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DEVELOPMENTAL PEDIATRICS TODAY

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Monthly e-Newsletter of IAP Chapter of Neurodevelopmental Pediatrics

Inside

Editorial

Dear Friends and respected Seniors,

Greetings from Neurodevelopmental Chapter of IAP!

As far as Covid situation goes, India's Covid 19 Vaccination coverage exceeds 81.85 crore. Vaccination paces up from 3lakh a day in January to 71 lakh a day in September 2021. India sets record of 2.5 crore Covid 19 jabs in one day on 17th September 2021. A sprint can now take India past Vaccine finish line by December. These figures are quite impressive and encouraging for us. India's score of daily Covid cases is still hovering between 25,000–30,000/ day, with most cases being reported from Kerala and Maharashtra.

Every year the world marks Breastfeeding week from August 1 to August 7. It is celebrated to encourage breastfeeding and to improve health of babies around the world. We have a writeup in this issue on Benefits of breastfeeding including better neurodevelopment.

August is also awareness month for – 'Children's eye health and safety', 'Child vision and learning', 'Spinal muscular atrophy awareness month' and 'Don't be a bully awareness month'. All are important days to spread awareness because they have immense contribution to child development. However, I would like to stress upon awareness regarding bullying, because in India most schools don't have a system to prevent bullying and there is lack of awareness amongst teachers as well as parents.

Long live our Chapter!

Dr. Lata Bhat
Chief Editor

Chairperson's Message

Dear Readers,

This issue comes to you with my greetings for the end of summer, ushering in cool breeze of autumn. Mother Nature has been kind with us as the intensity of the sweep of COVID 19 infection is losing its momentum. We are all rejuvenated after the long pause to new thinking and new behaviour.

August brings in wonderful celebrations of the importance of Breast-Feeding week, the "Amrit" of life and growth. But with the advent of COVID 19 additional thoughts have emerged understanding that breast feeding is a tool box with bioactive components that help prepare the infant to survive. However, in this pandemic, suspicion and positivity of infection have unfortunately resulted in child and mother separation during parturition. This has forced national and international bodies to adopt innovative measures of keeping WHO Infection, prevention and control (IPC) measures through donor milk or expressed milk to continue breast feeding while missing out on kangaroo care. Short term goals of nutrition have been met but we as developmental pediatricians have to be aware of long-term neurodevelopmental effects. Are we going to see more of motor, emotional and social communication regulation problems? Those are something that time will say, but we need to be vigilant at this time for early signs and take appropriate action.

This issue is dealing with current issues and also highlights the importance of recognizing bullying and effects on social and neuropsychiatric outcome and also neurodevelopmental outcomes of neonatal jaundice.

Happy reading.

Dr. Shabina Ahmed MD, FIAP
National Chairperson
Neurodevelopmental Pediatrics Chapter of IAP

Snippets from the Secretary

Respected Seniors and dear friends,

Seasons greetings from the IAP Chapter of Neurodevelopmental Pediatrics.

The month started with the World Breastfeeding week. A simple but frequently neglected act in todays fast paced world, breastfeeding needs a special mention in order to remind us of this natural act of mammals. Initiation of breastfeeding within the first hour of birth, followed by exclusive breastfeeding for six months and continued breastfeeding for up to two years or beyond offer a powerful line of defense against all forms of child malnutrition, including wasting and obesity. Breastfeeding also acts as babies' first vaccine, protecting them against many common childhood illnesses. This year's World Breastfeeding Week, under its theme 'Protect Breastfeeding: A Shared Responsibility' is a time to revisit the commitments made at the start of this year by prioritizing breastfeeding-friendly environments for mothers and babies. Human milk has special constituents which promote the development of baby's nervous system as well as establishes a strong bond between the mother and the child.

"A newborn baby has only three demands. They are warmth in the arms of its mother, food from her breasts, and security in the knowledge of her presence. Breastfeeding satisfies all three."

Grantly Dick-Read

The current issue of the newsletter has some interesting articles submitted by budding developmental pediatricians pursuing IAP fellowship in Neurodevelopmental pediatrics. The chapter is also working towards starting a journal of neurodevelopmental pediatrics and looks forward to suggestions and support from members for the same.

Happy reading and stay safe.

Jai Hind! Jai IAP !

Wg Cdr (Dr) KS Multani
National Secretary
IAP Chapter of Neurodevelopmental Paediatrics

ACUTE BILIRUBIN ENCEPHALOPATHY – Newer Perspectives

Riya Lukose[1], Shyamal Kumar[1], MKC Nair[2]

Neonatal jaundice is a common occurrence seen in upto 60-80% of babies, however the incidence of kernicterus is very rare affecting only 2% of the total[1]. Though, traditionally the cut off point for exchange blood transfusion to avoid morbidity has always been considered as hyperbilirubinemia >20 mg/dl,it may be seen even at lower levels or become worse in babies with low gestational age, low birth weight, haemolysis, sepsis, andcephalhaematoma. In a neonate with pathological hyperbilirubinemia, the toxic effects of free unconjugated bilirubin are mediated by inflammatory cytokines, bilirubin-induced lipid peroxidation, excitotoxicity as well as sustained energy failure1.Such bilirubin induced neurologic dysfunction (BIND) has been seen in low to middle income countries, and in situations where there is early discharge of the mother and baby, within 48 hours following delivery, without adequate postnatal follow up.[2]

Acute Bilirubin Encephalopathy (ABE) and Kernicterus Spectrum Disorders are the new terminologies which has been put forward to describe the acute and the chronic changes brought by bilirubin respectively. Till the recent past many terminologies like acute and chronic bilirubin encephalopathy, bilirubin induced neurological dysfunction have been interchangeably used and has created much confusion.In 2004, AAP suggested the use of the term acute bilirubin encephalopathy to describe acute bilirubin induced neurological symptoms manifesting in the first few weeks of life, and kernicterus for the chronic sequelae of bilirubin encephalopathy[3].Le Pichon, in 2017 proposed a new nomenclature, clarifying acute bilirubin encephalopathy and kernicterus spectrum disorders[4].

Acute Bilirubin Encephalopathy(ABE): ABE describes the signs associated with bilirubin neurotoxicity at the time of exposure. It describes all the findings seen in a baby with bilirubin induced neurologic damage. The babies have decreased feeding, lethargy, abnormal tone (hypotonia and/or hypertonia), high-pitched cry, retrocollis and opisthotonus, setting-sun sign, fever, seizures, and possibly death [5].

The 'kernicteric facies' in acute bilirubin encephalopathy includes a combination of; the setting-sun sign (i.e., paresis of upward gaze) with eyelid retraction, together comprise the Collier sign, and facial dystonia[6]. These findings make the infant appear scared, or anxious. Some infants may also exhibit dysconjugate or wondering eyes. This kernicteric facies persists for at least two to three weeks after acute bilirubin encephalopathy. Apnoeic events are a common clinical sign of bilirubin neurotoxicity in late preterm and term neonates with severe jaundice associated with bilirubin levels greater than 25 mg/dL.Any new onset apnoea/ bradycardia or desaturations /or an increase in severity and frequency of apnoeic episodes requiring medical assistance in a baby with

1. *IAP Fellows in Developmental & Behavioural Pediatrics, NIMS-Spectrum-Child Development Research Centre (CDRC), NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram*

2. *Director, NIMS-Spectrum-CDRC, NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram,*

Address for communication: Dr. Riya Lukose, IAP Fellow in Developmental & Behavioural Pediatrics, NIMS-Spectrum-CDRC, NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram. Email: lukoseriya@gmail.com; Phone: 9495391241

hyperbilirubinemia may indicate encephalopathy.[7] Any such change in the frequency and/or severity of apnoea should warrant a measurement of total serum bilirubin levels as it may suggest acute bilirubin encephalopathy.

The spectrum of signs can be classified into 3 phases depending on the time of onset of symptoms.5

Phase 1(acute phase) Early ABE- presents early usually at 3–5 days of life with decreased alertness, poor feeding, hypotonia and weak Moro reflex.

Phase 2(intermediate ABE)- may vary in onset and duration, usually presents in the latter part of the 1st week but also present later with stupor, irritability, hypertonia of extensor muscles, which may alternate with hypotonia, opisthotonos, retrocollis and high-pitched cry.

Phase 3(advanced ABE)- presents after the 1st week and is typically characterized by hypotonia. Other features include coma, pronator spasm of upper extremities, sun setting eyes, fever, inability to feed and apnoea.Mortality may be at least as high as 21%,usually due to respiratory failure or refractory seizures.

Seizures usually resolve several weeks after the acute insult[8]. Therefore, if seizures persist wehave to rule out other metabolic conditions too. The clinical features in a preterm maybe even more subtle due to neuronal immaturity and the levels of hyperbilirubinemia causing injury maybe lower.

Diagnosis:To diagnose bilirubin encephalopathy, the historyand physical examination is necessary,and also helpful is the BIND score,9 and electrophysiological and neuroimaging studies. Assessment of the encephalopathy must be individualized, taking into account predisposing risk factors.

The salient points in history that may cause the brain injury are;

(i)the severity and duration of hyperbilirubinemia, (ii)prematurity,(iii)sepsis, (iv) acidosis and (v)Rh disease.

The Bilirubin Induced Neurological Dysfunction(BIND) score

The BIND score was initially put forward by Bhutani et al[9,10](to objectively diagnose ABE and assess the neurological status of babies with hyperbilirubinemia.This score initially used mental state, muscle tone, and cry pattern to classify infants into subtle, moderate and advanced, depending on the scores. A modified BIND scale was evaluated in Nigeria by Radmacher et al.[11]which could predict the development and severity of acute bilirubin encephalopathy in resource-limited settings and could be used as a tool in population studies of low- and middle income countries to estimate the magnitude of ABE-related morbidity and mortality.

Modified bilirubin-induced neurologic dysfunction scale (M-BIND)11

The modified bilirubin-induced neurologic dysfunction scale (M-BIND),with a 12-point score, incorporates eye abnormalities such as a divergent gaze, paralysis of upward gaze, anxious appearance and nystagmus.

- Mental State: Under mental state-the levels of consciousness is divided into;

0-normal;

1-sleepy but arousable, decreased feeding;

2-lethargy, poor suck+/- irritability/jittery with short term suck ;

3- semi-coma, seizures, apnoea, coma; each scored from 0 to 3

- Muscle tone:

0-normal;

1-persistent mild hypotonia;

2-moderate hypotonia/moderate hypertonia/ arching of neck and trunk increased on stimulation ;

3-retrocollis / Opisthotonus/ Crossing or scissoring of arms or legs but without spasms of arms and legs and without trismus-each scored 0-3

- Cry pattern:

0-normal;

1-High pitched;

2-shrill cry;

3-cry weak or absent in child previously having shrill/high pitched cry

- Ocular movements:

0-normal ;

3-sun setting, paralysis of upward gaze ; score 1 and 2 is not there.

Hence, a score of 1-4 indicates mild ABE;5-6 indicates moderate ABE; and above that is severe ABE. The threshold for action maybe kept low for resource poor settings for earlier detection.

This scoring helps to differentiate degrees of BIND severity and in distinguishing ABE from other common causes of neonatal morbidity and mortality like tetanus, still seen in low-resources settings. The M-BIND algorithm in resource limited setting was assessed and was found to have a positive predictive value of 88.9%, a negative predictive value of 98.2% and a weighted kappa coefficient of 0.7969 (substantial agreement) between the scores obtained by the consultants and residents.

This BIND scale can thus be used not only for diagnosing and differentiating ABE from other causes but also initiating the appropriate treatment. But for the future outcome prediction, diagnostic tool kits which takes into account both the MRI and BERA findings have been proposed by Le Pichon; though the cost effectiveness in developing nations is questionable.

Evaluation

Step1.History:Abnormal neonatal neurologic signs or symptoms known to associate with ABE (abnormal tone, abnormal cry, posturing, abnormal eye movements or positions). If child presenting later in life, one should enquire about a history of delayed speech, gross or fine motor development, dental enamel dysplasia of deciduous teeth or hearing abnormalities, all consistent with Kernicterus Spectrum Disorder.

Step 2. Examination : Dystonia, choreoathetosis, ataxia, variable hypo/hypertonia, spasticity, incoordination, gaze abnormalities, staining or flaking of deciduous teeth, dental enamel hypoplasia, dysarthria, hearing impairment or difficulty localizing sound may be detected.

Step 3. MRI head: In ABE, MRI may show characteristic T1-hyperintense involvement of the globus pallidus and subthalamic nuclei, while KSD usually demonstrates increased signal intensity on T2-weighted images of the same regions, especially in children with classical and motor-predominant kernicterus. Though, MRI has a role in diagnosis , expertise is an utmost requirement when interpreting them, as sometimes benign changes due to incomplete myelination maybe reported as significant or even relevant changes may be missed[12]

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KERNICTERUS SPECTRUM DISORDERS (KSD)

Riya Lukose[1], Shyamal Kumar[1], MKC Nair[2]

In a neonate with pathological hyperbilirubinemia, the toxic effects of free unconjugated bilirubin are mediated by inflammatory cytokines, bilirubin-induced lipid peroxidation, excitotoxicity as well as sustained energy failure1.The brain injury predominantly occurs in theglobus pallidus, sub-thalamic nuclei, hippocampus, oculomotor nuclei, ventral cochlear nuclei and the Purkinje cells and dentate nuclei of the cerebellum2.Once there is damage caused by increased levels of bilirubin, it causes long-term consequences which may manifest as motor or auditory symptoms. After the acute injury,bilirubin induced damage evolves over many years; in the first year of life, they present with generalised hypotonia, hyperreflexia, persistence of tonic neck reflex and developmental delay. After the 1st year of life, there are more varied manifestations, which was previously termed as chronic bilirubin encephalopathy or kernicteruswith a tetrad of symptoms including;

(i) Auditory impairments(Auditory Neuropathy Spectrum disorders(ANSD) ± sensorineural hearing loss)

(ii) Visual (oculomotor paresis -especially paresis of vertical upward gaze)

(iii) Dental abnormalities (dental enamel dysplasia of the deciduous teeth),

(iv) Extrapyramidal disturbances (motor impairments like dystonia, athetosis).

The terminologies for these sequelae are many and confusing, ranging from kernicterus, BIND, to chronic bilirubin encephalopathy. Hence, Le Pichon et al 3introduced the new classification and terminologies to alleviate the confusion. Since motor and auditory disabilities are the most significant and easily quantifiable clinical features they alone are used in the new classification. Oculomotor dysfunction can be difficult to evaluate on examination, especially in infants and younger children, and dental enamel dysplasia is variably present, and invariably not present when permanent dentition appears.Similarly, all children with bilirubin induced neurological damage need not present with all the four clinical signs of kernicterus or may present with varying degrees of severity,therefore the better option is to categorise them as Kernicterus Spectrum Disorders. Thus, at the milder end of the spectrum, children may have movement disorders, isolated hearing loss and/or auditory dysfunction including isolated auditory neuropathy. Those children with more severe manifestations will have a permanent incapacitating condition characterized by all the four features, specifically dystonia, choreoathetosis, severe neurologic hearing impairment, paralysis of upward gaze and dental enamel dysplasia.This variations in chronic severe sequelae seen in those babies who survive acute bilirubin encephalopathy is termed as Kernicterus spectrum disorders.

Based on the severity of auditory and motor symptoms and the individual motor and auditory involvement, they can be divided into (i) no motor and no auditory, (ii) mild motor no auditory, (iii) moderate motor alone, (iv) severe motor;(v) mild auditory, and so on.

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1. *IAP Fellows in Developmental & Behavioural Pediatrics, NIMS-Spectrum-Child Development Research Centre (CDRC), NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram*

2. *Director, NIMS-Spectrum-CDRC, NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram,*

Address for communication: Dr. Riya Lukose, IAP Fellow in Developmental & Behavioural Pediatrics, NIMS-Spectrum-CDRC, NIMS Medicity Campus, Aralumoodu, Thiruvananthapuram. Email: lukoseriya@gmail.com; Phone: 9495391241

Combination of possible presentations[3]

X axis-Auditory Y-axis - Motor	**Auditory - None**	**Auditory - Mild**	**Auditory - Moderate**	**Auditory - Severe**
Motor - None	**none**	**mild auditory**	**moderate auditory**	**severe auditory**
Motor – Mild	**mild motor**	**mild motor and auditory**	**moderate auditory and mild motor**	**severe auditory and mild motor**
Motor - Moderate	**moderate motor**	**moderate motor and mild auditory**	**moderate auditory and moderate motor**	**severe auditory and moderate motor**
Motor - Severe	**severe motor**	**severe motor and mild auditory**	**severe motor and moderate auditory**	**severe auditory and severe motor**

Auditory abnormalities

These usually present as a neural hearing loss, often mistakenly referred as sensorineural hearing loss (SNHL), but it is best characterized by the term auditory neuropathy spectrum disorder (ANSD), since the auditory dysfunction is localized not only to auditory brainstem nuclei, but possibly the auditory nerve also, with no evidence of a primary sensory (i.e., hair cell) involvement.4So, when a BERA is done it will give abnormal results with persisting cochlear microphonics. This is one of the earliest features of ABE and KSDs and it may be seen even in the absence of other clinical manifestations of BE.

When to suspect ANSD and how to differentiate from SNHL?

In Auditory Neuropathy Spectrum Disorder(ANSD) associated with Kernicterus Spectrum Disorder(KSD),OAEs are present initially but may disappear with time in the first year of life, whereas cochlear microphonics (CMs) are always present. Thus;

o Abnormal or absent ABRs/BERA with the presence of CMs establish the functional diagnosis of ANSD, but abnormal or absent ABRs with absent OAEs does not distinguish between ANSD and Sensorineural Hearing Loss (SNHL).

o Abnormal ABRs of ANSD in KSD are characterized by the presence of wave-I (from the auditory nerve) with the absence of waves-III (from the cochlear nuclei in the pons) and wave-V (from the lateral lemniscus fiber tract of the midbrain as it enters the inferior colliculus).

o Children with KSD may also have concomitant SNHL, and severe ANSD may be confused with SNHL.

The severity of auditory KSD is determined by the amount and persistence of Auditory Neuropathy Spectrum Disorders (ANSDs), Central Auditory Processing Disturbance/Disorder (CAPD)5 and hearing loss, and the amount of hearing loss.Thus, according to this classification;

o Mild ANSD will mean mildly abnormal ABRs which may normalise later or there is central auditory processing disorder, or mild hearing loss.

o Moderate ANSD stands for absent / persistent abnormal ABRs, with mild to moderate hearing loss and delayed speech;

o Severe ANSD signifies absent ABRs with severe to profound hearing loss.5

Motor KSD features

The severity of motor KSD is based on the amount and severity of dystonia and athetosis, and the restrictions of voluntary movements.The commonest extrapyramidal manifestationconsist of dystonia and athetosis, although chorea may also occur. Bulbar functions may also be affected in these individuals. The main point to be remembered is that though the individuals with KSD may have gross motor impairments their cognitive functions is relatively spared. For example, according to this scheme;

(i) Mild motor KSD : Children with mild abnormal tone, writhing movements, and mild gross motor delays and with intelligible speech;

(ii) Moderate motor KSD:Children with dystonia and athetosis who ambulate with an abnormal gait with or without a walker and can feed themselves

(iii) Severe motor KSD : Non-ambulatory children without the ability to ambulate,feed themselves and with severe restriction of voluntary movement

(iv) Most severe motor KSD:Children without voluntary movements unable to speak, with very limited communication (via assistive technologies), dystonic crises and status dystonicus. These children are virtually locked in.

Subtle Kernicterus

Subtle Kernicterus includes neurodevelopmental disabilities that cannot be classified as classical kernicterus signs, especially in those babies who did not have significant hyperbilirubinemia but who had other risk factors that increaseunconjugated bilirubin and/or its movement into tissue like acidosis, hypoalbuminemia and conditions in which albumin ineffectively binds bilirubin such as sepsis, inflammation and extreme prematurity 6.The injury caused by hyperbilirubinemia is also seen to be different in preterm neonates due to differences in neuronal migration.The bilirubin toxicity may occur in areas or pathways that are not usually associated with KSDs and may be characterized by less severe injury including isolated hearing loss which does not meet ANSD criteria and motor involvement so mild that can be described as roughly clumsy or awkward.[7]

Kernicterus Spectrum Disorder Plus

This terminology is used for those children who have other symptoms in addition to kernicterus, for example; spasticity in a baby who had hypoxic ischemic insult in addition to hyperbilirubinemia encephalopathy .The indicators that suggest that it is not only due to bilirubin neurotoxicity are microcephaly, onset of signs before a significant rise in serum bilirubin levels and MRI abnormalities not typically seen in KSD (e.g., lesions of the cerebral cortex, thalamus, caudate, putamen, periventricular leukomalacia, or ventriculomegaly)

Other KSD associated findings may include (i) Gastroesophageal reflux (ii)Sleep disorders8,9 (iii)Failure to thrive (iv) Status dystonicus (v) Neuro-orthopedic conditions like scoliosis and hip dysplasia.(vi) Seizures etc.

Conclusion

Early discharge and the absence of strict follow-up may predispose for bilirubin neurotoxicity in infants, in the current era. This newer classification helps to pinpoint abnormalities clearly and helps in the further management of kernicterus spectrum disorders which includes cochlear implants for auditory abnormalities, drugs like trihexyphenidyl, baclofen, botulinum toxin and deep brain stimulation for dystonias10

Abbreviations: ANSD: Auditory Neuropathy Spectrum Disorder; ABR: Auditory Brainstem Response; CAPD: Central Auditory Processing Disorder; CP: Cerebral Palsy; KSD:Kernicterus Spectrum Disorder

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Benefits of Breast feeding including better Neurodevelopmental outcomes

Dr. Lata Bhat
Developmental Paediatrician, Delhi
Senior Consultant, Indraprastha Apollo hospital, Delhi
Director ,Palak Child Development Centre, Delhi

Breastfeeding is widely acknowledged as the normal and unequalled method for feeding infants due to its associated health benefits, both for the infant and the mother. The World Health Organization recommends that infants are exclusively breastfed up to the completion of six months of age, with breastfeeding continuing to be an important part of the diet until the infant is at least two years old. The several health benefits associated with breastfeeding are driven by the combined action of the nutritional and bioactive components in human milk and the magnitude of the majority of the ascertained biological effects is directly dependent on breastfeeding duration.

IN ADDITION TO SHORT-TERM benefits such as reduced gastrointestinal infections and pneumonia, the long-term benefits of having been breastfed in infancy are of great interest to clinicians, policy-makers, and individuals faced with personal decisions about how to feed their infants. Because the newborn infant brain is uniquely sensitive to nutrition and to other aspects of the environment, interventions to promote optimal brain development early in life can have lasting effects on neurodevelopmental function.

Breast milk provides abundant and easily absorbed nutritional components, antioxidants, enzymes, immune properties, and live antibodies from mother. Mother's more mature immune system makes antibodies to the germs to which she and her baby have been exposed. These antibodies enter her milk to help protect her baby from illness. Immunoglobulin A coats the lining of the baby's immature intestines helping germs and allergens from leaking through. Breast milk also contains substances that naturally soothe infants.

Breastfed babies have:

- Stronger immune systems
- Less diarrhoea, constipation, gastroenteritis, gastroesophageal reflux, and preterm necrotizing enterocolitis (NEC)
- Fewer colds and respiratory illnesses like pneumonia, respiratory syncytial virus (RSV) and whooping cough
- Fewer ear infections, especially those that damage hearing
- Fewer case of bacterial meningitis

- Better vision and less retinopathy of prematurity
- Lower rates of infant mortality
- Lower rates of Sudden Infant Death Syndrome (SIDS)
- Less illness overall and less hospitalization

Following table shows various components of human milk which are either absent or less in bovine milk , which either boost the immunity of the baby or those which contribute to better neurodevelopment :

Components	Human Milk	Bovine milk	Clinical Importance
Immunoglobulins	Yes	no	Strengthens Immunity
Lactoferrin	Yes	No	Potent antibacterial
Oligosaccharides	Yes	No	Prebiotics , immune modulators , neurocognitive benefits
Bifidus Factor	Yes	No	Maintains Gut health
Lysozyme	Yes	No	Antibacterial activity
Alphalactalbumin	7 times		Improves protein uptake and gut development
Glycerol Monolaurate	20 times		Augments antimicrobial and anti-inflammatory activity T
Trolox equivalent antioxidant capacity	8 times		Anti- Oxidant benefits

In healthy, full-term populations, breastfeeding seems to be beneficial to neurodevelopment. One proposed mechanism linking breastfeeding with brain development is the effect of specific nutrients in breast milk that are either absent from or present in lower amounts in infant formula. Another potential mechanism is through greater sensitivity to the infant shown by mothers who provide breast milk, because maternal sensitivity is associated with better neurodevelopment. Connections between breastfeeding and infant development may also be explained in part by shared social determinants such as maternal education and family income, and maternal IQ.

The majority of research studies examining breastfeeding and long-term neurodevelopmental outcomes suggest that children who breastfeed for longer than 6 months have better cognitive outcomes, lower risk of developing attention-deficit/hyperactivity disorder, and lower risk of being diagnosed with autism spectrum disorder.

Predominant breast milk feeding in the first 28 days of life was associated with a greater deep nuclear Gray matter volume at term equivalent age and better IQ, academic achievement, working memory, and motor function at 7 years of age in very preterm infants.

Paediatricians play a critical role in educating and counselling families about infant nutrition and feeding. Along with the many positive short-term medical effects that breastfeeding confers, physicians should be aware of the growing body of research suggesting that there are also significant long-term neurodevelopmental benefits of breastfeeding.

Conclusion : Mechanisms Linking Breastfeeding with Brain Development

Maternal milk feeding is common to all mammals and allows for the continued transfer of resources from mother to infant .The infant brain undergoes rapid development in the first year of life, and this development is strongly influenced by nutritional factors. Thus, the beneficial effects of breastfeeding on the infant brain may be explained by nutrients or even non-nutrient bioactive factors that are present in breast milk, but absent in infant formula

Another important effect of maternal milk feeding is to extend the period of maternal care. An infant's brain development is influenced by interactions with the environment, particularly mother–infant interactions. For example, breastfeeding mothers appear to spend more time engaged in emotional care than mothers who feed their infants formula. Thus, it is possible that breastfeeding is beneficial to the developing brain not just through nutritional effects but also due to differences in mother–infant interactions. The finding in preterm infants that donor milk does not appear to benefit neurodevelopment—whereas maternal milk feeding does—provides some support for this hypothesis; mothers who provide their own milk may be more engaged in other ways with their infant, and this engagement with the mother could explain differences in infant brain development independent of nutritional aspects of maternal milk.

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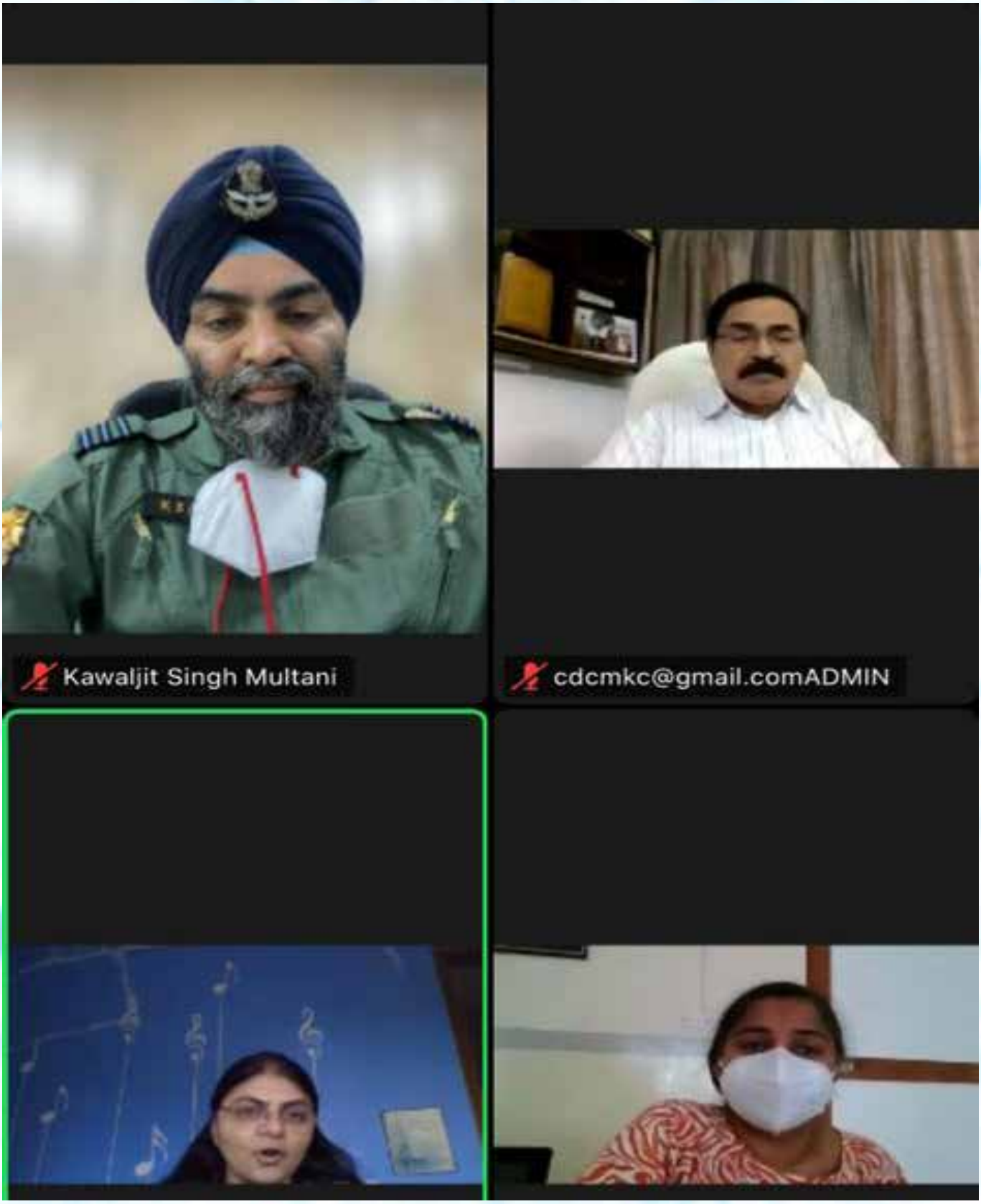

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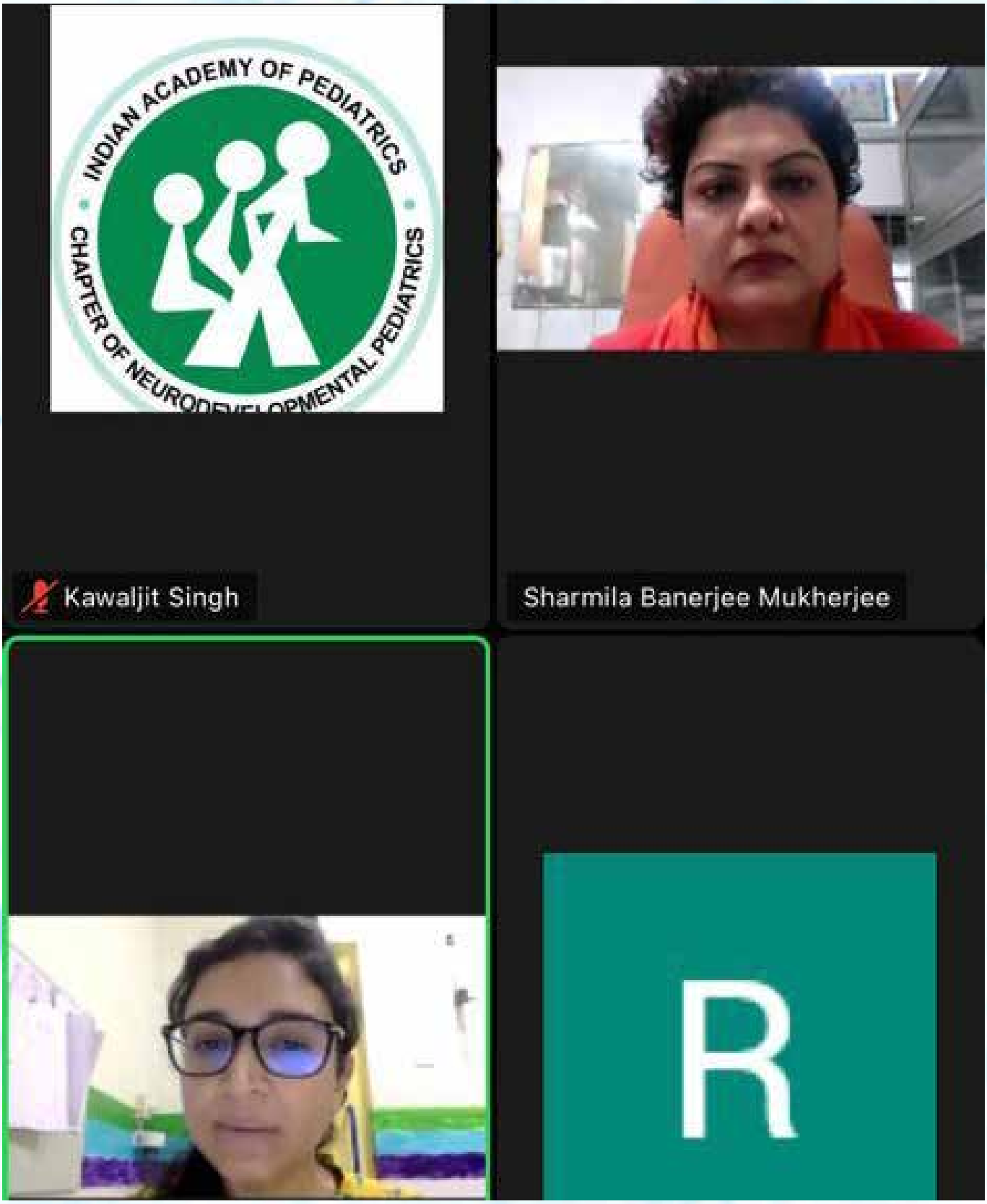

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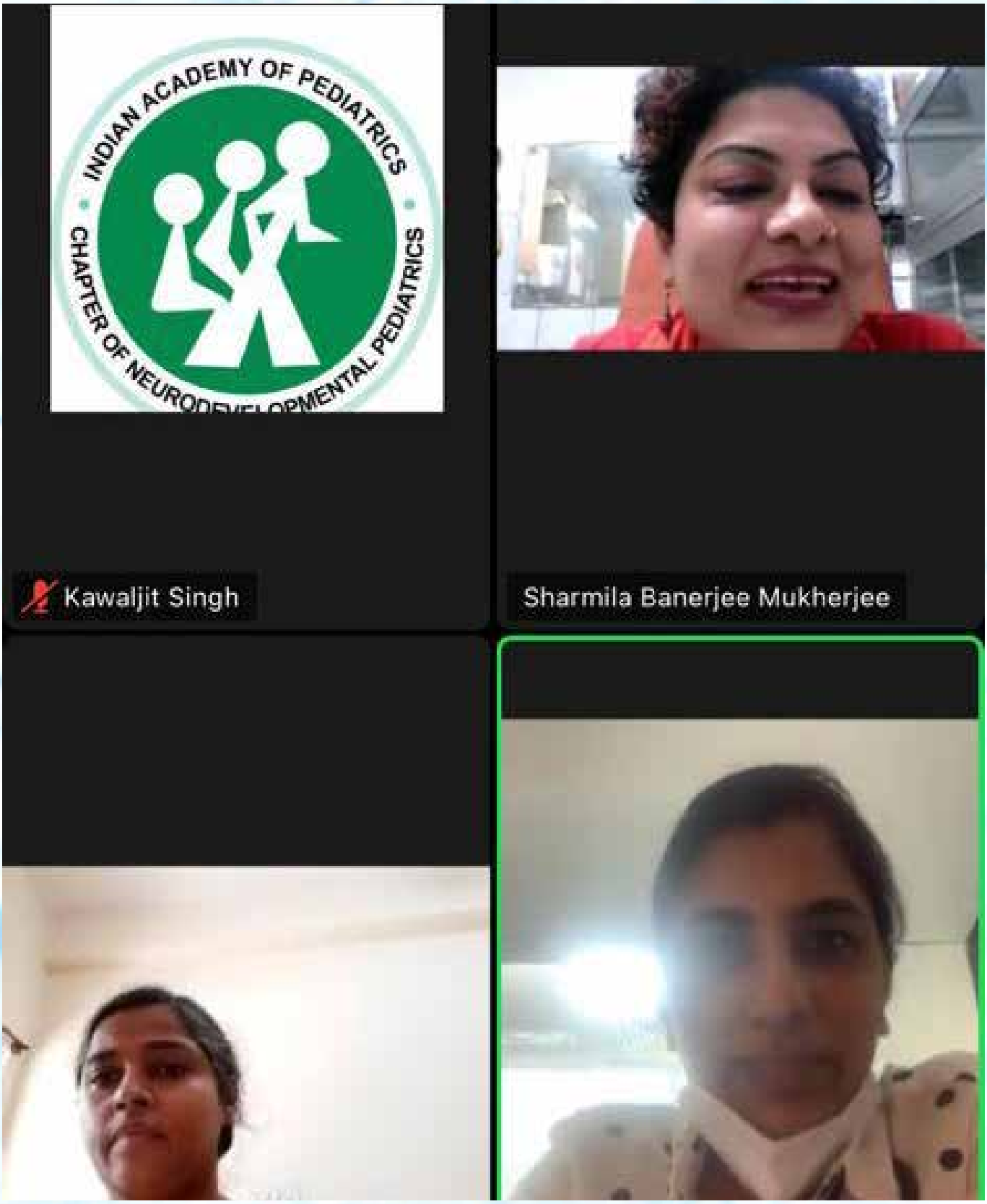

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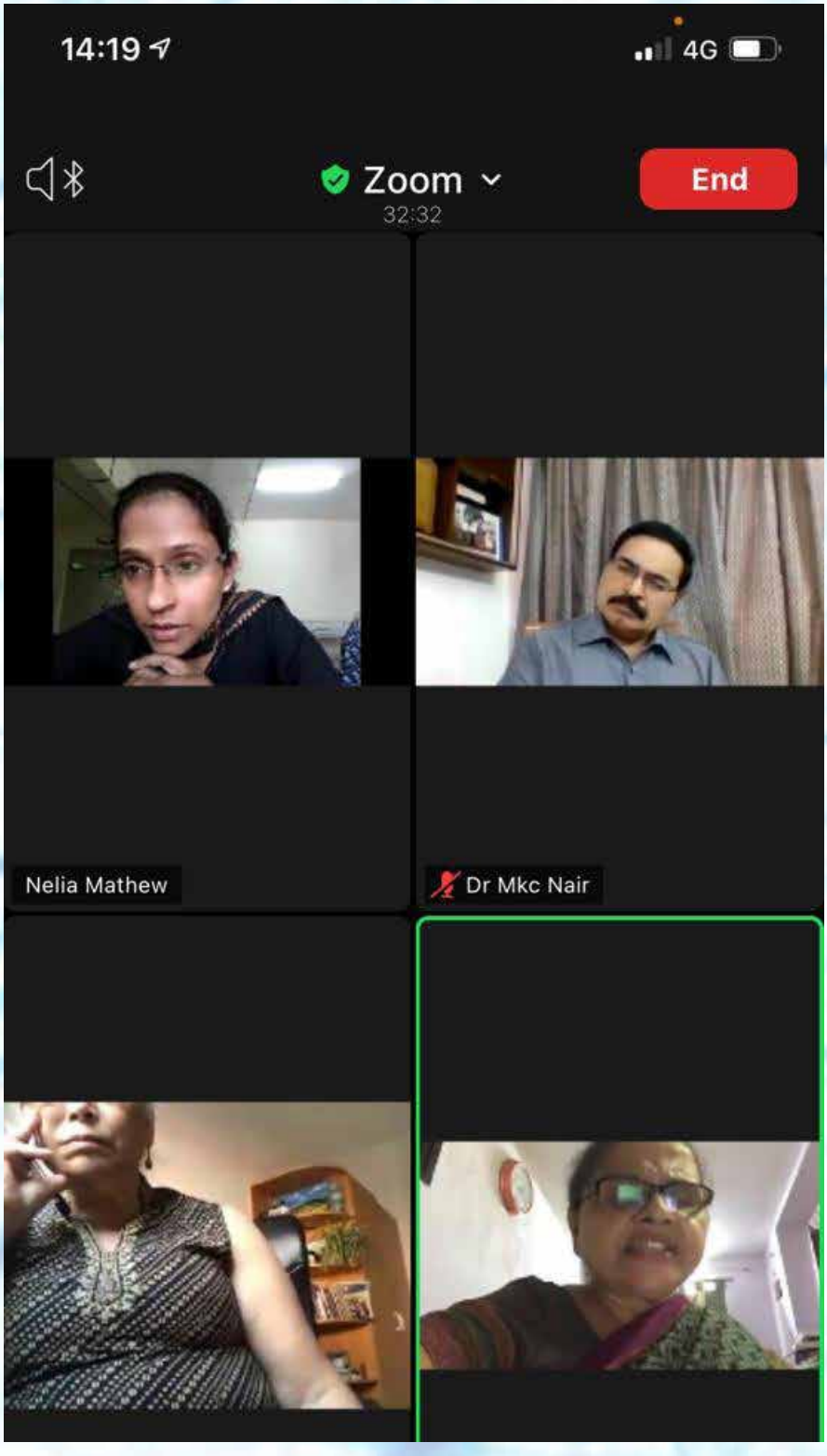

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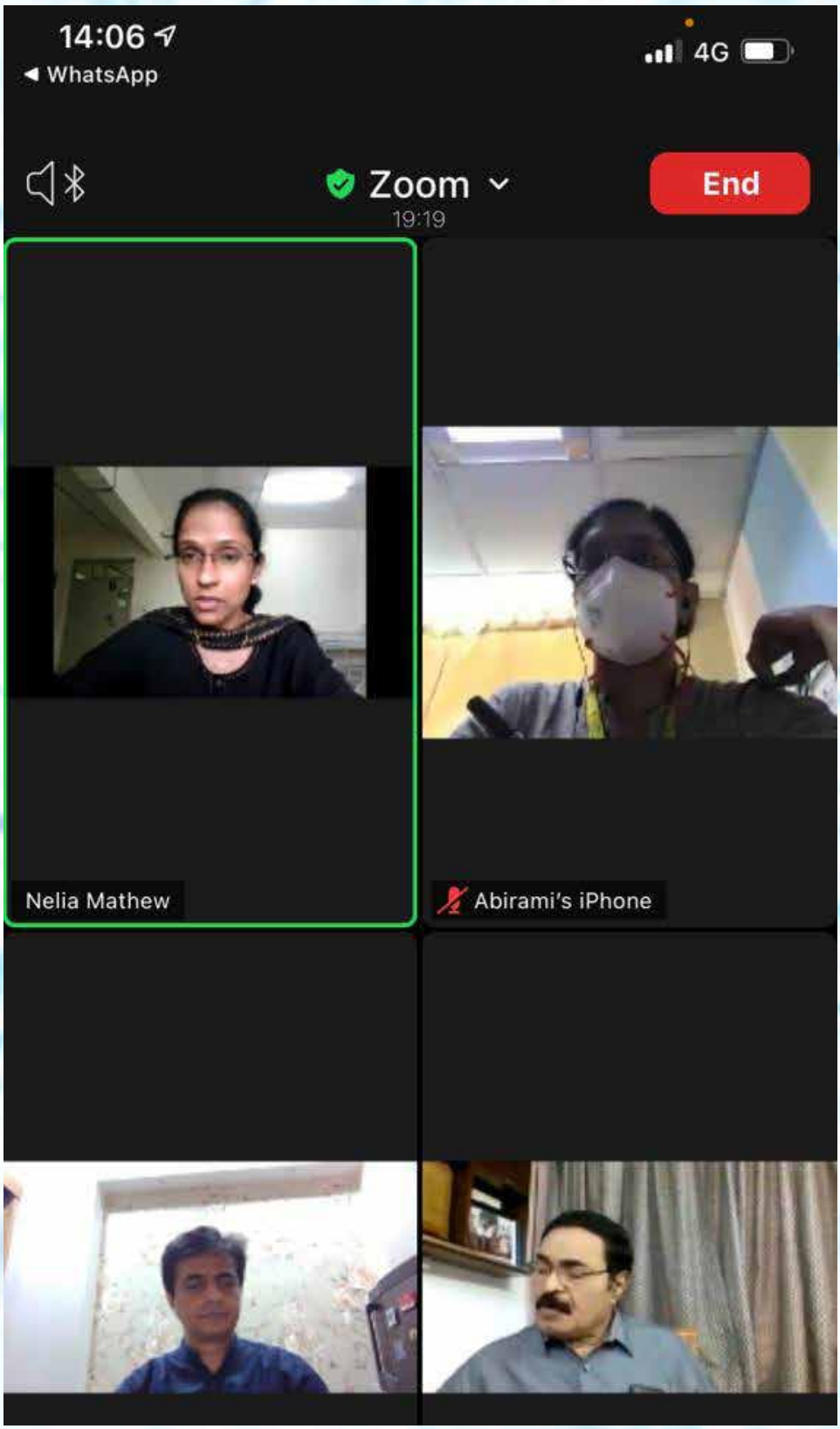

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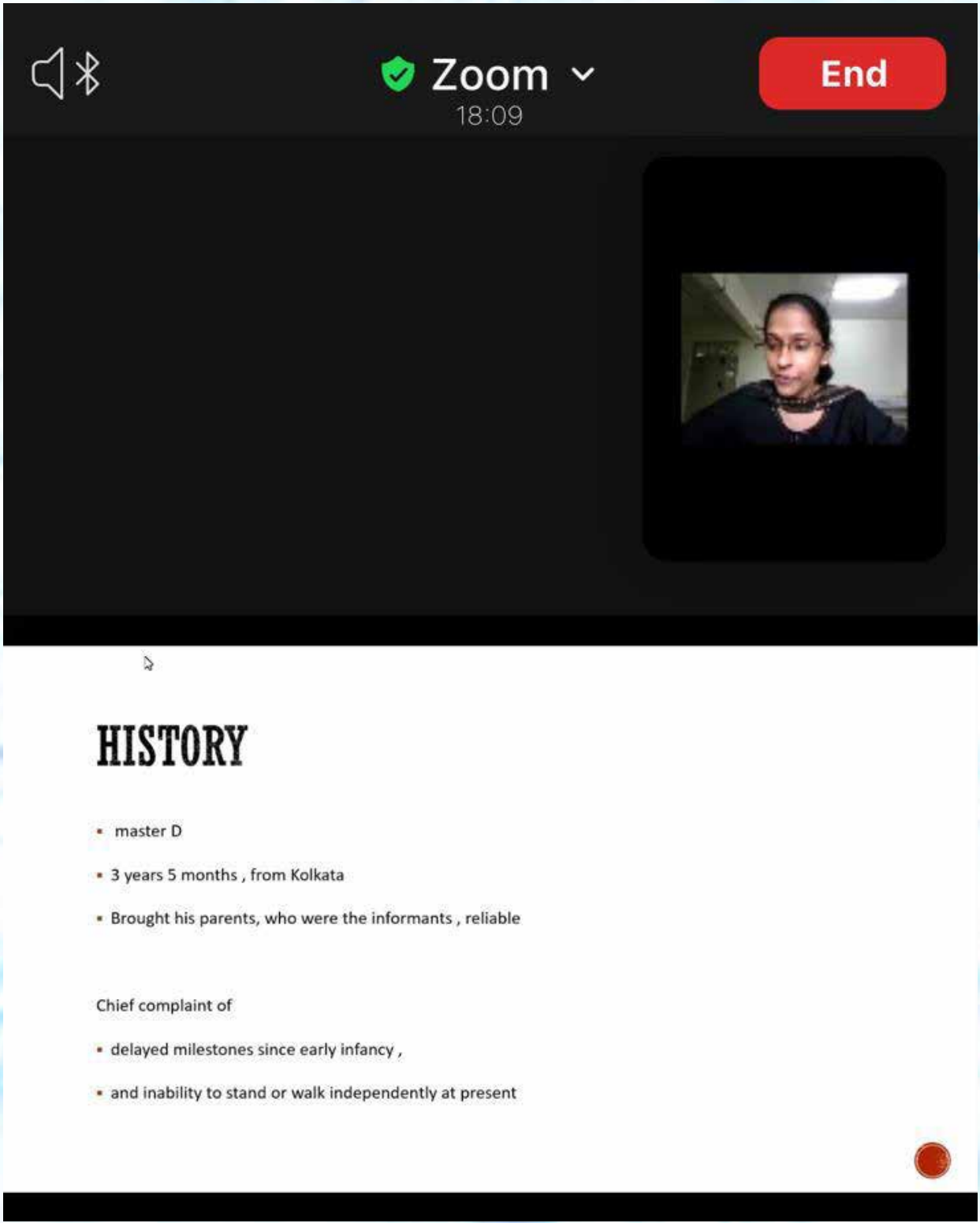

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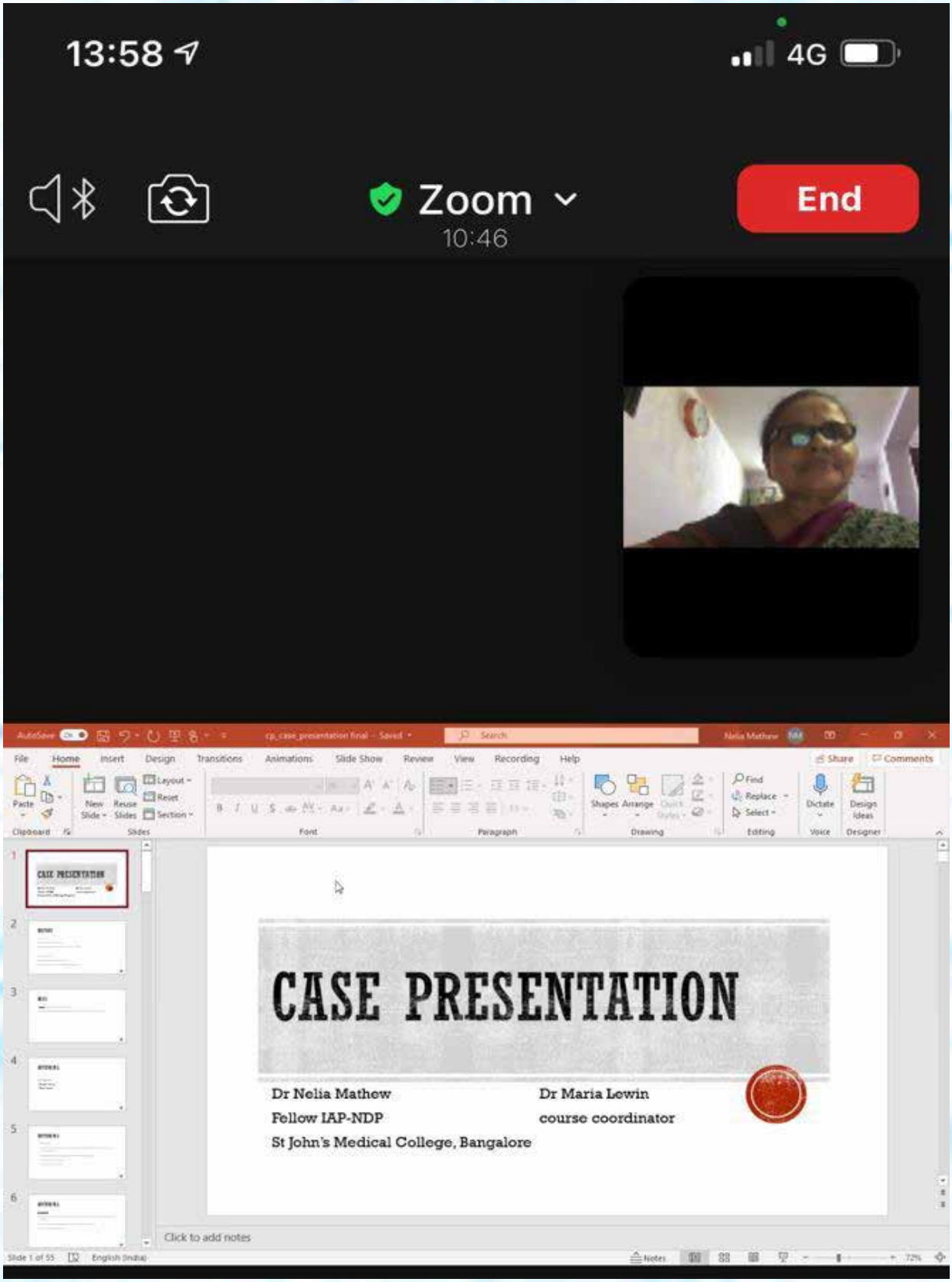

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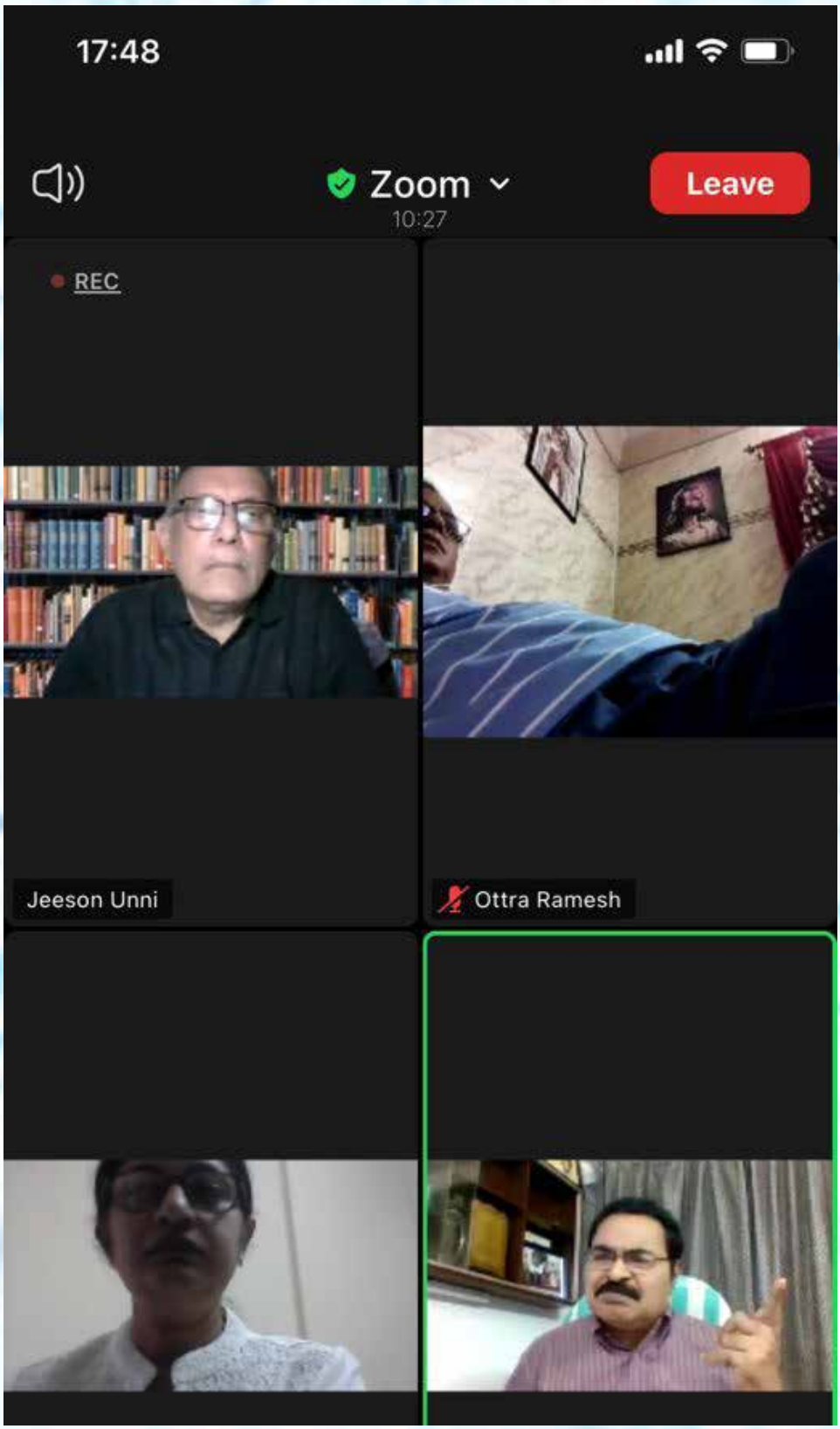

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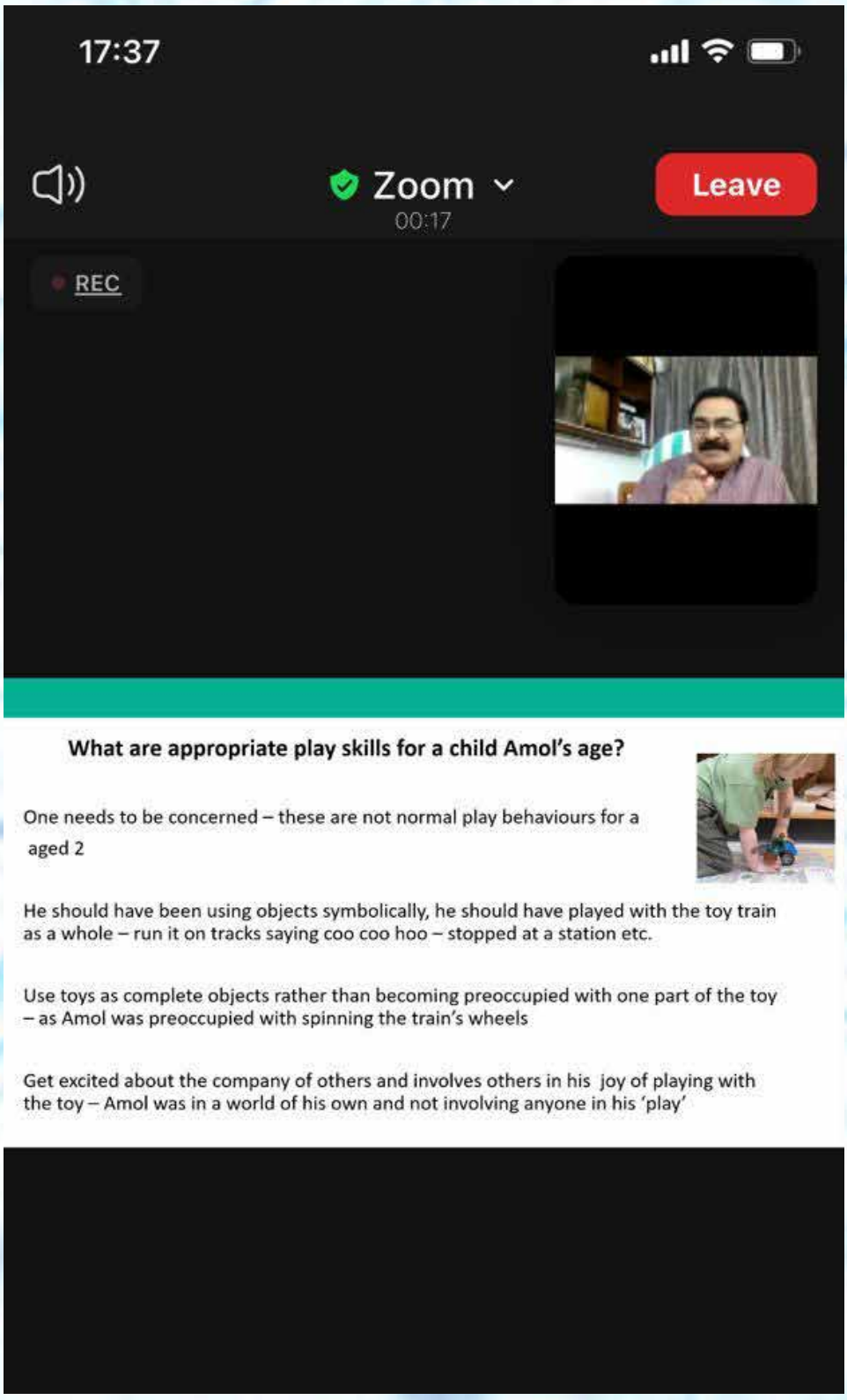

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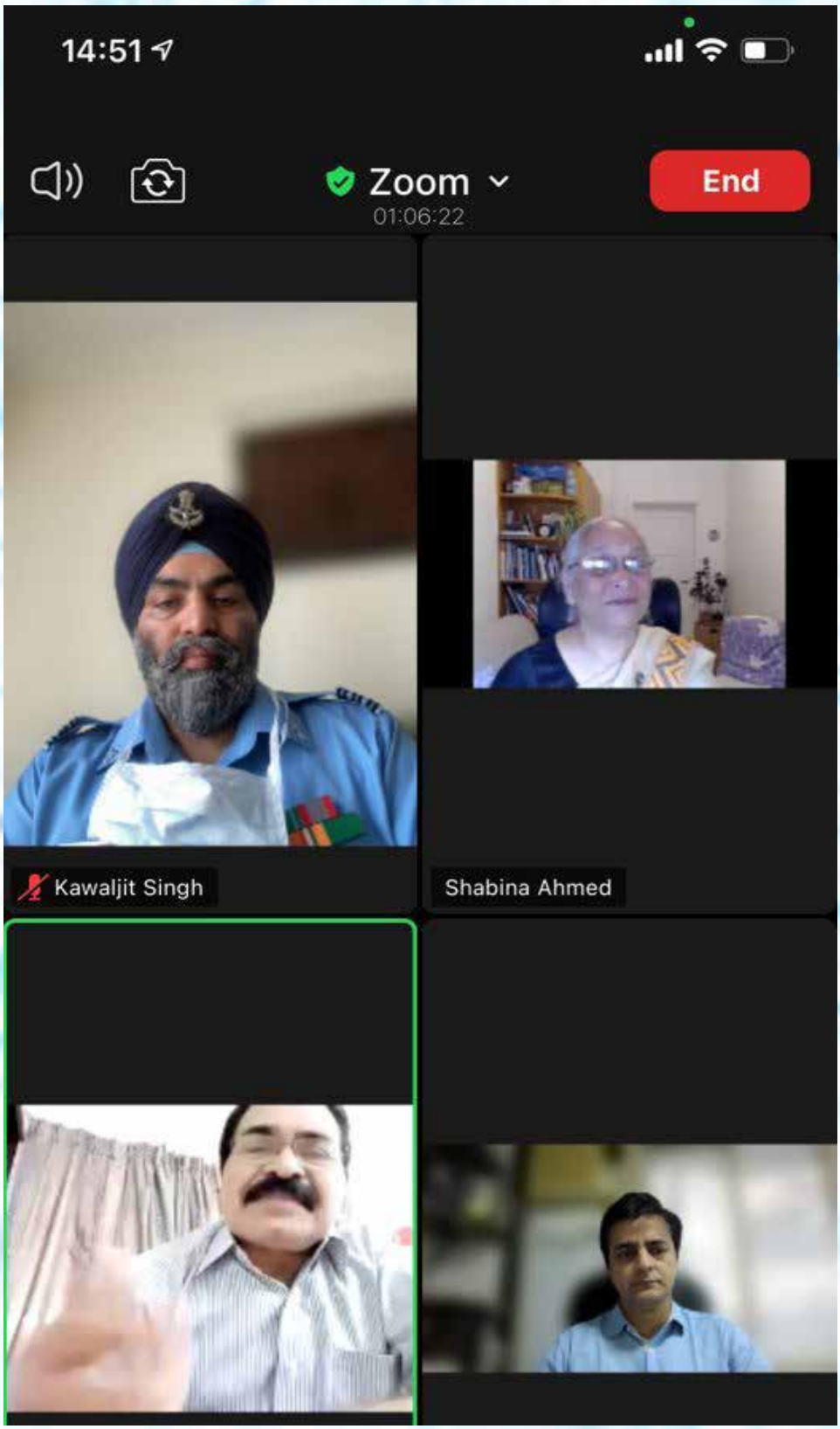

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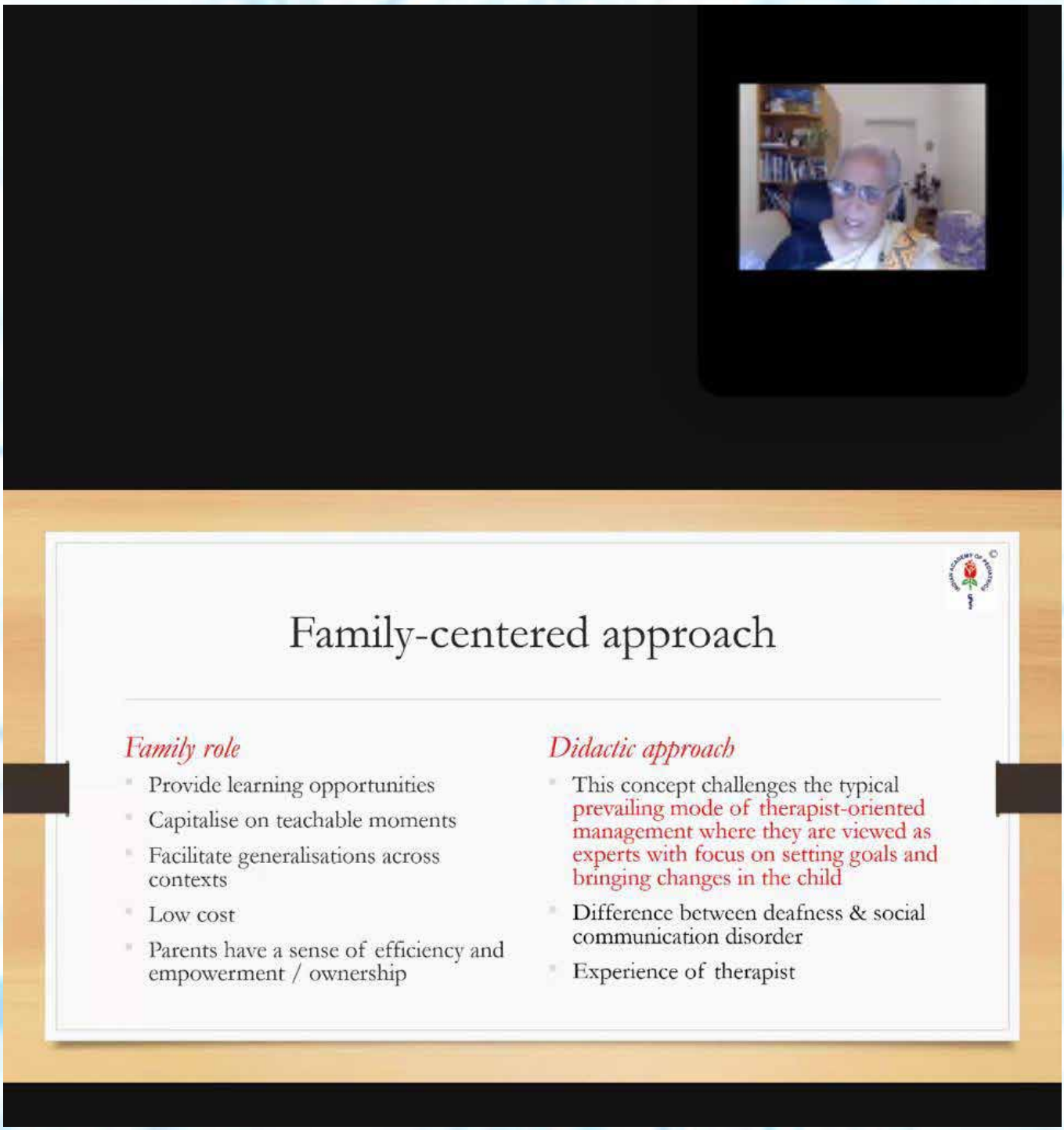

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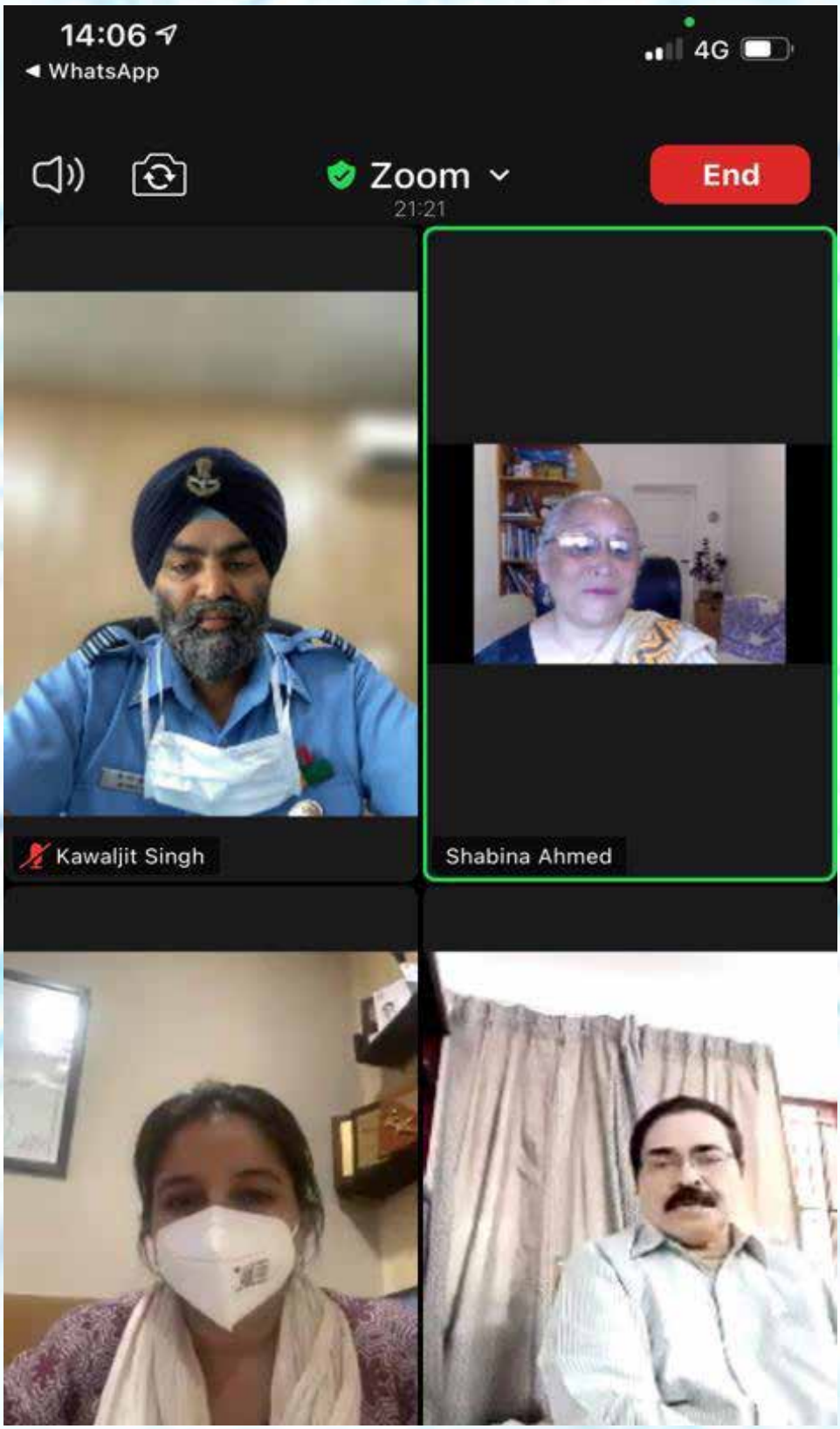

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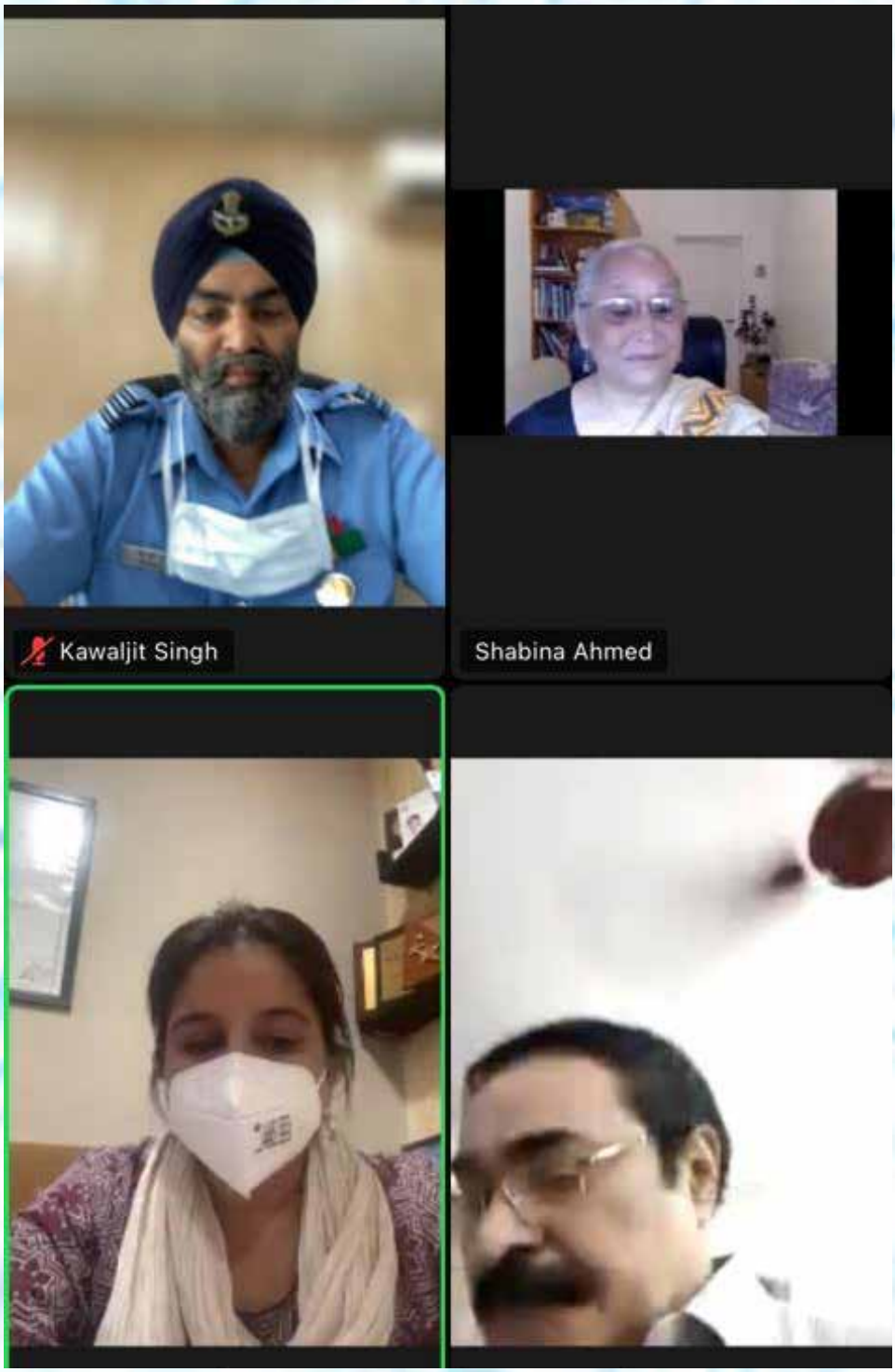

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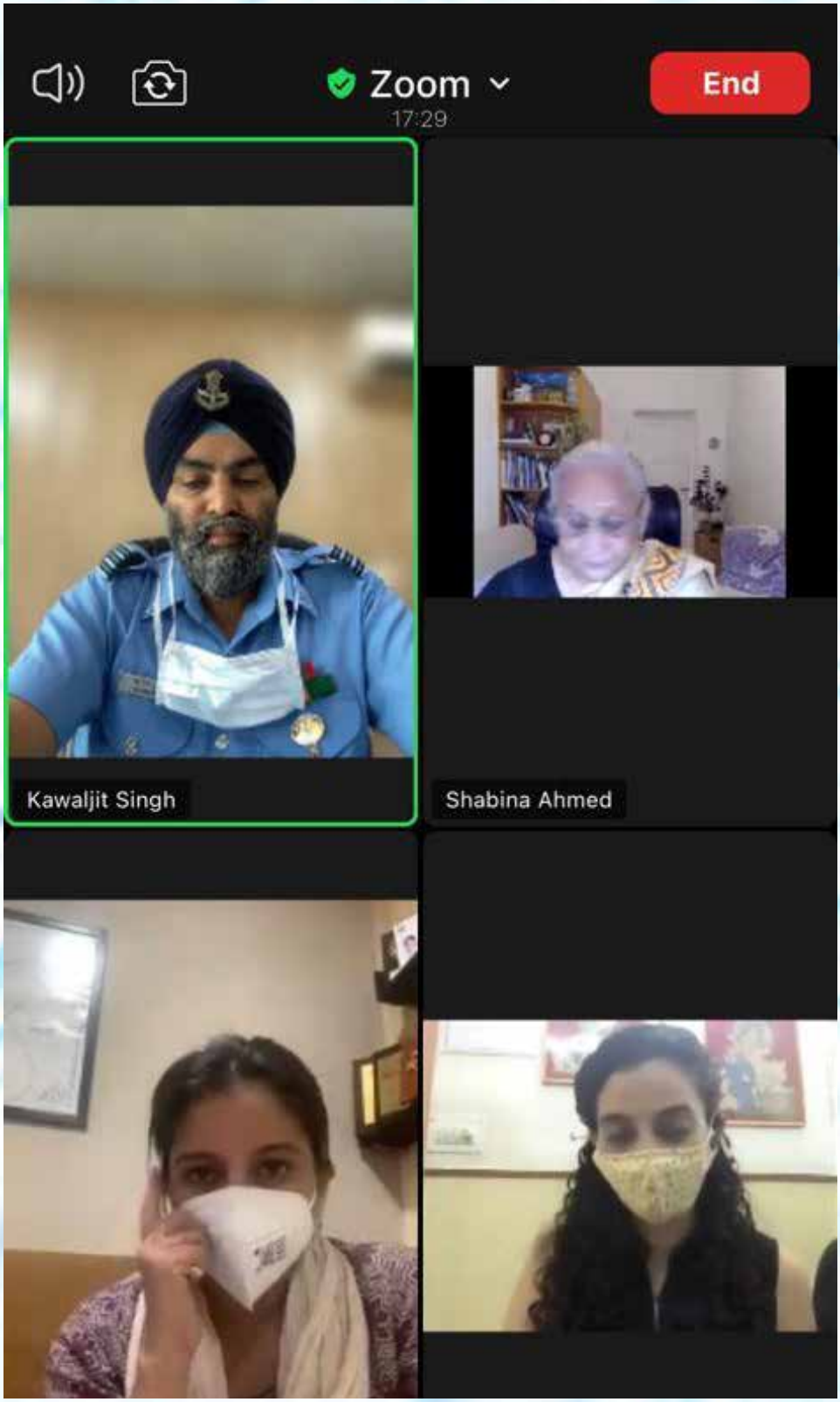

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