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## An overview on the diagnostic and therapeutic aspects of cardiac diseases in bovine

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### Abstract

Bovine animals suffering from cardiac diseases show non-specific clinical signs which largely depend upon the nature and severity of the disease process. Pericarditis is one of the most commonly recorded conditions in cattle and buffaloes. Myocardial disease can occur at any age and diagnosis of it is difficult unless in advanced stage. Endocardium is mostly affected with bacterial endocarditis and selection of antibiotic should be done on the ability of arresting valve destruction by the bacteria. The most common congenital heart disease in cattle is ventricular septal defect and till date no surgical protocol has been described in bovine. Cardiac auscultation should always be in routine practice for any case suspected for heart disease. Hemato-biochemical tests may aid to distinguish neoplastic from non-neoplastic conditions, bacterial endocarditis. Pericardiocentesis can be done in the standing animal under local anesthesia for harvesting samples to perform cell cytology and culture studies. Specific cardiac biomarker i.e. cardiac troponin I, cardiac troponin T are found useful in the early diagnosis of traumatic pericarditis, myocarditis. Electrocardiography is useful to detect abnormalities of cardiac rate, rhythm and conduction system. Phonocardiography can be an adjunct to animal presented for cardiac murmur, split heart sounds, loud third heart sound or other sounds such as rubs, clicks, or snaps associated with heart beats. Echocardiography is the most sensitive of all the diagnostic modalities available for disease related to heart. Prognosis in cardiac diseases in bovine generally ranges from guarded to poor. The treatment of cardiac diseases in bovine are being attempted to achieve short term goal of calving or superovulation.

**Keywords:** Heart disease, cattle, buffaloes, diagnosis, treatment, prognosis

### Introduction

It is challenging for the bovine practitioner to diagnose and manage various cardiac diseases in cattle and buffaloes. Heart diseases arises from three main structures of heart i.e. pericardium, myocardium and endocardium. Diseases related to conductive tissue of the heart are infrequent in bovine<sup>[1]</sup>. Cattle with cardiac disease may show signs of heart failure or may not. Cardiac diseases are usually fatal in Cattle and Buffaloes because of the limited availability of medicinal or surgical treatments. The economic loss due to heart disease can be prevented or reduced by early diagnosis of heart disease and initiation of suitable treatment or culling of the animal<sup>[2]</sup>. Prognosis of heart disease in bovine varies from guarded to poor depending upon the nature and severity of the disease<sup>[3-9]</sup>. The cattle without signs of heart failure are suggestive of early or mild cardiac disease and have a better prognosis than that with signs of heart failure<sup>[2]</sup>.

For diagnosis of disease related to heart signalment and history of the animal<sup>[2]</sup>, ancestral history<sup>[10, 11]</sup>, case history, chronic inflammatory process (metritis, mastitis, sole abscess)<sup>[4, 12]</sup>, chronic respiratory disease<sup>[7]</sup> should always be given emphasis. In any case suspected of heart disease, various ancillary tests should be performed<sup>[13]</sup> based upon the facilities available. Ancillary test recommended for suspected cardiac diseases includes cardiac auscultation, thoracic radiography, electrocardiography, echocardiography, phonocardiography; pericardiocentesis for cell cytology or culture, blood gas analysis, lymph node aspirate and biopsy, blood cultures; abdominocentesis, complete blood count and cardiac catheterization. Biochemical estimation such as gamma glutamyltransferase, aspartate aminotransferase, creatinine kinase, creatinine kinase isoenzyme (CK<sub>2</sub>-MB), lactate dehydrogenase, and fibrinogen level estimation may aid in diagnosis. Serology for Bovine Leukemia virus should be considered to rule out Bovine Leukosis as it is spread throughout the world. It has high prevalence in South America, some Asiatic countries, Middle East countries, and Eastern European countries<sup>[14]</sup> specific cardiac biomarker i.e. cardiac troponin I [CTnI] and cardiac

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troponin T(CTnT) can be valuable in the diagnosis heart disease at early phase [15].

The purpose of the review article is to describe the findings of the previous documented literature, on the diagnostic modalities, current therapeutic and management aspects and prognosis of various cardiac diseases in bovine. The article will act as a useful document for the large animal practitioner and researcher to formulate strategies for future research in the field of heart diseases related to cattle and buffaloes.

## Materials and Methods

The published articles in various journals, books available online and in Institutional library from 1953 to 2017 were used as the subject for compiling the information of the present manuscript.

## Pericardial Disease

The most common disease of pericardium is traumatic pericarditis [16, 17] followed by pericarditis secondary to pleural or lung infection [18, 19], neoplastic effusion secondary to a lymphoma or mesothelioma [20, 21, 22] and idiopathic aseptic pericarditis [23, 24]. Tamponade secondary to rupture of coronary artery following traumatic injury due to hardware disease are uncommon and fatal pericardial disorders [25].

Pericarditis is a condition in which inflammation of pericardium with accumulation of serous or fibrinous inflammatory products [26] occur due to trauma caused by hard ware (sharp/potential foreign bodies). The proximity of the reticulum to the pericardium appears to be primary cause of high occurrence of traumatic pericarditis in cattle and buffaloes. The incidence of pericarditis are reported to increase with increase in intra-abdominal pressure as a result of advance stage of pregnancy or any other affection of gastrointestinal tract. Its onset is either acute, subacute, or chronic [27]. The occurrence is less frequent with hematogenous origin [26] and is associated with colibacillosis, pasteurellosis, salmonellosis, anaerobic bacterial infection and is masked by the signs of septicemia [26]. In cattle, pericarditis is characterized by clinical signs such as tachycardia, muffled heart sound, asynchronous heart sound such as rubbing or splashing sounds, jugular vein distension and edema of the jaw, dewlap, ventral abdomen extending to udder [17], anorexia, decrease milk production, pyrexia, increased pulse rate [27]. Diarrhea and scanty faeces are also observed [28]. Congested mucous membrane and increased capillary refill time is also associated with pericarditis. Buffaloes with pericarditis, shows clinical signs common as that of cattle; however clinical manifestations of submandibular, brisket edema, jugular distension and abnormal heart sounds suggest advanced stages of traumatic pericarditis [29, 30, 31].

**Diagnosis:** The tentative diagnosis of pericarditis is based on clinical signs. On auscultation tachycardia with muffling heart sounds are usually noted. The severity of tachycardia increases with the increase in compression of the heart by pericardial effusions. The lung sound is heard louder than normal dorsally, while no lung sound is heard in ventral thorax which is because of dorsal displacement of the lungs due to cardiomegaly associated with pericardial effusions [32]. Pain test such as pole test, pain on percussion of xiphoid region, back grip test are positive in cattle but in buffaloes these are less common [17, 29]. Radiographic findings in cases of pericarditis include enlarge cardiac silhouette, dilated caudal vena cava, poor thoracic detail due to pericardial or

pleural effusions, fluid and gas accumulation [32]. In the initial stages, good thoracic detail is evident on radiograph; however, as the clinical condition progresses the detail and differentiation of thoracic structure is lost [33]. It is rare to detect presence of sharp foreign body in the thoracic region as it usually gets masked due to thick adhesions /effusions. Many cases of pericarditis need to be differentiated from the advanced cases of reticulo-diaphragmatic hernia as both may have similar radiographic signs. Ultrasonography is more sensitive diagnostic aid to distinguish pericarditis from other allied conditions [34].

Echocardiography is considered as gold standard diagnostic modality for diseases related to heart. To perform echocardiography in bovine a wide range of probe are being used by various authors. For cattle to obtain echocardiogram either in B- mode, M-mode, Pulsed Wave Doppler or Spectral Doppler phase array transducer of 2.5 to 3 MHz are highly sensitive [35, 36]. Sector probe of frequency 3.5 to 5 MHz was used by Mohammed (2010) [29] for the diagnosis of pericarditis in buffaloes. Hussein and Staufenbiel (2014) [37] used convex transducer of 3.5MHz in buffaloes for the diagnosis of heart disease. Third to fifth intercostal space (ICS) on both sides of the thorax [35, 36] and about 3-10 cm above the olecranon level is the ideal site to obtain different views of normal and disease echocardiogram in bovine [Fig. 2] [35]. On the left side wider window (4th and 5th ICS) is available for scanning of normal heart of cows and buffaloes compared to on right side where heart could be scanned from 4th ICS only [34].

Echocardiography is the most sensitive of all the diagnostic approaches for the investigation of diseases related to heart [4, 7-9, 20, 38-43]. However in cases of pericarditis, heart gets enlarged due to presence of effusions in the pericardial sac and lungs get contracted dorsally, the heart could be scanned from 5th and 4th ICS on either side [34]. Pericardial effusion is seen which causes separation of pericardium from the epicardium. The pericardial fluids are hypoechoic to echogenic [29, 34]. On the epicardium, echogenic strands of fibrin are observed. Strands of fibrins float occasionally in the fluid between pericardium and epicardium [Fig. 3] [39, 44, 45].

Electrocardiography is another tool used in the investigation of cardiac diseases. For electrocardiography in cattle and buffaloes base apex lead system is most preferred as it produces large amplitudes complexes and animal movement have minimal impact on the reading [13, 46-50]. The positive lead can be attached to the skin on the left side of 5th intercostal space (about the level of elbow) and negative lead on the on right jugular furrow about one to two third from the ramus of mandible to thoracic inlet and the ground limb attached to the skin of the neck or any other place which is remote to heart [13, 48, 51]. It can also be performed by placing the right arm lead to the neck, the left arm lead on the chest wall just above the sternum and the neutral lead on withers [52]. The recordings are made at paper speed of 25mm/sec and calibrated at 10mV. In electrocardiography of bovine with traumatic pericarditis using base apex lead system shows decreased amplitude of QRS complex (<1.5mV), electric alternans (altered configuration of the P, QRS, or T complexes on regular basis) and slurring or elevation in ST segment [53-55]. Pericardial fluid analysis from the 5<sup>th</sup>ICS between the base of heart and ventral thoracic vein is preferred for pericardiocentesis (Fig. 1) [13]. The pericardial fluid of cattle suffering from traumatic pericarditis has a typical smell of toxic metritis and or retained placenta [31]. Pericardial fluid of urine colour with

blood tinged, foamy, increased protein concentration above than 3.5g/dL and leukocytosis beyond 2500/ $\mu$ L<sup>[32]</sup> are indicative of pericarditis.

Haemato-biochemical findings in cattle with pericarditis includes reduced clotting time in glutaraldehyde test, leucocytosis, increased concentration of fibrinogen; increase in the concentration of Gamma Glutamyl Transpeptidase (GGT), Aspartate Transaminase (AST) and bilirubin than normal<sup>[17]</sup>. In buffaloes, increase in total protein concentration, hypoalbuminemia, hypergammaglobulinemia and increased free fatty acid were observed<sup>[29]</sup>. Cardiac specific marker i.e. cardiac troponin T (CTnT), cardiac troponin I (CTnI), creatinine kinase isoenzyme (CKMB)<sup>[15, 23, 56]</sup>, nitric oxide<sup>[15]</sup> are elevated in pericarditis and can indicate pericarditis in early stage<sup>[15]</sup>.

### Treatment

**Medicinal:** The increase in heart rate, improvement of venous return, reduction in after load can be achieved with digoxin in traumatic pericarditis (Mcguirk, 1991). However these are associated with risk of myocardial oxygen debt and induction of dysrhythmias<sup>[57]</sup>. The preferred route of administration of digoxin is intravenous as it causes severe muscle necrosis when given intramuscularly and are destroyed when incubated in ruminal contents when given orally<sup>[58,59]</sup>. Verapamil and hydralazine might be more effective but require evaluations before it can be used. The choice of antibiotic should be based on its bactericidal effectivity against gram positive and gram negative aerobic and anaerobic organism and should be modify as needed. Combinations of extended spectrum of penicillin e.g. amoxicillin or ampicillin along with aminoglycosides may be helpful<sup>[57]</sup>. Furosemide should be avoided as it causes reduction in cardiac output<sup>[57]</sup>. Pericardiocentesis from left side at 5<sup>th</sup> ICS is preferred however it can be performed from right side of the thorax at 5ICS [Fig.1] if the pericardial effusion is severe. Pericardiocentesis are suggested for short term survival [Fig.1]. The decrease in pericardial pressure causes improvement in the diastolic filling of the right ventricle and increases cardiac output<sup>[60]</sup>.

**Surgical treatment:** The surgical treatment should be considered only after assessing the economy, the risk associated and the probable outcome. Pericardiectomy and pericardiectomy are the treatment option after thoracotomy. In pericardiectomy, the pericardium is incised, followed by drainage of fluid and if foreign bodies are present it is removed. The pericardial cavity are thoroughly irrigated with isotonic saline solution containing antibiotics<sup>[27]</sup>, then an indwelling pericardial drain may be placed so that the lavaging, draining and instillation of antibiotic can be done. Pericardiectomy (partial pericardiectomy) has been reported successful in the treatment of constrictive pericarditis which is associated with thick mediastinal adhesions in buffaloes<sup>[61]</sup>.

### Prognosis

Long term successful survival of the animal is very rare. The objectives of the treatment is concentrated towards short term improvement from cardiac failure so that the animal can calve or can be used for the superovulation for embryo transplant. With the increase in the volume of pericardial effusions, edema of submandibular, ventral edema and jugular pulsation the prognosis becomes grave<sup>[30, 31]</sup>.

### Myocardial Diseases

In cattle myocardial diseases can occur at any age. It is difficult to diagnosis unless it is in generalized or at advanced progression<sup>[57]</sup>.

Dilated cardiomyopathy (DCM) is the primary and most common disease of myocardium in cattle<sup>[6]</sup>. It is a disease of unknown origin which results in dysfunction of the myocardium<sup>[62]</sup>. Primarily there is disruption of the cardiomyocytes by undetermined factors<sup>[6]</sup>. The Holstein – Friesian cattle are most susceptible to DCM. The autosomal recessive gene in Holstein- Friesian could be one of the factors for susceptibility of this breed of cattle<sup>[63]</sup>. It occurs due to a number of etiologies which persist together like abnormalities of immune function<sup>[64]</sup>, chronic viral infection<sup>[65]</sup> or genetic factor<sup>[66]</sup>. A persistent viral infection in genetically predisposed individuals is one of the most common suggestion<sup>[67, 68]</sup>. Venular sclerosis has been suggested as a primary cause of dilated cardiomyopathy in cattle by Tontis *et al.*, (1990)<sup>[69]</sup> and also observed by<sup>[70, 71]</sup>. Furuoka *et al.* (2001) has also suggested an association between the disease and myopathy of diaphragmatic muscle. Toxic cause of cardiomyopathy occurs secondary to ionophores toxicosis<sup>[72]</sup>. Pregnancy can precipitate the condition due to overloading of the heart<sup>[6]</sup>.Switzerland has been reported as the only endemic country in world for DCM<sup>[6]</sup>.

The most common clinical signs observed in cardiomyopathy are subcutaneous edema (presteral and/ or submandibular and/ or ventral), jugular vein distension, ascites followed by audible heart murmur, muffling heart sound, palpable liver, diarrhea and pulsating jugular vein<sup>[6]</sup>.

**Diagnosis:** Diagnosis of myocardial diseases can be achieved by virtue of clinical signs, rapid progression of the disease, echocardiography, increased activities of liver specific enzyme; urea, creatinine<sup>[6]</sup> and increased concentration of transferrin in urine<sup>[73]</sup>. Other haematological parameters are not of diagnostic value.

**Treatment:** No specific treatment for either primary or secondary dilated cardiomyopathy is been reported<sup>[6, 72]</sup>. For secondary DCM correction of electrolyte imbalance, cardiac dysrhythmia and trace mineral can be of some help<sup>[2]</sup>.

**Prognosis:** Prognosis is considered fatal in primary DCM<sup>[71]</sup>.

**Secondary myocardial disease** includes myocarditis i.e. inflammation of the heart muscles<sup>[74]</sup>. It occurs due to bacteria<sup>[75]</sup>, virus<sup>[76]</sup> or parasites<sup>[77, 78]</sup>. Other causes of myocarditis are nutritional which occurs due to Vitamin E or Selenium deficiency<sup>[79]</sup>, copper deficiency<sup>[80]</sup>. It is an important and unrecognized cause of DCM<sup>[74]</sup>. The pathogenesis of viral myocarditis includes entry of virus into cardiac myocytes and macrophages through specific receptors, inciting a cytotoxic effect<sup>[81, 82]</sup>. In advanced stage of myocarditis signs of congestive heart failure are evident<sup>[57]</sup>.

**Diagnosis:** The clinical signs, cardiac auscultation, haematology, biochemical analysis and cardiac biomarker (CTnT and CTnI) followed by electrocardiographic finding and echocardiography can be of help for diagnosis of myocardial diseases.

**Treatment:** The successful treatment of myocardial disease is dependent on the identification and resolving of the primary cause of the disease. In advanced myocardial disease cardiovascular drugs should be advocated to improve myocardial functions, resolve edema and to manage the cattle for short term goal of calving or superovulation [57].

### Prognosis

Prognosis is dependent on the early identification of the cause and the resolving the cause as early as possible.

### Endocardial disease

Endocardium of cattle is mostly affected by bacterial endocarditis [2, 83-85]. It occurs due to infection of one or more surface of endocardium [86]. It can occur due to potential source of infection from chronic mastitis, chronic metritis, traumatic reticuloperitonitis, musculoskeletal abscess formation and cellulitis [12]. It can also occur due to infusion of a solution, catheters, needles contaminated with bacteria, repeated rectal examination; thrombophlebitis especially of the external jugular vein; preexisting valvular diseases; and or cardiac anomaly [57]. In cattle bacterial endocarditis is mainly vegetative in nature [12, 4]. For pathophysiology to develop persistent bacteremia is essential [87, 88]. Recurrent bacteremia due to chronic active infection are believed as predisposing factor [31].

The common clinical signs observed are weight loss, decreased milk production, tachypnea, tachycardia, anorexia, recurrent fever, abnormal respiratory sounds, jugular and milk vein distension and pulsation, dyspnea with cyanotic mucous membrane, tachyarrhythmia, chronic mastitis, polyarthritis, abdominal distension, epistaxis, presternal edema, submandibular and ventral edema [38, 89] and chronic lameness [4].

**Diagnosis:** On auscultation tachycardia and cardiac murmur (systolic) are the common findings however cardiac murmur in cattle is not necessarily observed in association with bacterial endocarditis [90]. The absence of cardiac murmur may be due to lack of significant regurgitation at the affected valve or may be due to difficulty in auscultating slight murmur [2]. Hematological finding includes normocytic, normochromic anemias, leukocytosis, neutrophilia [12, 38, 57] lymphopenia. Elevated aspartate aminotransferase, gamma glutamyl transpeptidase, total protein, lactate dehydrogenase, hypoalbuminemia, hypergammaglobulinemia, azotemia and creatinine [38]. Arterial blood gas analysis shows metabolic alkalosis and elevated bicarbonate [38]. Ultrasonography finding with endocarditis includes echogenic or shaggy mass, acoustic reverberation, pleural effusion and dilated hepatic vein, congested and enlarged liver [89], hyper echogenicity, thickening and proliferative or vegetative lesion, oscillating vegetation, vibratory or mobile, moth eaten or fluffy appearance, nodular changes, focal or discrete lesions [38] leading to endocardial thickening [89]. The electrocardiography in bovine endocarditis reveals deep QRS complexes (1.7 to 2.5mV) and tall T waves (0.8-1.5mV) [38]. The confirmatory diagnosis for infective endocarditis can be made on positive blood culture along with echocardiographic evidence of valvular mass. The common bacteria isolated from bacterial endocarditis are *Arcanobacterium pyogenes* or streptococci [5], *Corynebacterium pyogenes*, alpha hemolytic *Streptococcus*, non hemolytic *Streptococcus* [12].

Various authors have observed different common sites for

endocarditis occurrence; right atrioventricular valve (tricuspid) followed by left atrioventricular valve (bicuspid) [31], pulmonic and atrioventricular valve followed by mitral valve [90], pulmonic valve followed by tricuspid, mitral and rarely aortic valve [91] pulmonic valve followed by tricuspid and mitral valve endocarditis [38].

Endocardial damage can also occur due to jet lesions or valvular dysplasia [92] or after cardiac implantation in experimental research [93].

**Treatment:** The treatment of infective endocarditis can be achieved by the use of antibiotic capable of arresting valve destruction by the bacteria within vegetation, eliminating sites of disseminating sepsis and preventing embolic formation. For adequate treatment antibiotic therapy for minimum of four week is needed [57].

**Prognosis:** Early diagnosis of bacterial endocarditis is important for prognosis and treatment.

### Congenital heart disease

Most common congenital diseases of heart observed in cattle are incomplete closure of ventricular septum [7, 8, 9, 94], followed by the non cyanotic heart diseases i.e. atrial septal defect, patent ductus arteriosus without pulmonary hypertension and cyanotic heart disease i.e. teratology of fallot, Eisenmenger's complex [95]. Most of the congenital heart disease occur due to defective septa and formation of the cardiac chambers during embryonic development [95].

Animal with signs of, ill thrift, poor growth, respiratory disease not responding to proper treatment, murmur heard on physical examination and sudden death, poor reproductive performance in long term [7, 96] can be suspected for congenital heart disease. Other clinical finding can be, increase in heart rate, jugular distension, increase in lung sounds, reduced appetite, increase in rectal temperature, diarrhea, stunted conformation [83].

**Diagnosis:** Echocardiography is most useful tools in diagnosis of congenital cardiac diseases [97]. Phonocardiography can demonstrate the shape of cardiac murmur, in ventricular septal defect or atrioventricular valve regurgitation the murmur is plateau shaped, murmur associated with ejection is diamond shaped (crescendo-decrescendo). Holosystolic murmurs are heard in calves with ventricular septal defect on both side of thorax in phonocardiography [13]. Angiography can be used in the assessment of complicated congenital cardiac defects [13]. Cardiac catheterization can be done for blood oxygen measurement to assess size of intracardiac shunt. Thoracic radiography may be helpful in the diagnosis of congenital cardiac disease, as in these cases enlarged cardiac cavities is seen [112]. Bulge in the pulmonary artery in thoracic radiograph can indicates patent ductus arteriosus [13]. However the thoracic radiograph are not sufficiently sensitive to detect the anomaly but are able to assess the presence and extent of pneumonia frequently observed in ventricular septal defect [7]. (Buczinski *et al.*, 2006a).

**Treatment:** Treatment till date for congenital heart disease in cattle is not available [95]. (Buczinski *et al.*, 2005).

**Prognosis:** Prognosis can vary from guarded to poor. Though ventricular septal defect is most common congenital heart

defect in human, horse and cattle; however, the prognostic factor are not been defined in cattle (Buczinski *et al.*, 2006a) [7].

### Miscellaneous diseases

#### Heart tumor/Neoplasia

Heart may be the primary site for neoplastic diseases or may be involved secondarily by tumors from adjacent structures such as lungs, pleura, lymph nodes or diaphragm [32]. Most common cardiac tumor in cattle comprised of lymphoma [3, 5]. There are no specific signs of neoplasia. If cardiac tumor involves pericardium signs of pericarditis or pericardial effusion, tachycardia, pain, jugular venous distension, peripheral edema and weak arterial pulses are evident. When tumors involve myocardium it may affect the conduction system which leads to cardiac arrhythmia, cardiac murmur (atrioventricular valve insufficiency), tachycardia and shows signs of congestive heart failure. Signs involving tumors of endocardium comprises obliteration of cardiac chambers, valvular obstruction or damage, embolic showering however tumors rarely occurs involving endocardium. Clinical signs of lymphoma are lymphadenopathy, weight loss, melena, exophthalmia or posterior ataxia. These clinical signs can be absent in cases of congestive heart failure secondary to cardiac neoplasia [21, 23]. Other bovine heart tumors noted are rhabdomyoma [98, 99], rhabdomyosarcoma [100], haemangioma [101], haemangiosarcoma [30, 99], fibroma [102], fibrosarcoma [102], angiolipoma [103], leiomyoma [99, 100], leiomyosarcoma [99], adenomatoid tumor [104], hamartoma [99], mesothelioma [22], myxoma [98], mesothelioma [22], lymphosarcoma [21] and malignant aortic body tumor [105].

**Diagnosis:** Ancillary tests are useful to confirm the diagnosis of cardiac tumours. Peripheral lymph node aspirate and biopsy are useful to confirm cardiac neoplasia. Lymph node affected with lymphosarcoma contains lymphoblast and numerous mitotic figures [106]. In lymphoma, biochemical findings noted are hypoalbuminemia, increased creatinine kinase, aspartate aminotransferase, gamma-glutamyl transferase [107]. Eosinophilia and lymphocytosis are noted. Pericardial fluid reveals hyperlactaemia in lymphoma [107] and other neoplasm (Coghe *et al.*, 2000) [109]. Electrocardiography produces arrhythmias, reduce amplitude of QRS and or altered normal appearance of the P, QRS and T complexes. Two dimensional echocardiography produces a hyperechoic structure either isolated to a heart chamber, pericardium and or valves or involving multiple chambers, pericardium and or multiple valves.

**Treatment:** Thoracoscopic pericardiectomy is considered as palliative treatment for lymphoma in cow with a survival period of 3 weeks after the initial diagnosis [109]. Pericardiocentesis is inexpensive; however, is associated with short to medium period of survival, allowing the cow to remain productive in the herd [107]. It allows survival for more than 6 months in some cases [57]. Repeated pericardiocentesis along with single dose of furosemide @ 1mg/kg and procaine penicillin @ 22000 IU/kg BID for two days was found effective in the treatment of tamponade due to cardiac lymphoma with survival period of 34 days in a cow [107].

**Prognosis:** Prognosis is usually poor [57] to grave for cardiac lymphoma [108].

**Congestive heart failure (CHF):** The terminal stage of heart disease is heart failure [110] and is characterized by syncope, exercise intolerance and weakness [110]. Effusion and edema are also noted which occur due to increase hydrostatic pressure and fluid retention [5]. Heart failure is a result of progressive adaptive changes in the neurohormonal axis that have multiple negative impacts on the myocardium and cardiac output [84, 85]. In cattle, right side heart failure is common as compared to the left side heart failure.

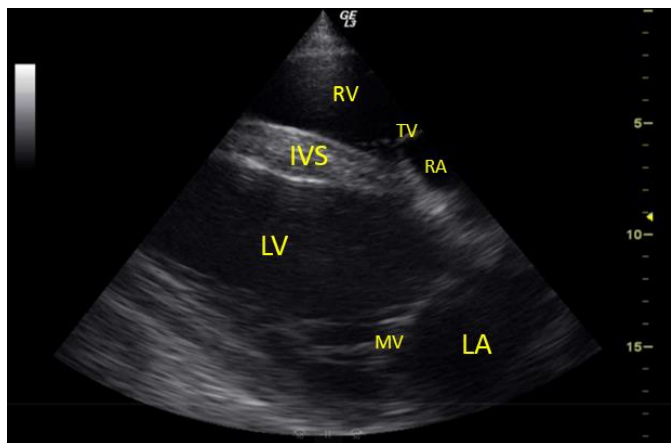
**Diagnosis:** Cattle with CHF especially without cardiac dysrhythmia or murmur should be carefully examined to rule out hypoproteinemia, pleural effusion, neoplasia, or other diseases leading to generalized edema [57]. Cattle with congestive heart failure are often hyponatremic. Diagnosis can be achieved by virtue of clinical signs, electrocardiography, echocardiography and other ancillary tests. There is increase in pericardial fluid which is observed in echocardiography. The cytology and protein content of the pericardial fluid is normal [13]. The arterial blood gas analysis can also be beneficial for diagnosis of CHF.

**Treatment:** The sole agent for initial therapy of CHF can be achieved by using digoxin @ 0.86µg/kg/h [111]. According to the change in body weight daily the dose of digoxin is to be adjusted. Potassium chloride (KCl) @ 100g orally should be used daily if the cattle is not eating [57]. Furosemide is useful in resolving pulmonary edema and pleural effusion. It should be used with caution as it lead to reduction in preload causing impair in cardiac output. It also causes potassium depletion in anorectic or hypophasic cattle increasing the risk of digoxin toxicity or cardiac dysrhythmias. It should be discontinued as soon as generalized edema, pulmonary edema or pleural effusion is resolved. Cattle with CHF and cardiac dysrhythmias, antiarrhythmic drugs (quinidine) should not be used till digoxin has stabilized the signs of CHF as it can lead to complication like hypotension, negative inotropic properties and or not able to correct dysrhythmias [57].

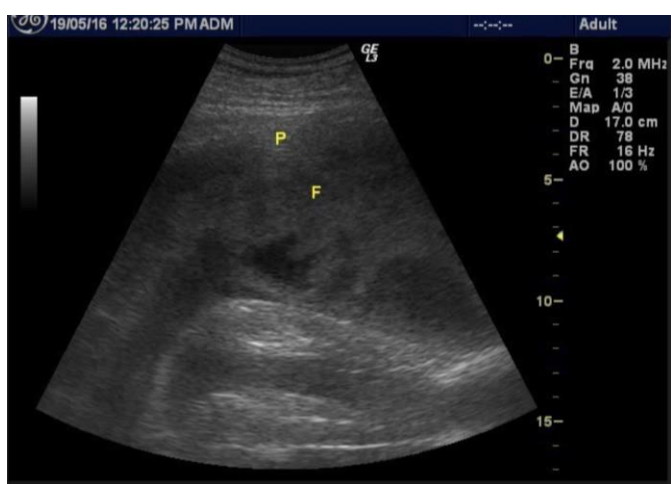
**Prognosis:** Medicinal therapy can be of some help for short time period goal however long term favorable outcome is not documented.



**Fig 1:** Showing Needle Pericardiocentesis from right side (5ICS) of thorax



**Fig 2:** Showing normal Echocardiographic image of heart chambers and valves in Buffalo; LA-left atrium, MV-Mitral valve, LV-Left ventricle, IVS-interventricular septum, RV-right ventricle, TV-tricuspid valve, RA-Right



**Fig 2:** Showing Fibrinous Pericarditis in Buffalo, F-Fibrin, P-pericardium

### Conclusion

Heart diseases in bovine are common with non-specific clinical manifestations. Diagnosis of heart disease is very complicated in field condition as mostly the clinical signs are shown when the disease has already progressed and has affected the ability of heart to act as a pump. A combination of various diagnostic aids including auscultation, hemato-biochemistry, serum biomarkers, thoracic radiography, electrocardiography and echocardiography may aid in the diagnosis of cardiac disease in bovine. Echocardiography is most sensitive noninvasive diagnostic tools in veterinary field at the present state. Treatment options for cardiac diseases are either unavailable or not rewarding. The present, aim of the medicinal and surgical treatment of heart disease is to achieve short term survival till calving or superovulation. There is a huge scope of research for developing better medicinal or surgical modalities for the bovine suffering from cardiac diseases.

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