



Epidemiological aspect and major constraints in controlling haemorrhagic septicemia in dairy animals of Punjab

M H MALIK¹ and H K VERMA²

Guru Angad Dev Veterinary and Animal Science University, Ludhiana, Punjab 141 004 India

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ABSTRACT

Present study was undertaken to study the epidemiological aspect of haemorrhagic septicemia (HS) in dairy animals and various constraints in controlling its occurrence in different agro-climatic zones of Punjab. The study was conducted in all the different agro-climatic zones of Punjab by multistage stratified random sampling of 720 dairy farmers and categorized them on the basis of herd size of dairy animals, viz. small (5–10), medium (11–50) and large (>50). The overall incidence and case fatality rate (CFR) of HS among dairy animals was 5.45 and 45.15% respectively. Incidence risk of HS on the species basis varied significantly and was observed highest in buffaloes (6.27%), followed by crossbred (4.67%) and indigenous cattle (3.91%). Within different herd sizes, the incidence risk of HS varied significantly and was highest in small herd size (10.52%) followed by medium (5.44%) and large herd size (3.01%). Incidence risk varied significantly between the different agro-climatic zones of Punjab within small and large sized herds but not in medium sized herds. CFR among the different herds was highest in small herd (49.28%) followed by medium herd (44.32%) and large herd (39.15%). The major constraints faced by farmers for controlling HS estimated by using Garrett's ranking technique included failure of prophylactic vaccination, cost of treatment, strict biosafety measures and hygienic sanitary conditions not followed, inadequate early disease detection and poor availability of veterinary and extension services. Various veterinary and extension tools should be chosen based on agro-climatic conditions and analyzing farmers in respect of education, herd size, extension contacts, teledensity and training etc. to overcome this dreadful disease of dairy animals .

Key words: Case fatality rate, Constraints, Dairy animals, Haemorrhagic septicemia, Incidence risk

Haemorrhagic septicemia (HS) is an important bacterial disease caused by *Pasteurella multocida* that primarily affects cattle and buffaloes. It is an acute, septicemic fatal disease in bovines, especially in tropical countries of Asia and Africa (Bain *et al.* 1982, De Alwis 1992, Ahmed 1996). The organism remains in the upper respiratory tract as a commensal and causes the disease when the animal undergoes stress. It is clinically characterized by an initial phase of temperature elevation (often unnoticed), followed by a phase of respiratory involvement, and a terminal phase of septicemia and recumbence leading to death. HS is endemic in India with most of the states reporting the disease (Venkataramanan *et al.* 2005). In India, HS ranked second during 1991–2010 in terms of number of outbreaks reported after FMD outbreaks (Gajendragad and Uma 2012). HS accounted for 58.8% of the aggregate bovine mortalities due to 5 major diseases and caused 50,000–55,000 deaths in animals leading to significant financial losses to farmers (Dutta *et al.* 1990, Singh *et al.* 1996, Dua 2003).

Punjab is predominantly agrarian state with dairy sector

Present address: ¹PhD Scholar (malik592hus@gmail.com), ²Director of Extension Education (hkvpa@gmail.com), Department of Veterinary and Animal Husbandry Extension Education.

as its sub-sector contributing 25.81% to the gross state domestic product at constant prices of which agriculture and livestock sector contributes 16.6 and 7.75%, respectively (ESO Punjab 2016–17). Punjab accounted for just 1.27% of the total cattle and 4.75% of the total buffaloes in the country but still ranks 5th in milk production with 1,032 grams/day capita availability of milk. In order to improve the livestock population and their production, the state has to be free of livestock diseases through vaccination and other disease control measures. The present study was conducted to estimate the epidemiological aspect of HS in dairy animals and various constraints in controlling this disease by dairy farmers in different agro-climatic zones of Punjab.

MATERIALS AND METHODS

Sampling was done by multistage stratified random sampling across 6 agro-climatic zones of Punjab (Mahi and Kingra 2013), viz. Sub-mountainous undulating region (Zone I), Undulating plain region (Zone II), Central plain region (Zone III), Western plain region (Zone IV), Western region (Zone V) and Flood plain region (Zone VI). From each zone, 2 districts were selected randomly, and then from each selected district, 2 tehsils were selected randomly.

From each selected tehsil, 3 villages were selected. Thus, the sample for the study comprised 12 districts, 24 blocks and 72 villages. On the basis of a pre-survey, a list of farmers having at least 5 adult cattle or buffaloes, were prepared from each selected village. Then, simple random sampling without replacement was followed to select 10 livestock owners/households from that list. Thus, 720 livestock owners/households constituted the final sampling units for the study.

On the basis of herd size, the dairy farmers were categorized into small (5–10), medium (11–50) and large (>50). The data were collected from above mentioned dairy farmers. The respondents were interviewed for data collection using interview schedule specially prepared for the purpose.

The epidemiological parameters pertinent to HS in Punjab like incidence risk and case fatality rate were studied. The information was obtained with the help of a structured interview schedule about constraints in controlling HS in this region. On the basis of the information collected, the data were tabulated and processed so as to develop certain conclusions.

In the interview, farmers were asked to describe the main epidemiological and clinical features of HS that they observed in their disease affected animals using open-ended questionnaire. Then for each category of dairy animals, the number of animals affected and died during its occurrence was recorded (2016–17) to determine incidence risk and case fatality rates, respectively at species level and herd level. The responses provided by dairy farmers were confirmed with the local veterinarian and matched with the existing data registers at the local dispensary. The animal level incidence risk was determined as the number of animals infected divided by the total number of animals at risk at species level and herd level. Case fatality rate was the proportion of animals that died due to HS among all animals diagnosed for HS over a certain period of time.

Garrett's ranking technique was used to analyze the constraints of controlling the HS in dairy animals as perceived by the affected dairy farmers. To find out the most significant constraints perceived based on its seriousness by dairy farmers, respondents were asked to

assign the rank for all constraints and the outcome of such ranking was converted into score value with the help of the following formula:

$$\text{Percent position} = \frac{100 (R_{ij} - 0.50)}{N_j}$$

where R_{ij} , rank given for the i^{th} factor by the j^{th} individual; N_j , number of factor ranked by the j^{th} individual.

With the help of Garrett's table, the percent position estimated was converted into scores. Then for each factor, the scores of each individual were added and then total value of scores and mean values of score was calculated. The factor having highest mean value was considered to be the most important factor.

RESULTS AND DISCUSSION

The overall incidence of HS among the different species of crossbred cattle, indigenous cattle and buffaloes was 4.67%, 3.91% and 6.27% respectively (Table 1) and varied significantly ($\chi^2=13.06$; $P<0.01$). The incidence risk of HS among the crossbred and indigenous cattle between the different agro-climatic zones of Punjab did not vary significantly ($\chi^2=10.09$ and 9.80 ; $P>0.05$) and ranged between 3.18% (Zone V) to 5.76% (Zone VI) and 2.22% (Zone II) to 8.62% (Zone V) respectively. However, in buffaloes, it varied significantly ($\chi^2=16.20$; $P<0.01$) and ranged between 4.58% (Zone II) to 8.49% (Zone I). Similarly, the CFR among the different categories of animals and between the different agro-climatic zones of Punjab did not vary significantly ($P>0.05$). The overall CFR among the different species of animals was higher in buffaloes (46.77%) and ranged between 38.70% (Zone V) to 53.70% (Zone I), followed by crossbred cattle (42.85%) [ranged between 35.29% (Zone II) to 50% (Zone V)] and indigenous cattle (41.67%) [ranged between 33.33% (Zone III) to 57.14% (Zone IV)].

Among the different herd sizes, higher incidence risk of HS in dairy animals was observed in small herd size (10.52%) followed by medium (5.44%) and large (3.01%) (Table 2) and was statistically significant among the different herd groups ($\chi^2=195.95$; $P<0.01$). Further, between the different agro-climatic zones of Punjab for small herd

Table 1. Incidence risk and CFR due to HS on species basis of dairy animals in different agro-climatic zones of Punjab.

Species basis	Category	Agro-climatic zone of Punjab							χ^2 value	Total animals	Affected animals	Prevalence (%)
		I	II	III	IV	V	VI					
Incidence rate (%)	Crossbred cattle	4.3	3.3	4.5	3.6	3.2	5.8	10.1 ^{ns}	4639	217	4.7	
	Indigenous cattle	5.4	2.2	3.2	2.8	8.6	6.4	9.8 ^{ns}	920	36	3.9	
	Buffalo	8.5	4.9	7.5	4.7	5.5	6.7	16.2*	6472	387	6.3	
Overall χ^2 value = 13.1*												
CFR (%)	Crossbred cattle	41.7	35.3	43.9	35.7	50.0	44.0	1.0 ^{ns}	217	93	42.8	
	Indigenous cattle	50.0	16.7	33.3	57.1	40.0	45.4	2.5 ^{ns}	36	15	41.7	
	Buffalo	53.7	51.2	42.6	47.4	38.7	46.0	2.6 ^{ns}	387	181	46.8	
Overall χ^2 value = 1.0 ^{ns}												

*($P<0.01$) and **($P<0.05$) indicate significant difference; ^{ns}($P>0.05$) indicate no significant difference.

Table 2. Incidence risk and CFR due to HS on herd basis of dairy animals in different agro-climatic zones of Punjab.

Herd size (%)	Category	Agro-climatic zone of Punjab						χ^2 Value	Total animals	Affected animals	Prevalence (%)
		I	II	III	IV	V	VI				
Incidence risk (%)	Small	13.8	10.4	11.6	8.5	10.7	6.7	12.7**	2661	280	10.5
	Medium	6.4	4.8	6.6	3.11	5.5	6.1	10.3 ^{ns}	3566	194	5.4
	Large	0	2.6	5.6	4.0	0	2.9	25.0*	5504	166	3.0
Overall χ^2 value = 195.9*											
CFR (%)	Small	48.2	54.9	50.0	47.5	47.9	43.7	0.9 ^{ns}	280	138	49.3
	Medium	38.9	41.4	51.6	47.4	44.0	47.2	1.6 ^{ns}	194	86	44.3
	Large	0	46.7	34.4	40.0	0	39.1	0.7 ^{ns}	166	65	39.2
Overall χ^2 value = 4.4 ^{ns}											

*($P < 0.01$) and **($P < 0.05$) indicate significant difference; ^{ns}($P > 0.05$) indicate no significant difference.

size ($\chi^2=12.75$; $P < 0.05$), medium herd ($\chi^2=10.33$; $P > 0.05$), and large herd size ($\chi^2=25.04$; $P < 0.01$). The incidence risk among the different herd groups, was observed highest in small herd size [ranged between 6.72% (Zone VI) to 13.79% (Zone I)], followed by medium herd size [ranged between 3.11% (Zone IV) to 6.62% (Zone III)] and large herd size (3.01%) with the highest prevalence of 5.61% in Zone III and no cases were observed in Zone I and V. Further, the overall prevalence (5.45%) due to HS among the dairy animals between the different agro-climatic zones of Punjab varied significantly ($P < 0.01$) and ranged between 3.31 to 9.61% (Zone VI and Zone V respectively).

Similarly, the CFR due to HS of small, medium and large herd size (49.28%, 44.32%, and 39.15% respectively) was not significant ($\chi^2=4.39$; $P > 0.05$), among the different herd size and between the agro-climatic zones of Punjab. In small herd size, it did not vary significantly ($\chi^2=0.98$; $P > 0.05$) [ranged between 43.75% (Zone VI) to 54.90% (Zone II)]; for medium herd size, incidence risk did not vary significantly ($\chi^2=1.61$; $P > 0.05$) [ranged between 38.89% (Zone I) to 51.61% (Zone III)]. Further, for large herd groups, it also did not vary significantly ($P > 0.05$) with the highest occurrence of 46.67% (Zone II) and no mortality observed in Zone I and V, respectively. The overall CFR (45.15%) due to HS among the dairy animals of different agro-climatic zones of Punjab did not vary significantly ($P > 0.05$) and ranged between 41.67 to 49.47% (Zone VI and Zone II respectively).

The highly endemic nature of the disease indicates that it is contagious due to high mortality than other diseases. This may be the first report on epidemiological aspect and economic impact of HS in Punjab using primary data collected from the dairy farmers. The significant difference in incidence risk of HS was observed between the species among the different agro-climatic zones of Punjab with higher occurrence in buffaloes followed by crossbred and indigenous cattle and concurred with previous reports (Verma *et al.* 2004, Khan *et al.* 2006, Farooq *et al.* 2011, Mondal and Yamage 2014, Singh *et al.* 2014, Govindaraj *et al.* 2017). This might be due to the inherent disease resistance in indigenous cattle and the susceptibility of HS more towards buffaloes than cattle. The young animals of

indigenous cattle suffered higher mortality and morbidity risk, whereas, the adults of crossbred cattle and buffaloes were at higher risk.

Among the different agro-climatic zones of Punjab, Zone I, III and VI following the highest incidence risk than Zone II and IV. In these zones, farmers may be engaged in agricultural operations and had less attention to animal husbandry during monsoon leading to HS occurrence. In some cases, there was a failure in prophylactic vaccination of HS in animals and its occurrence was accompanied with FMD. Further, it was observed that the peak HS occurrence was mainly towards the border districts of the state than the interior districts, indicating the need for different and strong vaccination programme for different regions. The significant difference of incidence risk and case fatality rate was observed among herd sizes, particularly higher proportion in small and medium farms than large farms (Govindaraj *et al.* 2017). It may be attributed to the lack of resources with small and medium farms to rear the animals under reduced stress levels mainly through adequate spacing, appropriate housing, poor veterinary service during an emergency and allocating monetary resources for treatment. Few small farmers had a wrong myth over the vaccination of their animals. Small and medium dairies reared mostly buffaloes and were more susceptible to HS compared to cattle population. The overall incidence risk of HS (5.45%) (range 2.96–10.28%) observed among the herd sizes concurred with the results from Bangladesh, Cambodia, India, Pakistan and Sri Lanka (De Alwis and Vipulassiri 1981, Farooq *et al.* 2011, Khan *et al.* 2011, Mondal and Yamage 2014, Kawasaki *et al.* 2015, Govindaraj *et al.* 2017).

Among the different herds, the estimated CFR (45.15%) (ranged 41.67–49.47%) in Punjab was contrary to the earlier reports of 50–100% in Karnataka (Govindaraj *et al.* 2017), 51.4% in Asom (Krishnamoorthy *et al.* 2015) and 89.5% in Tamil Nadu (Krishnamoorthy *et al.* 2016). This variation in CFR might be due to better awareness about HS in dairy farmers of Punjab, good coverage and effectiveness of HS vaccination programme by the state animal husbandry department and rearing of more indigenous resistant breeds in this state than the states of Karnataka and Tamil Nadu,

where more crossbred animals are reared and non-participation of farmers obstacle the vaccination efforts to control the disease. The overall incidence and CFR risk due to HS among the dairy animals in Punjab was 5.45 and 45.15%, respectively and was observed higher in buffaloes and small herd size groups among the species and the herd size of animals respectively. Similarly, the mortality risk or CFR due to HS was higher in buffaloes (especially young animals) and in small herd groups. Among the different agro-climatic zones of Punjab, Sub-mountain undulating region and Flood plain region had the highest occurrence of incidence risk of HS. Whereas, the Western plain region had the lowest occurrence of incidence risk of HS among the dairy animals. Hence, the study concludes that all the cattle and water buffaloes irrespective of age should be vaccinated to mitigate the incidence of HS. However, previous studies (De Alwis 1999, Shivachandra *et al.* 2011) had suggested vaccination of young animals (≤ 1 year) on priority, but, it would not be sufficient to prevent the disease incidence in the endemic regions (Punjab) where more adult animals were affected.

Prevalence of HS in this region causes a huge economic loss to the dairy farmers and requires an optimum decision to control this disease by planners and other people associated with this sector. Control of diseases and subsequently eradication requires isolation and quarantine of sick animals as well as animals suspected for disease, strengthening disease monitoring and surveillance, vaccines and vaccination strategies along with other control measures (Thrusfield 2007) which is not feasible under Indian perspective due to small units of dairy farming as well as small land holding by rural people. Hence strict and well

planned control measure needs to be taken in favour of farmers to overcome its burden. The various control measures that a dairy farmer perceived in the study area are given in Table 3.

First major constraint was the failure of prophylactic vaccination in Zone I, II, III and VI; whereas, in Zone V (Western plain), the major constraint was higher cost of treatment of affected animals and in Zone V, the first major constraint was inadequate early disease detection. From the previous study, there were sporadic cases of HS outbreak in various regions of the state that might be due to logistic factors in transportation, storage, administration of the vaccine adversely affecting the vaccination program. The other reason might be that animals may not adequately respond to vaccinations due to host factors like immunosuppression, parasitic or other such immunosuppressive diseases, nutritional deficiency, genetics and maternal antibody levels.

The next major constraint was the higher cost of medication for diseased animals except in Zone I, V and VI (ranks 6th, 1st and 4th respectively). Higher cost of veterinary service during the emergency time and use of costly medicines to treat the animals was perceived by the dairy farmers as the next major constraint in controlling HS in the region. Strict biosafety measures and poor sanitary condition of dairy farm ranks 3rd from the Garrett's mean value across all the different agro-climatic zones except in Zone III, IV and VI (ranks 2nd, 1st and 5th respectively) with inadequate early disease detection and its diagnosis in various regional laboratories. Due to overcrowding of animals, regular fumigation not practiced, strict movement of men and animals not followed and poor drainage system

Table 3. Constraints for controlling HS in dairy animals by Garrett's ranking technique from different agro-climatic zones of Punjab

Category of control measures	Agro-climatic zone												Overall rank
	I		II		III		IV		V		VI		
	GMS	Rank	GMS	Rank	GMS	Rank	GMS	Rank	GMS	Rank	GMS	Rank	
Failure of prophylactic vaccination	88.3	I	82.3	I	88.0	I	62.3	V	81.5	II	81.3	I	I
Higher cost of treatment	81.9	II	77.7	II	58.3	VI	78.7	II	82.8	I	70.5	IV	II
Strict biosafety and poor sanitary measures	72.4	III	64.9	III	75.0	II	81.9	I	77.9	III	67.8	V	III
Inadequate early disease detection	66.9	IV	64.2	V	61.5	IV	68.5	III	63.2	IV	74.4	II	IV
Poor availability of veterinary service during emergency time	65.0	V	64.7	IV	65.9	III	56.2	VIII	56.8	V	71.6	III	V
Poor extension service	54.8	VI	56.2	VI	58.7	V	46.7	IX	51.1	VIII	59.5	VI	VI
Segregation of affected animal protocols not followed	44.1	VIII	50.9	VIII	52.2	VIII	56.2	VII	51.1	VII	53.9	VIII	VIII
Disposal of affected carcass in the open	48.2	VII	57.6	VII	56.0	VII	67.2	IV	53.3	VI	55.6	VII	VII
Poor animal health status	42.6	IX	40.5	IX	41.3	IX	40.9	X	43.6	IX	34.5	IX	IX
Government regulations in slaughtering or culling of affected animals	33.38	IX	38.5	X	40.52	X	62.28	VI	36.26	X	28.48	X	X

GMS, Garrett's mean score

accelerates the occurrence of HS due to its contagious nature. Inadequate diagnostic tool for early detection at nearby regional diagnostic laboratories ranks 4th across the different agro-climatic zones of Punjab except in Zone II (ranks 5th) and Zone VI (ranks 2nd). Farmers were not aware about the early symptoms of HS, they came to notice once the disease had put its impact on animal health suddenly.

Poor veterinary service during the outbreak of disease was among the 5th major constraint perceived by dairy farmers in Zone I and V. This constraint was not prominent in this region as the farmers were well aware about the outcome of this disease. But, due to contagious nature of the disease, it should be controlled as early as possible which needs veterinary service to treat properly the affected animals and give proper guidance to them as per the requirement. The 6th major constraint perceived by dairy farmers across different zones of Punjab (Zone I, II and VI) was the poor extension service to aware dairy farmers backed up by good disease reporting or information system, as the farmers were not aware about the HS control measures and improved farm management practices. The next major constraint ranked at 8th position from the Garrett's mean score values across the different agro-climatic zones (Zone I, II, III and VI) to control HS was segregation of affected animal protocols not followed except in Zone I and Zone II (ranks 7th). Affected animals were not isolated from the healthy herd especially in small herd groups.

Disposal of affected carcass in the open area was ranked at 7th position among the different agro-climatic zones of Punjab and was considered an important constraint to control the HS at farm level. Affected animals were not buried deep or incinerated to prevent exposure of pathogens to targeted healthy animals. Similarly, poor animal health status due to deficiency of adequate balanced nutrients in the diet and stressful condition at the farm due to poor hygiene, poor ventilation and heat stress etc. was ranked at 9th position except in Zone IV (ranks 10th). The main reason for this constraint was due to higher cost of branded feed in the market, animal comfort zones were not sufficient and due to overcrowding of animals. Government regulations in slaughtering and culling of affected animals impedes the elimination of this disease and was ranked at 10th position from the overall Garrett's mean score value in Zone II, III, V and VI.

In India, due to limited resources, the use of vaccines based on epidemiological data for controlling HS has several challenges that need to be overcome. In future, recent molecular diagnostic tools, effective disease surveillance/monitoring systems are required to be applied widely for detecting HS organism and its disease outbreaks in animals so as to follow appropriate prevention and control measures timely. Hence, this study helps to find the occurrence of HS in dairy animals of Punjab, buffalo being the major affected animals followed by crossbred cattle and indigenous cattle. Also among the different herd size of farmers, small herd groups were mostly affected followed by medium and large herd size. Major hurdles in controlling

this disease at farm level were the failure of prophylactic vaccination, cost of treatment, strict biosafety measures and hygienic sanitary conditions not followed, inadequate early disease detection and poor availability of veterinary and extension services.

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