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Research Article

Enhanced energy efficient routing protocol for on demand distance vector routing to improve communication in border area military communication

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Abstract:

Soldiers get rescue services through static wireless node heliports and medical ambulance to provide special service, in a battle field. The Mobile Ad hoc Network environment takes wireless communication across border communication to connects the source of multiple serves in military applications. The mobile node acts as mobile equipment to rescue the soldier. Due to increasing delay tolerance and latency overhead the performance eon network is degraded, to resolve this problem , this paper concentrates on Region and Mobility based Route Request Processing in AODV (RMRRP) is proposed in controlling Route Request Processing mechanism based on node mobility for reducing the routing overhead in AODV. The routing algorithm which guarantees services to the soldier in a shortest time also evaluate the energy efficiency of RMRRP with the existing AODV, DSDV, DSR routing algorithms. Efficiently reduce the overall overhead to a considerable level and significantly improve the overall performance by finding a rectangular region as a forwarding zone and only the nodes within the rectangular region are allowed to forward the RREQ message from source to the destination, hence the overhead in establishment of a stable shortest path gets reduced very much. Network region is minimized. Routing request packets generated is less and route request is reduced. Region width is limited to 150m and within that covered area only route discovery and route maintenance is carried out. Control packets are reduced within the limited rectangular region and data packets are able to send more. Avoiding link breaks to send and receive more data packets with a limited number of control packets hence consumes considerable energy. Simulation result reveals that with nodes 50 the Packet delivery Fraction is 90.60 , Routing overhead is 11376, Normalized Routing Load is 3.61 , Throughput is 261.94Kbps, MAC Load is 39.17 , Energy consumption is 4.64 Joules.

1. Introduction

Border area communication is important for military application for controlling troops all over the regional coverage. The wireless networking takes adhoc network to connect all the communications and cooperate to create communication and infrastructure with number of devices [1]. The MANET works as centralized communication medium to the military data transition with wireless interfaces to transfer the data from source to destination which is directed to the service sharing. The communication behinds with so many protocols in infrastructure level,

service level, and transmission level to connect the military environment. The on demand source routing is one of the protocol which is used in the communication medium to reduce the packet flow delay in MANET to improve the communication [2]. Such a cases the problems is degradation in the communication flow leads to reduce the throughput to create poor connections in wireless medium.

The problem in routing creates minimize the closest neighbor coverage in dynamic source medium leads poor connection and network communication failures to create loss function [3]. It is proved that UDP over DSDV yields poor performance among all the compared methods. TCP over AODV sends more packets and provides higher throughput than all other methods. In terms of PDF, TCP over all the routing methods provides better performance. UDP over DSDV shows poor performance among the all the compared methods [4]. The performance seems to decrease in proportion to the upsurge of mobile nodes in the network. While using TCP, the network consumed much energy. This is because, while using TCP over the routing protocols, it is able to send and receive much data hence, consumes much energy [5].

- AODV and DSR performed well, but the overhead and routing load is high. This makes the possibility of applying Geographic Routing techniques in AODV and DSR to reduce such overhead. Even TCP over AODV and DSR provided the best performance. Even UDP over other routing algorithm provided good PDF under this Quasi MANET.
- AODV drops more packets at all layers despite of its high throughput. Hence there is much scope for improving AODV using the Geo routing concept.
- AODV unnecessarily spends much effort for achieving that level of throughput and delivery ratio. As a result, all these overhead can be reduced by incorporating suitable Geo routing based mechanism in AODV.

The contribution of the paper is to improve the communication in battle filed are to make affordable communication through modified ADHOC network with conservation low levl energy with best communication. To make such improved network with higher throughput, it is indispensable to design networking protocols that can surmount pertinent quandaries that arise from MANET environments. This paper addresses MANET as a Quasi MANET where all the nodes are neither in mobility nor in static condition. Quasi MANET contains where certain nodes are partly mobile and partially static throughout the period of operation. In this scenario every day application has specific restricted predefined functionality and usage. In real life, the mobile nodes necessity to communicate with certain static nodes that are kept at a specific physical location through the short lifetime of the overall network. Hence, Quasi MANET has unnecessary overhead due to the location sharing needs in their design. The increase in node density and the mobility reduces the performance of any routing protocol under Quasi MANET. The proposed system improves the communication as well in remote are with higher throughput best latency with transmission rate.

2. Background Study

The chapter reviews various communication protocols and approaches from improving the network in AODV. Likewise, FACE routing known as compass Routing or Perimeter Routing. As shown in the Figure 1, it is a method ensures guaranteed delivery. The Basic system used in Face routing is a planar graph in which the progress of FACE routing is monitored. The Right Hand Rule is followed to examine the complete borderline of faces. It is undesirable on the surroundings [6].

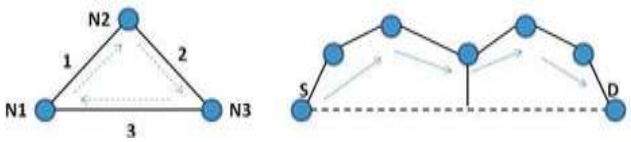

Figure 1: *Face protocol standard level routing*

Most routing is based on the DIR (direction) and also called as Compass Routing Method/Perimeter Routing. The sender calculates the direction to forward the packet based on the available information on the destination node. It is called as Compass routing. DIR another variation is called as f-DIR in which Flooding is used and ensures guarantee delivery [7]. The Geographic and Energy Aware Routing works for improving network life time with the assumption of localization system. Forwarding the packet towards a focused region and within that region broadcasting the information are the two forwarding phases processed in this protocol [8]. By calculating the destination distance the first phase routes the packets. For each destination every node retains an estimated and a learned cost value. To avoid holes in the network, nodes residual energy is measured [9].The Beacon-less Routing (BLR) protocol is based on reactive routing. Through distributed mode forwarding node is selected and broadcasting packets to a zone [10]. From the selection of nodes, only one is chosen based on shortest forwarding delay to forward the packet using Dynamic Forwarding Delay (DFD) concept [11]. In most cases, the Energy Efficient Geographic Routing

protocol (EEGR). As shown in Figure 2 this protocol mainly deals with the sensor position error. The paths having progressed and energy consumption [12].

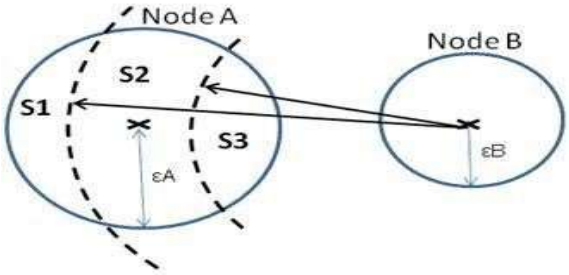

Figure 2: *EEGR forwarding cases for the communication probability calculation.*

Most of energy conservation protocols are handle the packets which is sent to the neighbor with the best advance. Its goal is to exploit possible progress in a specific direction [13]. As shown in the Figure 3,4 shows the most forward within radius protocol (MFR) improve the communication in wireless communication medium.

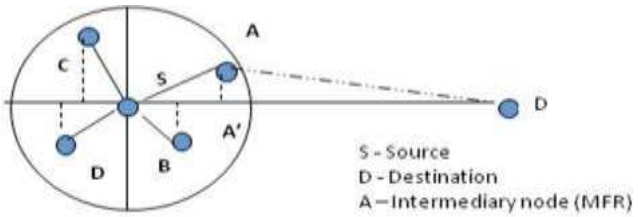

Figure 3: *Illustration of progress with MFR*

One of the proactive routing protocols called Distance Routing Effect Algorithm for Mobility (DREAM) in which routing table is updated with location information in all the nodes. The method called distance effect is used with low frequency the location tables are updated and based on the mobility the frequency is increased. To find node distance between source to destination control packets is incorporated [14].

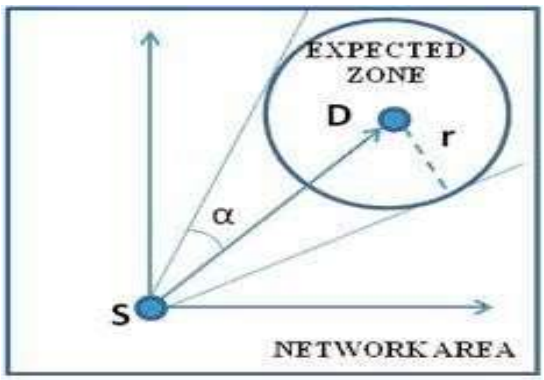

Figure 4: *Illustration of progress with DREAM*

The Improved progress Position Based Beacon Less Routing (I-PBBLR). In this sender node uses non-deterministic routing decisions with the help of beaconless approach based on improving progress metric. If the packet forwarding schemes are used in prior to relaying the packet, the nodes apply Dynamic Forwarding Delay (DFD) [15].The Blind Geographic Routing (BGR) based on the beacon-less LAR algorithm in which it aims to minimize energy consumption. It focuses on the forwarding zone to forward packet. The timer stops first is participating in the forwarding process [16]. By using Avoidance of Simultaneous Forwarding (ASF) strategy concurrent forwarding is prevented by using the comparison of the number of hops between the available in the packet header and the node. By changing the forwarding zone at 60 degrees left or right, it implements a recovery strategy [17]. Modified Directional Source Aware Routing Protocol (MDSAP). It is an extension of DSAP and it works based on the cooperation. Messages are considered as high priority, low priority and medium priority and different routing are assigned based on priority [18]. As shown is the Figure 5 Routing takes place with maximum power for higher priority messages, and low priority choose the shortest path and medium priority message routing is based on the shortest path with certain energy threshold. Processing overhead is considered, but aggregation is optional [19].

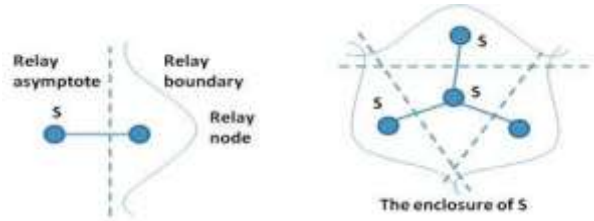

Figure 5: *Relay area and enclosure for MDSAP*

In routing function from source to destination location errors are included and tries to maximize the probability to attain minimum power consumption [20]. Energy consumption is optimized by finding on a single hop optimality in forwarding thereby optimization is achieved in the entire path.

3. Proposed methodology

In an endeavor to address this issue, Region based Route Request Processing in AODV (RRRP) is used for Quasi MANET scenario that can efficiently reduce the overall overhead to a considerable level and significantly improve the overall performance by finding a rectangular region as a forwarding zone and only the nodes within the rectangular region are allowed to forward the Route Request(RREQ) message from the source to the

destination, Region and Mobility based Route Request Processing in AODV (RMRRP) is proposed in controlling Route Request Processing mechanism based on node mobility for reducing the routing overhead in AODV.

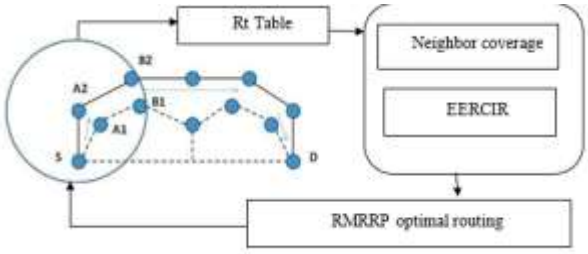

Figure 6: *Proposed region coverage with RMRRP*

Hence that the overhead in establishment of a stable, shortest path gets reduced very much. It is observed that the proposed RMRRP routing algorithm delivered better packet delivery fraction and consumed much energy than the normal AODV since routing request packets generated is less and route request is reduced due to limited region-based route request (figure 6). The performance of RMRRP with AODV, DSDV and DSR the proposed RRRP routing algorithm provided high throughput and consumed almost equal energy than the normal AODV and at low node densities in the case of the DSR routing algorithm.

A)Energy efficient Region based communication impact rate (EERCIR)

Let us taken X(n) number of nodes on military coverage with Route information RT to get the neighbor coverage, to get energy efficient traffic less communication, Compute the progress of all node in route Input = $\{x_1, x_2, \ldots, x_{mo}\}$ to cover 1500 *1500 sq meter are to cover all nodes, to fnd the squared Euclidean distance of nodes to cover all the closest neighbor distance,

$$\|x - x_j\|^2 = \sum_{k=1}^{mo} (x_k - x_{jk})^2$$

To estimate the X→ Traffic, energy packet delay, tolerance throughput of each node handover

$$\varphi_j(x) = \varphi(x - x_j) = \exp\left(-\frac{1}{2\sigma_j^2}\|x - x_j\|^2\right), \quad j = 1, 2, \ldots, K$$

With Traffic PT = $\int_{i=1}^{\text{Hops(Pi)}} \sum \varphi_j(x) \text{Tr}(\text{Hi}(\text{Pi}))$

Compute average one hop delay between all neighbors conservation energy E

$$A = \frac{\sum_{i=1}^{n} \mu(N_i)}{n}$$

$$T(N_s) = \begin{cases} \dfrac{PT.A(N_{p.}\ E)}{1 - N_p * \left(E * mod\ \dfrac{1}{N_p}\right)} & if \quad s \in E \\ 0, & otherwise \end{cases}$$

The region covered area T returns the transmission of conservation of N nodes with maximum support of energy nodes to be taken in single route to improve the communication. According to the Quasi network, the energy conservation are differently along with node of conservation.

B) The Quasi MANET Geo Routing Scenario

Consider the mobile nodes geocast region to connect neighbor to each node, they try to communicate with the static nodes at service providing locations very often. As shown in Figure 7 by considering a MANET disaster recovery scenario with 45 nodes and assume that there are 4 static nodes N0, N2, N4 and N6, at some special service providing locations for troops communication to connect with each other. The black circles filled with yellow are mobile nodes – they may be a mobile equipment carried by a communication reattained location to transfer the data.

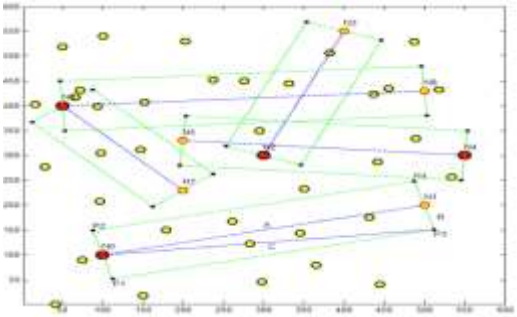

Figure 7: *Topology of Quasi MANET Scenario*

At an instant of this scenario, the nodes N1, N3, N5, N7 and N8 are trying to communicate with that 4 static nodes at the service providing locations. The blue dotted lines connecting the mobile nodes and the static nodes is the line of sight.

If the routing message packets sent among one particular set of mobile nodes and a motionless node also the data packets sent among that particular set of movable node and a stationary node will be handled only by a selected set of intermediate nodes over and near the line of sight, then the delay of communication will be minimum and the routing overhead also will be minimum. That is, if a selected set of nodes with in an imaginary rectangular region drawn over the blue line connecting mobile node and a static node, will only allowed to process the messages or packets sent or received among these two nodes, then it will reduce all kinds of overhead and lead to a considerable improvement in performance.

C) RMRRP Routing Protocol Implementation

The following is the simplest and quite optimal implementation of the above algorithm. It is based

on checking the location of point in that the triangle two edges created the side of half plane.

boolIsPointInTriangle (x1, y1, x2, y2, x3, y3, x4, y4)
For all node route RT (X→ $T(N_s)$)
{
For all traffic less T→bool b1, b2, b3; take # level so conservative route
b1 = sign(x4,y4, x1,y1, x2,y2) < 0.0;
b2 = sign(x4,y4, x2,y2, x3,y3) < 0.0;
b3 = sign(x4,y4, x3,y3, x1,y1) < 0.0;
return ((b1 == b2) && (b2 == b3));
}
In the above function x1, y1, x2, y2, x3, y3 are the coordinate of the three points of the triangle and x4, y4 are the coordinate of the point of interest.
double sign (x1, y1, x2, y2, px, py) {
return Rute Request (x1 - px) * (y2- py) - (x2 - px) * (y1 - py);
}
In the above function, x1, y1, x2, y2 are the coordinate of any two points of the triangle and px, py are the coordinate of the point of interest for each cluster. For verify the all the nodes to connecting float sign(fPoint p1, fPoint p2, fPoint p3)
{
return (point p1.x - p3.x) initial cluster * (p2.y - p3.y) – retained cluster (p2.x - p3.x) * (p1.y - p3.y);
}
boolPointInTriangle(fPointpt, fPoint v1, fPoint v2, fPoint v3)
{
bool b1, b2, b3;
cluster→b1 = degreeofsign(pt, v1, v2) < 0.0f;
cluster→ b2 = degreeofsign (pt, v2, v3) < 0.0f;
cluster →b3 = degreeofsign (pt, v3, v1) < 0.0f;
Route dependency support Max→return ((b1 == b2) && (b2 == b3));
}
The evaluation is made using network simulator version NS2.35 under Ubuntu Linux operating system for all the simulations.

4. Result and discussion

The simulation is carried out in network simulator to cove the border area communication in military region. Table 1 describes the Environment setup and values considered. The simulation results reveal the impact of node density and Node Mobility on network performance with respect to throughput, Packet Delivery Fraction(PDF) and consumed battery energy.

Metrics considered for evaluation

To check the performance, the used metrics are as follows:

Table 1: *Simulation setup progress and values*

Tools used	Ns2 TCL tool command
Area coverage	1500 m x 1500 m
Number of nodes	500 nodes
Duration running	Ins-Network layer
Type Layer	150 sec
Mobility access	Dynamic access point
Pasket size	520kbps
MANET vector	AODV

- Throughput: It measures how well the network can constantly provide the data to the sink

Throughput=Total Received Bytes/Time (Kbps)

- Packet Delivery Fraction (PDF):

It is the percentage of number of packets received at static nodes to the total number of packets sent from the mobile nodes.

- Consumed Energy: It is the consumed battery energy of a node in Jules. Consumed battery energy is equal to the initial energy minus the remaining energy.

The Figure 8 exhibits the performance of RMRRP_AODV,RRRP_AODV and the normal AODVin terms of PDF. The proposed RMRRP_AODV routing algorithm is able to provide almost equal PDF of RRRP_AODV and higher than that of normal AODV routing algorithm.

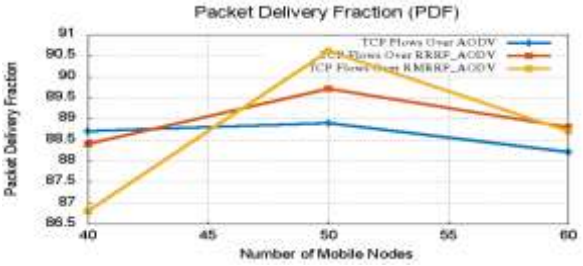

Figure 8: *No of Mobile Nodes vs. PDF*

From Figure 9 it is observed that the proposed RMRRP provided almost equal throughput of RRRP and higher throughput than the normal AODV routing Algorithm. The Figure 10 shows the performance of Consumed Battery Energy. The proposed RMRRP consumed almost same energy as AODV. In Figure 11 comparing the results of proposed RMRRP,RRRP and normal AODVin terms of PDF. The proposed RMRRP and RRRP routing algorithms performed equal and AODV and DSR. In fact, proposed algorithms were able to send and receive very high number of packets than all other compared algorithms. Since the ratio of sent and received is deciding PDF, RRRP provided

less PDF since it is not receiving all the packts it is sending.

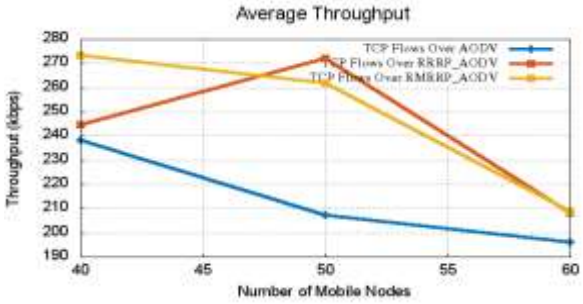

Figure 9: *No of Mobile Nodes vs. Throughput*

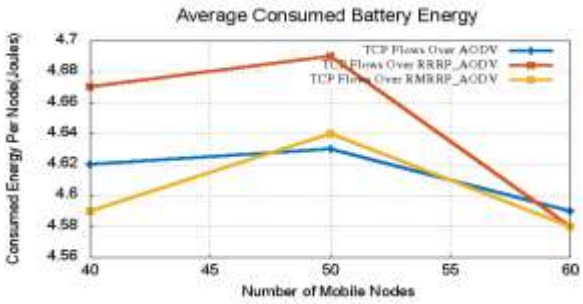

Figure 10: *No of Mobile Nodes vs. Consumed Battery Energy*

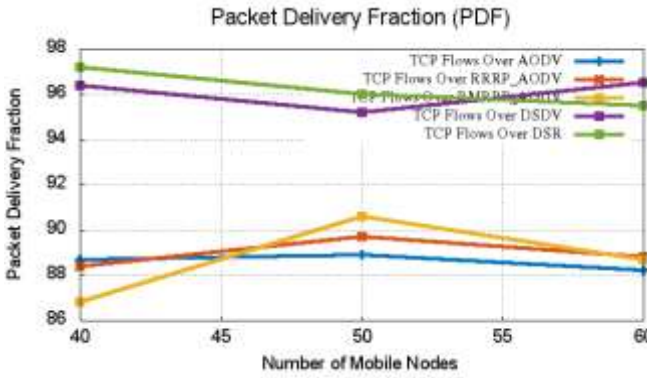

Figure 11: *No of Mobile Nodes vs. PDF*

From the Figure 12 the performance ofproposed RMRRP, RRRP and normal AODV is analyzed in terms of throughput. The proposed RMRRP and RRRP routing algorithms performed equal and provided high througput than the RRRP as well as the normal AODV and other compared algorithms. DSDV provided very poor throughput because of its poor performance. The Energy consumption of Figure 13 implies that the proposed RMRRP routing consumed less energy than RRRP. In the case of DSDV, the energy consumption is very low. Because DSDV was not able to send much packets due to its poor performance and preserves the energy at most of the nodes. The figure 13 projects he energy consumption parameters actively improve the stable routing in the communication area which discovers the tolerance avoidance to improve the communication in military applications.

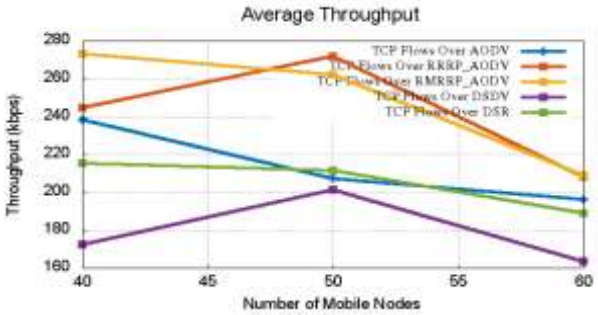

Figure 12: *No of Mobile Nodes vs. Throughput*

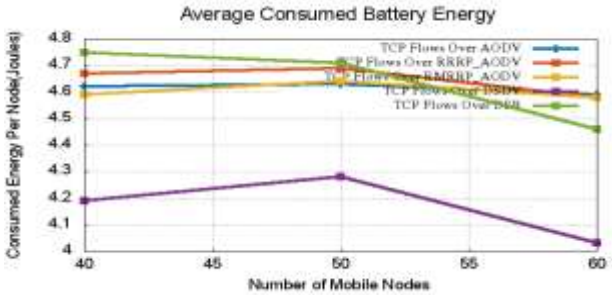

Figure 13: *No of Mobile Nodes vs. Consumed Energy*

5. Conclusions

The proposed RMRRP routing algorithm provided low PDF than the normal AODV. It doesn't mean that RMRRP performed poorly. In fact, RMRRP is able to send and receive very high number of packets than all other compared algorithms. The ratio of sent and received decides PDF, RRRP provided less PDF since it is not receiving all the packets it is sending. However, the RRRP cannot control the Node Speed. Hence, the proposed method, namely the RMRRP utilizes the Node Mobility predicated geo routing method for reducing the routing overhead in Quasi MANET. The proposed RMRRP routing algorithm provided almost equal PDF, equal throughput and consumed same energy due to the mobility threshold. The simulation result reveals significant improvement in the performance of RMRRP. Based on the results of the evaluation, RMRRP outperforms AODV, DSDV, DSR and RRRP.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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