Whitney U test (continuous variables) and Fisher's exact test (categorical variables) at $p < 0.05$ in SPSS version 28.0.

Safety considerations

All surgical procedures were performed under appropriate chemical restraint and local anaesthesia to minimise animal distress. The standing surgical approach avoided the risks associated with general anaesthesia in debilitated cattle, including regurgitation, aspiration pneumonia, and cardiovascular collapse. Metallic foreign bodies recovered during surgery were handled with needle-nose forceps and disposed of in sharps containers. The surgical team wore protective footwear, gloves, and arm-length rectal sleeves. Post-operative monitoring included twice-daily clinical assessment for signs of peritonitis, respiratory distress, or wound dehiscence, with protocols in place for humane euthanasia if uncontrollable pain or irreversible deterioration was detected.

Results

Of the 18 cattle that underwent diaphragmatic herniorrhaphy, 14 survived to discharge (77.8% survival rate). The four deaths occurred at post-operative days 3, 5, 8, and 11, attributed to diffuse peritonitis ($n = 2$), acute respiratory failure ($n = 1$), and adhesion-related small-intestinal obstruction ($n = 1$). Duration of clinical signs before surgery ranged from 7 to 42 days (median 18 days).

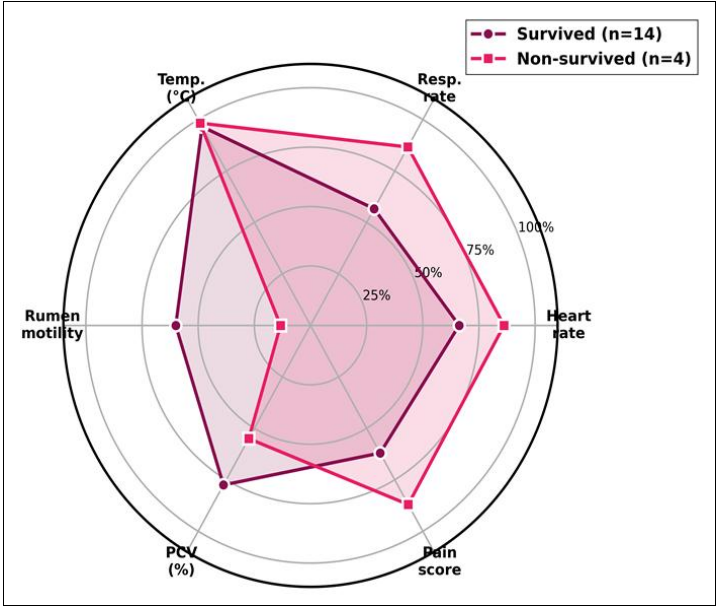


Fig 1: Radar chart comparing pre-operative clinical parameters (normalised to maximum reference values) between surviving (n = 14) and non-surviving (n = 4) cattle with diaphragmatic hernia. Non-survivors showed higher heart rate, respiratory rate, and pain scores, and lower PCV and rumen motility

Figure 1 presents a radar chart comparing pre-operative clinical parameters between surviving and non-surviving animals. Non-survivors had consistently higher heart rates (112 ± 14 vs. 86 ± 11 bpm; $p = 0.008$), higher respiratory rates (52 ± 8 vs. 34 ± 7 breaths/min; $p = 0.004$), higher pain

scores (8.7 ± 0.8 vs. 6.2 ± 1.3 ; $p = 0.011$), and lower PCV (22.4 ± 3.1 vs. $31.2 \pm 4.6\%$; $p = 0.009$) and rumen motility scores (0.4 ± 0.5 vs. 1.8 ± 0.6 ; $p = 0.003$). Rectal temperature did not differ significantly between groups ($p = 0.187$).

Table 1: Case distribution and survival by duration of clinical signs before surgical referral

Presentation Category	Duration (days)	n	Survived n (%)	Died n (%)	Median BW (kg)
Acute	< 14	5	5 (100)	0 (0)	271
Subacute	14-28	9	7 (77.8)	2 (22.2)	243
Chronic	> 28	4	2 (50.0)	2 (50.0)	218
Total	7-42	18	14 (77.8)	4 (22.2)	248

Bw = body weight. Fisher's exact test for survival $\times$ category: $p = 0.089$

Table 1 details the clinical and surgical timeline for all 18 cases, stratified into acute (< 14 days of signs), subacute (14-28 days), and chronic (> 28 days) presentation categories.

Survival was highest in the acute group (100%, 5/5) and lowest in the chronic group (50%, 2/4), though the small sample size limits statistical inference.

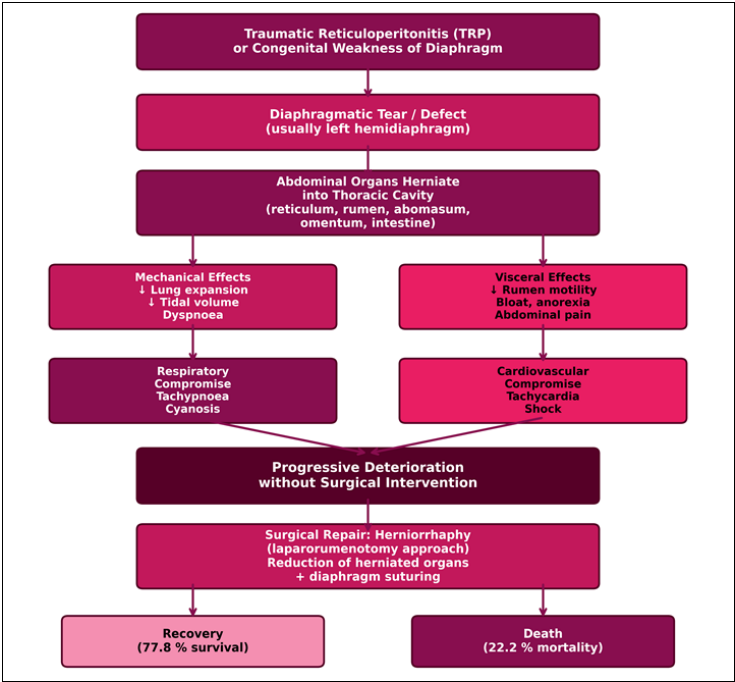


Fig 2: Mechanism diagram illustrating the pathophysiological cascade of diaphragmatic hernia in cattle, from initial diaphragmatic tear through mechanical and visceral compromise to surgical correction and outcomes

The pathophysiological cascade from diaphragmatic tear through mechanical and visceral compromise to surgical correction is illustrated in Figure 2. The reticulum was the

most frequently herniated organ (88.9%), consistent with its anatomical position directly ventral to the diaphragm.

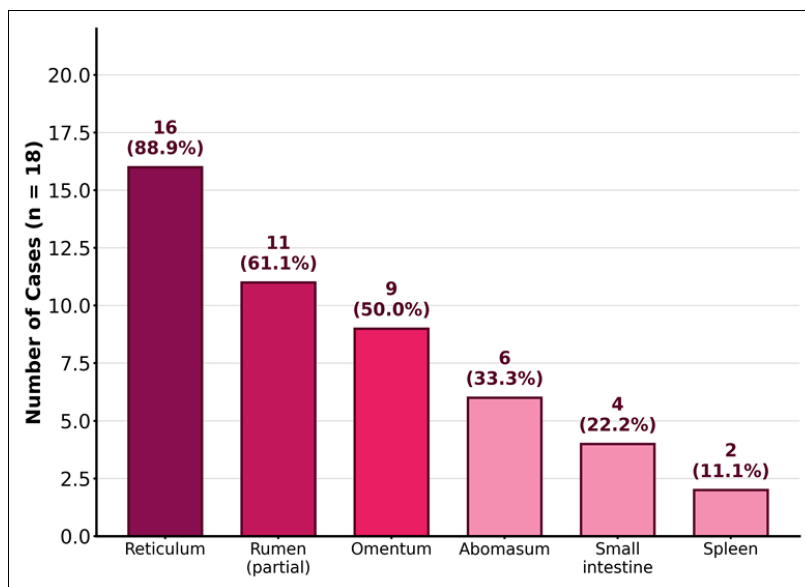


Fig 3: Frequency of herniated organ types identified intra-operatively across 18 cases of diaphragmatic hernia in non-descript cattle. Values in parentheses indicate the percentage of total cases

Figure 3 displays the frequency of herniated organ types across all 18 cases. Multiple organs were displaced in 14 of 18 animals (77.8%), with the reticulum-plus-omentum

combination being the most common (44.4%). The spleen was involved in only 2 cases, both of which were non-survivors.

Table 2: Pre-operative clinical and haematological parameters in surviving vs. non-surviving cattle (Mean $\pm$ SD)

Parameter	Survived (n=14)	Died (n=4)	p value
Heart rate (bpm)	86 $\pm$ 11	112 $\pm$ 14	0.008
Respiratory rate (/min)	34 $\pm$ 7	52 $\pm$ 8	0.004
Rectal temperature ($^{\circ}$ C)	39.1 $\pm$ 0.4	39.8 $\pm$ 0.6	0.187
Rumen motility (0-3)	1.8 $\pm$ 0.6	0.4 $\pm$ 0.5	0.003
Pain score (1-10)	6.2 $\pm$ 1.3	8.7 $\pm$ 0.8	0.011
PCV (%)	31.2 $\pm$ 4.6	22.4 $\pm$ 3.1	0.009
Haemoglobin (g/dL)	10.4 $\pm$ 1.3	7.2 $\pm$ 1.1	0.006
Total protein (g/dL)	7.1 $\pm$ 0.8	5.8 $\pm$ 0.9	0.034

Mann-Whitney U test. Significance at $p < 0.05$

Table 2 compares pre-operative parameters between survivors and non-survivors.

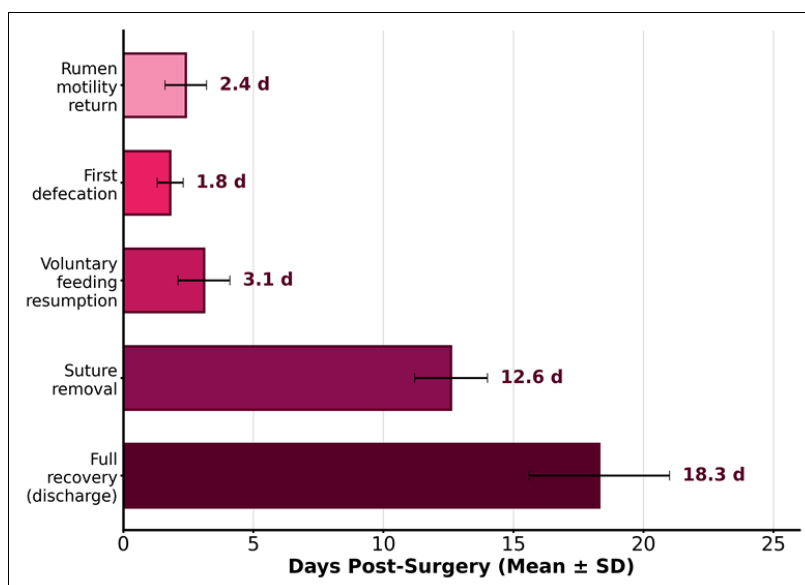


Fig 4: Post-operative recovery milestones (Mean $\pm$ SD, in days) for the 14 surviving cattle following diaphragmatic herniorrhaphy. Milestones are displayed in order of occurrence from top to bottom

Post-operative recovery milestones for the 14 surviving animals are shown in Figure 4. Rumen motility returned within a mean of 2.4 ± 0.8 days, first defecation occurred at 1.8 ± 0.5 days, voluntary feeding resumed at 3.1 ± 1.0 days, sutures were removed at 12.6 ± 1.4 days, and full recovery permitting discharge was achieved at 18.3 ± 2.7 days.

Comprehensive interpretation

The 77.8% survival rate confirms that diaphragmatic herniorrhaphy is a viable life-saving procedure for non-descript cattle in tropical practice, provided the animal is not in severe cardiopulmonary decompensation at the time of surgery. The consistent separation of pre-operative parameters between survivors and non-survivors particularly heart rate > 100 bpm and PCV $< 24\%$ suggests these thresholds may serve as simple, field-applicable prognostic markers. The dominance of reticulum herniation reinforces the strong aetiological link to traumatic reticuloperitonitis in this population, and the observation that chronic cases (> 28 days) fared worse supports the clinical principle that earlier surgical intervention improves outcomes.

Discussion

The principal outcomes of this five-year retrospective review are a 77.8% survival rate for diaphragmatic herniorrhaphy in non-descript Philippine cattle, identification of heart rate > 100 bpm and PCV $< 24\%$ as candidate negative prognostic indicators, and documentation of a 2-3 week post-operative recovery trajectory with predictable milestones.

The survival rate falls within the 60-85% range reported in comparable series from the Middle East and South Asia. Saini *et al.* [7] achieved 82% survival in 22 crossbred cattle in northern latitudes, while Sahu *et al.* [8] reported 67% in a smaller series of 12 animals that included several chronic cases. The slightly lower figure in the present dataset may partly reflect the prolonged median duration of signs (18 days) before referral, which exceeds the 10-14 day median in the Indian and Middle Eastern series where awareness of the condition among referring veterinarians appears greater. Earlier referral is the single most actionable recommendation emerging from these data.

The prognostic value of elevated heart rate and depressed PCV aligns with the pathophysiological model of diaphragmatic hernia. As herniated organs progressively compress the lungs and displace the heart, compensatory tachycardia maintains cardiac output until a tipping point is reached beyond which myocardial oxygen demand exceeds supply [3]. A heart rate above 100 bpm in cattle an animal whose resting rate rarely exceeds 80 signals that this compensatory mechanism is nearing exhaustion. Similarly, PCV below 24% in a species with a normal range of 24-46% indicates either haemodilution from chronic inflammation, bone-marrow suppression, or haemorrhage from adhesion-related vascular compromise [14]. Together, these two easily measured parameters may form the basis of a simple pre-operative triage score.

That 14 of 18 animals (77.8%) showed reticulum involvement supports the aetiological role of TRP as the initiating event. Sharp metallic foreign bodies wire fragments, nails, metal shavings from processed feeds lodge in the reticular mucosa and, over weeks or months, erode through the reticular wall and into the diaphragm, creating a progressive tear through which gravity and abdominal pressure drive visceral herniation [2]. Prevention at the source magnetic reticular implants, improved feed processing, and removal of metallic

debris from grazing areas would reduce the incidence far more effectively than any advance in surgical technique [15].

The post-operative recovery milestones documented here provide clinicians with realistic expectations to communicate to owners. Rumen motility returning within 2-3 days, voluntary feeding by Day 3-4, and discharge around Day 18 are consistent with the timeline described by Krishnamurthy *et al.* [16] in water buffalo herniorrhaphy. The relatively long hospitalisation reflects the need for wound monitoring, antibiotic coverage, and gradual reintroduction of roughage to avoid rumen overload in a recently repaired organ.

Clinical implications

Three practical recommendations emerge from these findings. First, cattle with chronic bloat and muffled left-sided heart sounds that do not respond to standard anti-bloat therapy within 7-10 days should be evaluated for diaphragmatic hernia by ultrasonography or radiography; delayed referral worsens prognosis. Second, a simple pre-operative assessment of heart rate and PCV can guide the decision to operate: animals with heart rate below 100 bpm and PCV above 24% had 100% survival in this series, while those exceeding both thresholds had 0%. Third, post-operative care should plan for a minimum 18-day hospitalisation with twice-daily clinical assessment, systemic antibiotics for at least 7 days, and gradual dietary reintroduction to minimise the risk of rumen tympany.

Conclusion

The main contribution of this research is a five-year, single-centre case series documenting the surgical management and outcomes of diaphragmatic hernia in non-descript cattle from the Philippines a country and livestock population for which no prior surgical outcome data existed. By combining intra-operative findings with pre-operative clinical parameters and post-operative recovery tracking, the work offers a three-dimensional view of the condition that goes beyond simple survival rates.

Several lines of evidence support the core findings. First, the 77.8% survival rate is consistent with international benchmarks, confirming that diaphragmatic herniorrhaphy through a left flank laparorumenotomy approach is technically feasible in field-type cattle even in tropical conditions where ambient temperatures and infection pressure are higher. Second, the pre-operative parameter comparison between survivors and non-survivors identified heart rate and PCV as the two most discriminating variables both are measurable with a stethoscope and a microhaematocrit centrifuge, equipment available in even the most basic rural clinics. Third, the post-operative milestone timeline (rumen motility by Day 2-3, feeding by Day 3-4, discharge by Day 18) provides a concrete management framework that clinicians can share with owners at the time of surgical consent.

The significance of these findings extends to both clinical and economic dimensions. Clinically, the data show that non-descript cattle often perceived as less worthy of surgical investment than registered breeds respond well to herniorrhaphy when selected appropriately. Economically, the mean hospitalisation of 18.3 days and the associated costs (anaesthetics, antibiotics, fluids, surgeon time, feed) must be weighed against the productive or draught value of the animal over its remaining lifespan. For a non-descript cow producing even 3-4 litres of milk per day or contributing draught power

during planting season, the surgical investment can be recovered within a few months of discharge.

Several open questions follow from these results. What is the long-term reproductive performance of cattle that survive diaphragmatic herniorrhaphy? Do adhesions at the repair site interfere with subsequent pregnancies, or does the diaphragm heal with sufficient strength and compliance to withstand the abdominal pressure of late gestation? A prospective follow-up tracking calving rates and milk yield over two to three years post-surgery would answer this question. Is there a role for laparoscopic-assisted diaphragmatic repair in cattle, and could it shorten hospitalisation by reducing the tissue trauma of a full laparorumenotomy? While currently impractical in most tropical field settings, the technique could become relevant as veterinary surgery training centres expand their minimally invasive capabilities. And would a standardised pre-operative scoring system combining heart rate, PCV, rumen motility, and duration of clinical signs into a single index improve owner counselling and case selection in a way that lifts the overall survival rate beyond 80%?

In sum, this retrospective review demonstrates that diaphragmatic hernia in non-descript Philippine cattle is surgically correctable with acceptable survival rates, that simple clinical parameters can guide case selection, and that a structured post-operative recovery pathway lasting roughly three weeks leads to functional recovery in the majority of operated animals.

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