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This journal is published to expand the academic activities and spread the knowledge, ideas and latest research in the field of ethics, trauma, and victimology. This journal publishes original research papers, review articles, case reports, letters to the editor and review of books on ethics, trauma, and victimology. This journal is supported by the Society for Prevention of Injuries and Corporal Punishment (SPIC) and Indo Pacific Academy of Forensic Nursing Science (INPAFNUS). This journal is supporting the aims of the SPIC and the INPAFNUS. This journal also highlights the achievements of the SPIC, INPAFNUS and their members.

This journal covers the various aspects of ethics, evidence-based medical ethics, ethical dilemmas and various dynamic issues related to ethics. It also covers the ethical issues related to Forensic Nursing Science, Forensic Odontology, and Forensic Psychiatry. It also covers the ethical aspects of Toxicology including Environmental Pollution. It covers issues related to all sorts of corporal punishment and their prevention, particularly in schools. It covers physical as well as psychological aspects of trauma and clinical forensic medicine related to all types of injuries and prevention of injuries. It covers all aspects of victimology including etiology, crime scene investigation, and prosecution.

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From the Editor's Desk

With the publication of the 22nd issue of the International Journal of Ethics, Trauma and Victimology, we pause with a deep sense of gratitude and quiet pride as the journal completes 11 years of uninterrupted scholarly journey. What began as a focused academic initiative has steadily evolved into a respected interdisciplinary platform that critically engages with ethics, trauma, victimology, forensic sciences, mental health, nursing, law, and allied social sciences. Over the past decade, the journal has remained committed to amplifying evidence-based scholarship, ethical reflection, and victim-centred perspectives in an increasingly complex global landscape marked by conflict, disasters, and technological change.

This milestone would not have been possible without the unwavering support and intellectual contributions of many dedicated individuals and institutions. I extend my sincere thanks to our authors for trusting the journal with their research, to our reviewers for their rigorous, ethical, and selfless academic service, and to the Editorial Board and Advisory Committee for their guidance and vision. Our gratitude also goes to the publishers, technical and administrative teams, and institutional partners who have ensured quality, continuity, and integrity in every issue. Most importantly, we thank our readers—academicians, clinicians, policymakers, students, and practitioners—whose engagement gives meaning to our efforts.

As we step into the next phase of this journey, we reaffirm our commitment to academic excellence, ethical integrity, and social relevance. The International Journal of Ethics, Trauma and Victimology will continue to serve as a credible voice for interdisciplinary dialogue, innovation, and advocacy for victims and vulnerable populations. We look forward to deeper collaborations, emerging global perspectives, and sustained scholarly contributions in the years ahead. Together, we move forward rooted in ethics, informed by evidence, and guided by humanity.

Warm regards,

Rakesh K Gorea
Editor-in-Chief

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Safeguarding Childhood: Recognition, Assessment, Management and a Comprehensive Response to Child Maltreatment utilising the POCSO Act

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ABSTRACT

Child abuse and child maltreatment are not uncommon in the world, and the police and medical professionals should keep this in mind while dealing with children. There are different reasons in different parts of the world that make children more prone to child maltreatment. There are different types of child maltreatment, which include physical abuse, sexual abuse, emotional abuse, domestic abuse, exploitation of children and neglect. Child maltreatment needs to be recognised and reported by the various persons encountering the abused children. If, upon investigation, child abuse is substantiated, then a suitable response should be there so that the child can be protected from further abuse, and the offender is punished suitably. The victim child needs to be treated by the medical professionals appropriately and rehabilitated by the concerned government agencies. In India, in cases of sexual abuse, cases are dealt under the POCSO Act, and medical and police professionals need to know the provisions of the Act for managing the cases of child sexual abuse so that they are not negligent in managing the cases.

Keywords: Child abuse; child maltreatment; recognition of child abuse; assessment of child abuse; comprehensive response; POCSO Act.

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INTRODUCTION

According to the World Health Organisation, “Child maltreatment is the abuse and neglect that occurs to children under 18 years of age. It includes all types of physical and/or emotional ill-treatment, sexual abuse, neglect, negligence and commercial or other exploitation, which results in actual or potential harm to the child’s health, survival, development, or dignity in the context of a relationship of responsibility, trust, or power.”¹

Child abuse is the term that is commonly used and known to the common people. In child abuse, there is an act by a person in a position of power, trust, or responsibility, which causes physical or emotional harm to the child.² Child abuse is possible by an older child or an adult.

Incidence

Cases of child maltreatment are often not reported, and what is reported is the tip of the iceberg; even these reported cases seldom receive the required support.³

In a report by the WHO, 1 in 4 adults was abused physically as a child, and the incidence was 23%. Sexual abuse was 8% in boys and 18% in girls. Emotional abuse was in the maximum number of cases, i.e., 35% cases. Neglect was observed in 16% of cases.⁴

In November 2024 World Health Organisation reported that 6 out of 10 children under 5 years of age suffer physically

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and emotionally, and this makes a big number of children in the world who are being maltreated, i.e., 400 million.¹

There are 40,150 deaths due to homicide, many of which are likely due to child maltreatment. This number may be less, as many deaths are erroneously reported as accidents due to various reasons.¹

In India, 20% of children of the world’s children live.⁵ It is estimated that 74% reported physical abuse, 72% emotional abuse, and 695 reported sexual abuse. Neglect is 71% overall, with physical neglect being 58% and emotional neglect being 60%.⁶

In India suicide rate among students is alarming (7.6% in 2017, 8.2% in 2020, 8% in 2021, and 7.6% in 2022), which is due to stress and frustrations of studies in their crucial years of study. All types of neglect are higher in rural and slum urban areas.⁷

Neglect has been responsible for the deaths in 75% of cases and was due to a lack of necessities, care, and protection from hazards.⁸

1 in 5 women (650 million) and 1 in 7 men (500 million) have been exploited sexually when they were children. In wars and refugee camps, female children are at a greater risk of sexual exploitation by the army personnel and aid workers.⁹

In India in 2022, under the POCSO number of cases increased by 8.7%, due to better reporting under the POCSO Act.¹⁰ Due to similar reasons, it increased to 9.2% in 2023.¹¹

In 2022, total cases of rape reported under 18 years of age were 1017, which is 3.2% of all cases of rape.¹²

Causes

Children under 4 years and adolescents are more prone to maltreatment. Unwanted children are also more prone to maltreatment.¹

Special needs children, with intellectual disability and neurological disorders, are also commonly maltreated, and those who are crying more may irritate their parents, and in turn, they are maltreated. Those who are sexually deviant, like gays, lesbians, transgender, and bisexual individuals, are also more prone to maltreatment during childhood.¹

Those children who are not meeting the expectations of their parents are also more prone to maltreatment.¹

It is not only that a special group of children are more prone, but if parents who themselves were abused in childhood are more likely to abuse their children, and this system passes on from generation to generation, especially if they are also having low self-esteem, financial difficulties, and have less impulse control.¹ If there is intimate partner violence in the family, that also increases the risk of child maltreatment.⁴

Family breakdowns, violence between family members, and the stoppage of support from extended family members, especially if they are alcoholics, using drugs and involved in criminal activities, and compounded by the facts of difficult bonding with the newborn and pain of nurturing them and having unwanted expectations from them, make them more prone to being involved in child maltreatment.¹

Poor living standards, social inequality, easy availability of alcohol and drugs, child pornography and prostitution, and glorification of violence in communities also add to the problem of child maltreatment.¹ Unemployment also increases the risk of child maltreatment. Poor legislation also adds to the incidence of child maltreatment.⁴

There can be sibling sexual abuse, and there may be coercive sexual behaviour of an elder sibling.¹³

Recognition

Child maltreatment can be observed in different forms, i.e., physical abuse, sexual abuse, psychological or emotional abuse, domestic violence, poisoning, exploitation and neglect.^{2,4,14}

Physical abuse

In physical abuse, we commonly see beating, hitting and shaking violently, cigarette burns, poisoning, attempted strangulation and in females, genital mutilation. Injuries can be abrasions, bruises, burns and scalds, bites, fractures (ribs) and dislocations of joints.^{2,4,14,15}

Sexual abuse

Intruding into the privacy of a child is not good for the child. In Sexual abuse, there may be exposure to sexual material or acts and sexual contact in the form of sexual touching, sexual intercourse or oral sex. Children may be sexually groomed or procured for sexual acts.^{4,14} There may be online sexual abuse.¹⁶ Abusers may be sexting.¹³ Photographs of children may be taken during sexual activity, and they live in fear that these photographs may come out at any time, as these pictures are usually shared between different offenders.¹⁷

Digital abuse

Due to the easy availability of the internet and digital devices to children, children can be abused by cyberbullying, digital stalking, online sexual abuse, online sexual exploitation, online emotional abuse, online revenge pornography, online grooming, and online child trafficking.¹⁸

Emotional abuse

In Psychological or Emotional abuse, there may be excessive criticism, ridicule, insulting, threatening or confining. Withholding affection by the parents and caregivers may cause damage to the self-esteem and confidence of children.^{4,14}

Domestic abuse

Domestic violence usually involves bullying behaviour, abusive or violent behaviour. Domestic abuse can be verbal, emotional, financial, physical, image-based and sexual abuse. It may be simple harassment or stalking. There may be reproductive abuse. Sometimes it may be religious or spiritual abuse. Underage, forced marriage is not common, but it can be an abuse if it happens. Exposing the child to domestic violence may cause damage to the child.⁴ In family violence, children are the unintended and secondary victims.¹⁹

Poisoning

Cases are reported when poisoning can be a mode of child abuse, and in 20% of such cases, child battering was also present along with poisoning. Even cases of death due to poisoning have been reported in cases of child maltreatment.²⁰ A suspicion of a high degree in the mind of emergency medical professionals can only bring this diagnosis.²¹

Exploitation

A child is used in a harmful way, resulting in a benefit to someone. To name a few examples, using children for pornography, labour, and drug trafficking are common examples of the exploitation of children.² They may also be used for prostitution.¹³ There may be sexual tourism where children are exploited sexually.²²



Neglect

In neglect, despite the funds or money available child is not provided with education, Medicare and dental care, shelter or facilities for their healthy development. In many countries, children cannot be left alone at home till they reach a particular age, but they are left alone.^{4,14} Even not giving proper love to children is neglect.²

Other forms of abuse, though not common, but are exist, e.g., foetal abuse due to maternal drug or alcohol abuse, community violence, institutional abuse (religious and supporting groups, foster homes) and state-sanctioned abuse (female genital mutilation in South Africa).²³ Induced or fabricated illness in children is a form of child abuse where, due to fabricated illness child is taken to the hospital due to various motives by the caregivers and exposed to pain and suffering of lab tests, medication and procedures for the fabricated illnesses, which can lead to morbidity and mortality. This is also labelled as Munchausen syndrome.^{24,25}

Signs of Recognition of Abuse

There may be various signs which should be looked for if there is suspicion or complaint of child maltreatment. They may be missing their school often. These signs can show as irritability, anxiety, nightmares, learning problems or withdrawal. There may be low self-esteem or fear of certain individuals. Physically, there may be frequent headaches, unexplained injuries and bed wetting. They may not want to go home. There may occur thoughts of self-harm and even suicide. They may be begging or stealing for food as they are hungry. They may be harming animals and property.^{2,26}

Assessment

Every reporting or notification must be investigated and then substantiated, and only then should the case be labelled as a case of child maltreatment. After notification, more details are sought during investigation and seen if it has resulted in harm to the child, the degree of the harm and what is needed to protect them. Seeing the child, meeting the child, and interviewing the child in a safe environment is very important. After this, if it is felt that the child has been maltreated and child abuse is substantiated, then it is decided what is to be done.²⁷

Examination by a medical professional may be important to reach a correct diagnosis. Perpetrators usually accompany, and their history cannot be relied upon. The history of children and accompanying persons should be taken separately. Bruises, burns and scalds, abusive head trauma, fractures (rib, metaphyseal lesions, spiral fractures), liver and splenic ruptures and intestinal injuries are suggestive of child abuse. Radiographic skeletal evaluation may show abuse-related fractures. CT scans and MRI may show thoracic and abdominal injuries and abusive head trauma with subdural and subarachnoid haemorrhages. Assess for child abuse mimicking lab parameters (bleeding and metabolic disorders), and occult injuries can be identified. Conditions of osteogenesis imperfecta and bleeding disorders must be kept in mind and ruled out before reaching a diagnosis of child abuse.¹⁵

A distinct entity is battered baby syndrome, in which children are seen with nonaccidental injuries and neglect. Signs and symptoms may vary from mid bruising, subperiosteal haemorrhages, fractures of ribs and long bones, and subdural hematoma with fracture of skull or without fracture of skull.²⁸ It may copycat some diseases like metabolic abnormalities or may resemble signs and symptoms of sepsis or intoxication.²⁹

Some get minor trauma, which is repeated. Some do not get love or nourishment and are victims of passive neglect.²⁸

Shaken baby syndrome is another unique form of child trauma in infants, in which there can be serious neurological damage or death due to ischemic encephalopathy resulting from the whiplash phenomenon, causing subdural and retinal haemorrhages (83% cases).^{30,31}

Effects of child maltreatment

The effects of child maltreatment can be immediate or lifelong

The effects of child maltreatment can be immediate in the form of injuries. Death, too, can occur due to immediate effects. Effects can be lifelong. They can be victims of violence late on, too, or they may become perpetrators of violence themselves. They may become obese and have unwanted pregnancies or indulge in high-risk sexual behaviour.⁴

Physical health is impaired lifelong. In girls, there are chances of pregnancy as well as sexually transmitted diseases.¹

Mental health is impaired lifelong. Post-traumatic stress Disorder PTSD, Anxiety, and depression are common due to child maltreatment. Stress early in life can lead to poor development of the nervous system and immune system. This can lead to eating disorders, smoking, alcohol intake and drug intake.^{1,2,4}

The academic performance of the affected children may also become poor. There is 13% chance that such students may not complete their school education.¹

Slow Economic and social development can be the result of child maltreatment. There is an increased burden on the nations for treating the affected children, legal costs and lost productivity.¹

Challenges

Challenges to stop and prevent child maltreatment in India are low levels of the application of trauma-informed care to the victims of child abuse, an overburdened judicial system and criminal investigative system, illiteracy, poverty and gender inequality.^{5,32}

Prevention

It is better if we prevent child maltreatment before it starts happening. One of the methods is teaching positive parenting skills to the parents. Parenting skills can be provided by a nurse.¹

Children can be educated and provided with skills so that they can reduce the risk factors and become more resilient. They can get the skills to ask for help, especially if there is sexual abuse.

In schools, there should be a violence-free atmosphere, and schools should have a zero tolerance for corporal punishment.³³⁻³⁵ In schools in 2007, guidelines were issued by the National Commission for the Protection of Child Rights. The National Policy for Children 2013 also made it mandatory that there should be no physical punishment or mental harassment in schools. Some state governments have made laws banning corporal punishment in schools.³⁶ Teachers use it as a disciplinary measure.³⁷

In homes, we must achieve the stoppage of corporal punishment, though it is prohibited in alternative childcare institutions under the Care and Protection of Children Act, 2015, for juvenile justice.³⁶

To prevent violence against children, there is a framework for different countries named INSPIRE, meaning Implementation, Norms, Safe environments, Parent support, Income strengthening, Response services and Education.³⁸

Support should be provided to the parents and caregivers for positive and healthy strategies for raising the children. Norms and values should be promoted for non-violent behaviour.⁴

Children should be taught the skills to judge child maltreatment and protect themselves.⁴ They should know their rights and, if these rights are violated, how to report.⁶

Investment in the prevention of maltreatment should be promoted. Support services and response to child maltreatment should be quicker and better. A safe environment for the children should be created and maintained.⁴

Strong laws can go a long way in preventing child maltreatment.¹

MATERIAL & METHODS

Academic search engine Google Scholar has been used to find the relevant literature, i.e. Journal articles, conference papers, using the keywords. Google Search engine has been used to supplement the scholarly research for some reports and whitepapers from reputed organisations, government websites, and academic institutions, which have been used to review the current situation. Only relevant material available in English has been used. Materials from non-credible sources and not in English have been excluded. A thematic analysis was conducted for recurring patterns, gaps and emerging trends. Methodological strengths and limitations were studied by comparative evaluation.

DISCUSSION

Comprehensive Management

If a child tells you about child maltreatment, tell him that he has done the right thing by telling you, and he is brave, and you believe him, and it is not his fault. You will do everything that will make him feel safe.

Early recognition of the cases and prompt reporting and action can go a long way in reducing child maltreatment. Responsible adults who witness these can report, and such cases may be investigated further by the concerned agencies. Teachers,

early educators, nurses and doctors are legally responsible for informing.²

If, after substantiation, it is seen that the parents of the child might be dead or this is a case of child abandonment, then a suitable caregiver is to be provided, or the child is kept in a suitable childcare centre.²⁷

If there is an urgent need for a health checkup, it should be done. Only a small portion of children get attention from health professionals.¹ Usually, health sector personnel are not fully equipped to provide full help to the victims of child maltreatment.³

There is a need for stabilisation of the victim, managing the acute medical conditions and informing the concerned agencies and police. Paediatricians and psychiatrists can play an important role, and in the case of sexual assault on females, prevention of sexually transmitted diseases and screening for pregnancy should be taken care of.¹⁵

A higher rate of suicides among students in India is due to higher expectations for them. Is this the lack of care for them or neglect on the part of someone?

In Australia in the year 2017-18, reporting or notification was done by police in 30% cases, teachers in 19% of cases, doctors/health professionals in 14%, families in 10%, NGOs 9%, social worker 5% and by the children themselves in <1% of cases and 13% were other persons.²⁷

Laws should be enforced and implemented for the prevention of violent and corporal punishments in schools and homes.⁴

For the prevention of child maltreatment, WHO emphasises that the problem should be well defined, risk factors should be known so that interventions and testing can be done for prevention, and information should be spread on the effectiveness of interventions.¹

The health sector, especially forensic nurses, can play a crucial role in raising awareness of the problem of child maltreatment by emphasising the long-term negative effects of child maltreatment and its social effects in the form of increased financial burden on society.⁴

Response under POCSO

For the comprehensive management, the sexual abuse must be tackled under this Act. For this Act to be applicable age of the person must be below 18 years, which means it applies to children. This Act aims to protect children from offences of sexual assault, sexual harassment and pornography and provide for the establishment of Special Courts for the trial of such offences and for matters connected therewith or incidental thereto. This Act categorises sexual offences into penetrative sexual offences, aggravated penetrative sexual offences, Sexual assault, aggravated sexual assault and sexual harassment.³⁹

- With the latest amendments in the Act in 2023, Punishment for penetrative sexual offences carries a minimum punishment of 10 years, extendable to life imprisonment for severe cases and is liable to a fine.
- Aggravated penetrative sexual offences have a minimum punishment of 20 years, also extendable to life imprisonment or death in extreme cases.



- Sexual assault is punishable with 3 to 5 years of imprisonment
- Aggravated Sexual assault is punishable with 5 to 7 years of imprisonment
- Any person, who stores or possesses pornographic material in any form involving a child, in case of use of child for pornographic purposes punished with imprisonment for a term which shall not be less than five years and shall also be liable to fine and in the event of second or subsequent conviction with imprisonment for a term which shall not be less than seven years and also be liable to fine.
- But fails to delete or destroy or report the same to the designated authority, as may be prescribed, with an intention to share or transmit child pornography, shall be liable to a fine not less than five thousand rupees and in the event of a second or subsequent offence, with a fine which shall not be less than ten thousand rupees.
- Any person who stores or possesses pornographic material in any form involving a child for transmitting, propagating or displaying, or distributing in any manner at any time except for reporting, as may be prescribed, or for use as evidence in court, shall be punished with imprisonment of either description which may extend to three years, or with fine, or with both.
- Any person, who stores or possesses pornographic material in any form involving a child for commercial purpose shall be punished on the first conviction with imprisonment of either description which shall not be less than three years which may extend to five years, or with fine, or with both and in the event of second or subsequent conviction, with imprisonment of either description which shall not be less than five years which may extend to seven years and shall also be liable to fine.
- Special courts can order an interim payment to the child at any stage of the case.
- The state government must pay within 30 days
- The child welfare committee assesses if the child needs care & protection
- Support person maintains confidentiality & assists the child through the legal process
- Emergency medical care must be arranged within 24 hours, and confidentiality about the victim must be maintained
- Medical and forensic nursing personnel should note that:
- A medical officer must provide treatment for injuries without requiring legal documentation, and forensic evidence must be collected during medical care. They are supposed to do Prophylaxis for STD, Prophylaxis for HIV, treatment for HIV, Contraceptive measures, Referral for psychological help or counselling.
- In case the victim is a girl child, the medical examination shall be conducted by a woman doctor. The medical examination shall be conducted in the presence of the parent of the child or any other person in whom the child reposes trust or confidence. Where, in case the parent of the child or other person referred to in sub-section (3)

cannot be present, for any reason, during the medical examination of the child, the medical examination shall be conducted in the presence of a woman nominated by the head of the medical institution.

Advocacy

By doing the research in their countries, paediatricians, nurses/ forensic nurses can communicate the data to the public about its prevalence, risk factors, consequences and evidence-based interventions on parenting programs and home visits. They can also provide support and services to the victims of child maltreatment. Collaboration can be done with education, social welfare and criminal justice departments.⁴

Balancing the child's welfare with legal and ethical obligations

Dealing nurses and other professionals may be in dilemmas as the ethical guidelines for children may not be clear, especially in the younger children, when the consent of the parent is required, and parents may not consent to report child abuse. Professionals should talk with each other, respecting the viewpoints of both. It will be better if there are ethical guidelines that may be specific to the different cultures, to deal with such cases, and stakeholders are trained in these ethics.⁴⁰

There may not always be the need for criminal prosecution; sometimes, civil prosecution may help.⁴¹

A child's interest should be seen irrespective of religion and culture. Sometimes parents may not be willing to undergo a lifesaving procedure, and in these circumstances, the state should subrogate the rights of the parents in the best interest of the child.⁴²

There may be a difficult choice while dealing with cases of children on how much autonomy and independence should be given, while keeping their safety in mind.⁴³

Usually, there are helpline numbers for seeking guidance, assistance and counselling in cases of child abuse in every country, and in India is 1098.

Sometimes it is a complex situation that if we go for legal obligations in case of child abuse child may be in a worse condition, as the financial support of the family is lost if the perpetrator is the only earning member of the family. It is the responsibility of all stakeholders to do their duties, keeping in view the laws, but they must also do their duties ethically. Whatever approach is taken approach should be child-focused. Social workers should evaluate the family circumstances and do what is good for the child and the family.

CONCLUSION

It is important for the health professionals to recognise, assess, learn skills and provide remedial measures for the child's maltreatment. They should be at ease communicating with victims and their caregivers, and they should be adept in this communication. They should understand that the best results can be given if a multidisciplinary work culture can be adopted, as the experiences and skills of different disciplines need to be

recognised in tackling cases of child maltreatment. Awareness in teachers, parents, police officials, nursing, dental and medical professionals and society will help in the reporting of child abuse to the proper agencies and advocating for the cause of the maltreated children. Investigating agencies and medical professionals should understand the provisions of the POCSO Act and its amendments and work accordingly. Teaching parents the positive parenting skills, teaching children skills and resilience, involving all the stakeholders and enacting the proper laws will go a long way in preventing child maltreatment and rehabilitating the victims of child maltreatment.

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Anxiety, Depression and Loneliness Due to Internet Addiction Among Selected Senior Secondary School Students of Bhopal

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ABSTRACT

Background: The internet is being used extensively throughout the world, especially among adolescents and youth. Early detection of the adolescent population with internet addiction (IA) and prompt measures to redirect them towards sound use of technology is essential. The objectives of the study were to: i) identify the magnitude of depression, anxiety, and loneliness among senior secondary school students with IA; ii) assess the relationship between internet addiction and depression, anxiety, and loneliness; and iii) find the association of sociodemographic variables with depression, anxiety, and loneliness.

Materials and Methods: A cross-sectional survey was conducted among 220 participants from senior secondary schools in the Bhopal district. The Institutional Ethics Committee approved the study. Participants were selected using a convenient sampling technique. The tools used were the CHEN Internet addiction scale, Generalized Anxiety Disorder (GAD) scale, Patient Health Questionnaire-9 (PHQ-9), and UCLA loneliness scale. Data was analyzed using SPSS (v. 20)

Result: About 99 (45%) participants were internet addicted. Among the internet addicted, the majority had mild anxiety (35.4%), moderate depression (39.4%), and loneliness (58.6%). The relationship of IA with depression was weak and negative ($r = -0.32$), but was positive with anxiety ($r = 0.104$) and loneliness ($r = 0.053$). There was no association of depression, anxiety, and loneliness with sociodemographic variables of the students with IA.

Conclusion: Internet addiction is prevalent among senior secondary school students in Bhopal. Context-specific causes and risk factors for IA should be identified and measures to address these need to be initiated.

Keywords: Anxiety, Depression, Internet addiction, Loneliness

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INTRODUCTION

Revolutions in the fields of information and communication technology, particularly the internet, have led to radical social changes.¹ Internet has become an essential part of a larger population, especially among adolescents and youth. Ever since the internet began revolutionizing work, social life, leisure time, and communication, it has been seen with optimism and apprehension. Some people have a hard time restraining their use to the extent that it impacts their lives negatively. This has sparked an extensive field of research, ranging from psychology and sociology to neurobiology.²

Several tags have been used to describe the problem, of which problematic internet use (PIU), internet addiction (IA), gaming disorder, and pathological internet use are the most common.² In the Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), the American Psychiatric Association presented internet gaming disorder as a probable future addition as a non-substance-related addictive disorder, given that it is reinforced by plenty of good research. The World Health Organization (WHO) introduced gaming disorder in the latest edition of its International Classification of Diseases, 11th revision.³

Pathological internet use can negatively affect the psychological, emotional, social, and physical quality of life.⁴

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Research shows that regular use of the internet causes a lot of psychological and mental disorders like stress, anxiety, depression, and Obsessive-Compulsive disorder (OCD).⁵ IA is typically characterized by psychomotor agitation, anxiety, craving, depression, hostility, substance experience, preoccupation, loss of control, withdrawal, loneliness, impairment of function, reduced decision-making ability, and constant online surfing despite negative effects on social and psychological welfare.⁶ As the level of internet addiction increased, the level of aggression, impulsivity, and depression also increased.⁷ Young *et al* developed diagnostic criteria for IA in which withdrawal, poor scheduling abilities, tolerance,

obsession, impairment of control, and unnecessary online time were defined as core indicators.²

Worldwide prevalence of IA ranged from 1.6 to 18%.⁸ As of December 2017, 560 million of the Indian population used the internet, and the prevalence of IA in India among adolescents ranged between 0.7 to 37%.⁹ IA among adolescents increased during COVID-19 and will continue to rise.¹⁰ Internet and technology use are very much necessary in the education sector where adolescents are in larger numbers. UNICEF (2021) recommended that central and state governments explore avenues to reduce the digital divide by increasing access to fast internet and technological devices.¹¹ However, as the review also reveals, dependency on digital technology showed several effects on health and impact on family life, and appropriate usage should be emphasized.

Early detection of IA among the adolescent population and prompt measures to redirect them towards sound use of technology are essential. As there were limited studies on the magnitude of IA among senior secondary school students in Bhopal District, central India, this study was planned. The objectives of the study were to: i) identify the magnitude of depression, anxiety, and loneliness among senior secondary school students with IA; ii) assess the relationship between internet addiction and depression, anxiety, and loneliness; and iii) find the association of sociodemographic variables of students with IA and depression, anxiety, and loneliness.

Materials and Methods

Ethical Consideration

The study was approved by the Institutional Human Ethics Committee for Post Graduate Research, AIIMS Bhopal (Ref No.: IHEC-PGR/2021/MSc Nursing/ July/28). Permission to collect data was obtained from the Principal of secondary schools in Bhopal. Participants were explained the objectives and nature of the study in person. Voluntary participation, anonymity, and confidentiality were assured. Assent from participants and Informed consent from the parents of the participants were obtained.

Study Design, Setting, and Sampling

A cross-sectional survey was conducted among senior secondary school students enrolled in 11th and 12th standards in Government or private schools in Bhopal. Students aged 15 to 18 years, willing to participate, able to read and write in the English language, and available at the time of data collection were included in Phase 1. The Sample size was calculated based on a previously published study by Preetha A *et al.*, in which the prevalence of IA was 82.8%. With an absolute precision of 5% points and a type 1 error of 5%, the estimated sample was 220. In phase 2, the participants with IA formed the sample. A non-probability convenience sampling technique was used.

Data Collection Tools

A background proforma, inclusive of age, gender, grade, residential area, type of family, father's employment, mother's

employment, socio-economic status, place of access to the internet, duration of internet use, time of internet use, and reason for its use, was prepared by the researchers. Standardized tools were used to identify IA, depression, anxiety, and loneliness, as per the suggestions of a panel of experts from the fields of nursing, psychology, and psychiatry.

CHEN Internet Addiction Scale (CIAS)

CIAS scale is a 26-item rating scale developed by Chen S-H *et al.* (2003), assessing five dimensions of internet addiction, namely compulsive use, withdrawal, tolerance, problems with interpersonal relationships, and problems with health and time management. The reliability (Cronbach's alpha) was 0.94. The minimum and maximum scores were 26 and 104, respectively. A score of more than 64 was described as internet addiction.¹²

Generalized Anxiety Disorder (GAD) Scale

A seven-item, four-point rating scale (0 - not at all, 1 - several days, 2 - more than half the days, and 3 - nearly every day) was used to measure anxiety among the adolescents with IA. A score of less than 5 was classified as less anxiety, 5-10 as moderate anxiety, and 10 to 15 as severe anxiety. The reliability coefficient (Cronbach's alpha) for the GAD-7 scale was 0.76.¹³

Patient Health Questionnaire-9 (PHQ-9)

It is a nine-item, four-point scale (0 - not at all, 1 - several days, 2 - more than half the days, and 3 - nearly every day) was used to assess depression. A score of 1-4 was categorized as minimal depression, 5-9 as mild depression, 10-14 as moderate depression, 15-19 as moderately severe, and 20-27 as severe depression. The reliability (Cronbach's alpha) of this scale was 0.72.¹⁴

UCLA loneliness scale

A 20-item, four-point rating scale (1 - never, 2 - rarely, 3 - sometimes, and 4- often) was used to measure loneliness as well as feelings of social isolation. The Higher the scores, the higher the loneliness. Reliability (Cronbach's alpha) of this scale was 0.89.¹⁵

Procedure of data collection

The Date and time for data collection were fixed with the school Principal. During the first visit, 11th and 12th-standard students were explained about the study purpose, objectives, and significance. Participant information sheets and parental consent forms were given to participants with instructions to discuss with parents about their participation and to seek parental consent. On the second visit, participants who obtained parental consent were administered the CIAS in person, in the school, in their respective classrooms, ensuring no discussion during the process of filling. The average time duration used to fill out questionnaires was 20 minutes. On the third visit, the participants who were found to be internet addicted (n = 99) were administered GAD, PHQ-9, and the UCLA loneliness scale. The time duration between the second and third visit was 3 days. The data was analysed using SPSS (version 20).

RESULTS

Participant characteristics are presented in Table 1. Participants used either their own or their parents’ devices to access the internet. A total of 99 participants had IA (Figure 1). The level of depression, anxiety, and loneliness of participants with IA is presented in Table 2. Table 3 reveals that the relationship of anxiety($r=0.104$) and loneliness ($r = 0.053$) with IA was weak but statistically non-significant ($p < 0.05$). However, depression and IA showed an inverse relationship ($r = -0.32$). Tables 4, 5 and 6 show no association between the sociodemographic characteristics of participants with IA and depression, anxiety, and loneliness.

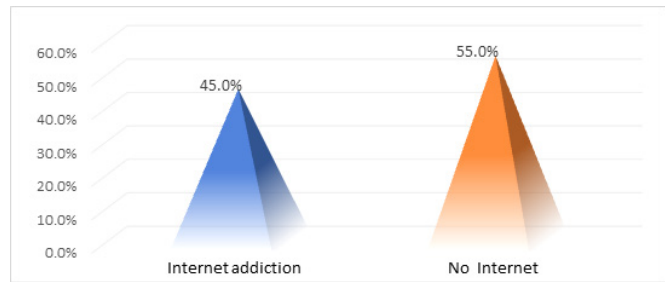


Figure 1: Pyramidal diagram showing the percentage distribution of senior secondary school students with internet addiction

Table 1: Frequency and percentage distribution of participants’ characteristics n = 220

Variables	Frequency	Percentage (%)
Age (in years)		
15	48	22.0
16	62	28.0
17	75	34.0
18	35	16.0
Gender		
Male	107	49.0
Female	113	51.0
Grade		
11th	118	52.0
12th	102	48.0
Residential Area		
Rural	64	29.0
Urban	156	71.0
Type of Family		
Nuclear	172	78.0
Joint	48	22.0
Socio-economic Status		
Above poverty line (> 1,286 rupees per month)	165	75
Below poverty line (< 1,286 rupees per month)	55	25
Father’s Employment		
Employed	180	82.0
Unemployed	40	18.0
Mother’s Employment		
Employed	82	37.0
Unemployed	138	63.0
Place of access of internet		
Home	220	100.0
Duration of internet use		
1–2 years	22	10.0
3–4 years	198	90.0
Daily internet usage (on average)		
1–2 hours	32	15.0
3 hours and more	188	85.0
Purpose of use of the internet		
Education	115	52.0
Entertainment	105	48.0

Table 2: Frequency and percentage distribution of level of depression, anxiety and loneliness among students with internet addiction.n = 99

Variables	Level of Scores	Frequency	Percentage (%)
Depression	Severe	14	14.1
	Moderately severe	6	6.1
	Moderate	39	39.4
	Mild	19	19.2
	Minimal	21	21.2
Anxiety	Severe	32	32.3
	Moderately severe	32	32.3
	Mild	35	35.4
Loneliness	Moderately high	41	41.4
	Moderate	58	58.6

Table 3: Relationship between internet addiction, depression, anxiety and loneliness among senior secondary school students with internet addiction n = 99

Variable	Anxiety	Depression	Loneliness
Internet Addiction r value	0.104	-0.32	0.053
Internet Addiction p-value	0.305	0.752	0.603

DISCUSSION

Internet use has become a part of everyday life. The prevalence of moderate problematic internet use among school-going adolescents in India was 21.5% in pre-COVID times.¹⁶ The overall prevalence of IA ranged between 19.9 to 40.7% in India¹⁷⁻¹⁹ and 30 to 43% in Madhya Pradesh (MP) in the pre-COVID times.¹⁷ The post-COVID era has further reduced the gap in access to the internet and technology in India, especially among children and adolescents. The prevalence of IA in the present study is higher than that reported in other districts of MP or the national average, which implies that the availability of gadgets and internet access has risen substantially. The duration of its use in terms of years and number of hours per day, as well as its use for non-educational purposes among adolescents, justifies that the young are active users of social media in India. Though the relationship observed between internet addiction and anxiety, depression, and loneliness in the present study is mildly positive, which was statistically not



Table 4: Association between depression and characteristics of students with internet addiction $n = 99$

Variables		Levels of depression					χ^2 test/ FET	p-value	df
		Severe	Moderately Severe	Moderate	Mild	Minimal			
Age (in years)	15	3	0	11	2	5	14.339**	0.280	12
	16	1	2	14	7	7			
	17	9	2	10	6	6			
	18	1	2	4	4	3			
Gender	Male	6	2	20	9	10	0.828**	0.935	4
	Female	8	4	19	10	11			
Grade	11th	7	2	24	9	11	2.361**	0.670	4
	12th	7	4	15	10	10			
Residential area	Rural	2	1	12	5	7	2.169**	0.705	4
	Urban	12	5	27	14	14			
Type of Family	Nuclear	10	6	32	16	17	2.434**	0.656	4
	Joint	4	0	7	3	4			
Socio-economic status	APL	12	3	27	13	19	6.623**	0.157	4
	BPL	2	3	12	6	2			
Father's Employment	Employed	14	4	30	13	19	7.624**	0.106	4
	Unemployed	0	2	9	6	2			
Mother's Employment	Employed	3	2	15	5	10	3.425**	0.489	12
	Unemployed	11	4	24	14	11			
Place of access of internet	Home	14	6	39	19	21			
Duration of internet use	1-2 years	3	2	3	3	3	3.811**	0.432	4
	3-4 years	11	4	36	16	18			
Daily internet use time (on an average)	Less than 2 hr.	2	1	6	4	5	0.910**	0.923	4
	3hr or more	12	5	33	15	16			
Reason for internet use	Education	5	3	21	12	15	4.924**	0.295	4
	Entertainment	9	3	18	7	6			

χ^2 – Chi square (*)
 FET- Fischer exact test (**)
 df- degree of freedom

significant, one cannot underscore the likelihood of increasing the burden of psychological distress among adolescents in India.

It is essential to identify the risk factors of IA if measures to tackle the problem of IA are to be streamlined. Systematic reviews on internet addiction have identified a few risk factors of IA, such as male gender, younger age, higher family income, using social and gaming applications, psychosocial factors, namely impulsivity, neuroticism, and loneliness, as well as a few co-morbid symptoms such as depression, anxiety and psychopathology.²⁰ Studies in India report that 26.3% of adolescents used the internet for more than four hours per day (90% in the present study), 38.7% of users were less than 12 years old and 32 to 41% were spending more than rupees 300-500 per month for using internet.^{6,18} Saquib *et al.*²¹ observed odds of having problematic internet use were 1.4 times higher among those with unhealthy dietary habits, and 1.2 times higher among smokers, those with less than excellent grade point average, and those with moderate to low religiosity. In the present study, adolescents who used the internet for a longer duration and had better socio-economic status (above the poverty line) showed moderate to severe

forms of depression, anxiety, or loneliness. Further, the relationship between IA and depression was inverse, thus it is not clear whether IA was an outcome or a source of depression. Though statistically no significant association was observed in the present study between IA, depression, loneliness, and anxiety, Merchant *et al.*²² alerts on negative influences in terms of self-harm and mental distress out of high internet use and IA. Engaging adolescents in a discussion about internet use is very much needed as an effort to create awareness of the impact of IA. Health care providers should seek the history of internet use among adolescents at frequent intervals, irrespective of their reasons for seeking health care.

Mental disorders such as anxiety, depression, and loneliness often first develop in adolescence and continue into adulthood. The magnitude of anxiety, depression, and loneliness levels among adolescents in the present study was higher (nearly 60% with IA had moderate to severe anxiety or depression, and 41.4% had moderately high loneliness) than that of other studies in India and Southeast Asia.²³ Although the present study did not find an association of sociodemographic variables with depression or with internet addiction, a similar study in Bhopal identified a few risk factors of depression such

Table 5: Association between anxiety and characteristics of students with internet addiction n = 99

Variables		Levels of anxiety			χ^2 test FET	p-value	df
		Severe	Moderate	Mild			
Age (in years)	15	7	8	6	0.903*	0.989	6
	16	10	10	11			
	17	11	10	12			
	18	4	4	6			
Gender	Male	17	17	13	2.318*	0.314	2
	Female	15	15	22			
Grade	11th	19	16	18	0.662*	0.718	2
	12th	13	16	17			
Residential area	Rural	12	7	8	2.502*	0.286	2
	Urban	20	25	27			
Type of Family	Nuclear	22	29	30	5.699**	0.058	2
	Joint	10	3	5			
Socio-economic status	APL	22	25	27	0.910*	0.635	2
	BPL	10	7	8			
Father's Employment	Employed	25	29	26	3.097**	0.213	2
	Unemployed	7	3	9			
Mother's Employment	Employed	9	15	11	2.826*	0.243	2
	Unemployed	23	17	24			
Place of access of internet	Home	32	32	35			
Duration of internet use	1-2 years	1	5	8	5.446**	0.066	2
	3-4 years	31	27	27			
Daily internet use time (on an average)	Less than 2 hr.	5	6	7	0.225*	0.893	2
	3hr or more	27	26	28			
Reason for internet use	Education	16	19	21	0.832*	0.660	2
	Entertainment	16	13	14			

 χ^2 - Chi square (*)

FET- Fischer exact test (**)

df- degree of freedom

as fights of parents, arguments with parents, peer pressure, female gender, pressure of examinations, academic satisfaction of parents, bullying in school, not performing well in studies, and loss of loved ones.²⁴ A study in northern India reported an association of anxiety with female gender, lower middle socio-economic status, and stressful events within the past year.¹⁸ A Finnish study reports the risk factors for involuntary loneliness among adolescents, namely social transitions, isolation, not having anyone to contact, group differences, ill-being, social expectations, negative emotions, former destructive experiences, and a negative self-image.²⁵ Mental health issues affected academic performance and suicidal behavior among adolescents. As the tools and methodologies used in these studies across India are dissimilar, and hence the findings are not comparable, systematic inquiries using sound methodology to explore the risk factors for such psychological symptoms as well as their impact on the general health of the individual and family, in the Indian setting, across regions are necessary. Policymakers may use such data to plan appropriate, region-specific, and culture-sensitive strategies to eliminate the risk factors responsible for adverse health outcomes.

With 51% growth in e-commerce, and about 26.5% population under 15 years of age in India, one can anticipate

the likely burden of psychosocial distress in India.²⁶ Arvind *et al.*²⁷ believed that about one-third of patients reporting to general health care services in India could have symptoms related to depression. Gaiha *et al.*²⁸ in a systematic view reported that young people in India are not able to recognize the causes and symptoms of mental health problems and are determined that recovery is impossible. Mental health issues often go undiagnosed and untreated in low-income countries like India, where many barriers to seeking mental health care exist, especially stigma associated with mental illness and limited access to mental health services. Misinformation and misunderstandings about behavioral and mental health problems and faith in traditional healers prevent them from seeking treatment from professionally trained health care providers. This suggests that mental health services in India must first address the barriers to seeking health care services. There is a need to integrate the National Mental Health Programme into general health services and at all levels of care. Universal health coverage and the use of a primary health approach should be the guiding principles.

The lifetime prevalence for any mental morbidity in India was 13.7% and for current mental morbidity, is 10.6% in the pre-COVID times.²⁹ However, the lower prevalence signifies



Table 6: Association between loneliness and characteristics of students with internet addiction n = 99

Variables	Level of loneliness		χ^2 test	p-value	df	
	Moderately high	Moderate				
Age (in years)	15	8	13	0.342	0.952	3
	16	14	17			
	17	13	20			
	18	6	8			
Gender	Male	16	31	2.004	0.157	1
	Female	25	27			
Grade	11th	22	31	0.000	0.984	1
	12th	19	27			
Residential area	Rural	9	18	0.999	0.318	1
	Urban	32	40			
Type of Family	Nuclear	36	45	1.686	0.194	1
	Joint	5	13			
Socio-economic status	APL	35	39	4.180	0.041	1
	BPL	6	19			
Father's Employment	Employed	32	48	0.344	0.558	1
	Unemployed	9	10			
Mother's Employment	Employed	14	21	45	0.833	1
	Unemployed	27	37			
Place of access of internet	Home	41	58			
Duration of internet use	1-2 years	9	5	3.516	0.061	1
	3-4 years	32	53			
Daily internet use time (on an average)	Less than 2 hr.	6	12	0.592	0.442	1
	3hr or more	35	46			
Reason for internet use	Education	20	36	1.726	0.189	1
	Entertainment	21	22			

 χ^2 - Chi square

df- degree of freedom

the tip of the iceberg, rather than the actual mental morbidity in India, given the attitude and belief related to mental illness and behavioral disorders. WHO in 2017 stated that one out of four children faces loneliness between 13 and 15 years of age.³⁰ Further, there is a gross shortage of mental health professionals, special educators, and counsellors in India. Kokane *et al.*³¹ point out that the prevalence of any mental morbidity in MP is higher (16.7% for lifetime and 13.9% for current mental morbidity) than the national average and the treatment gap is 91%. Further, Bali *et al.*³² report that there is low awareness and utilization of Adolescent Friendly Health Clinics in MP. It implies that trained community health workers at the grassroots level have a larger responsibility to cater to mental health services in the region. School administration, teachers, parents, health care providers, local leaders or religious organizations, and the local Government must collectively plan measures to build positive lifestyle behaviors among the young population such as outdoor activities, real-life family interactions, healthy competitions among youth, social gatherings inviting active involvement of youth, as well as guidance, counselling and awareness programs at school and health centers.

The findings of the present study should be interpreted in light of the limitations. The use of convenience sampling, the use of tools in a non-native language, and the likely social desirability bias from the use of rating scales limit the generalizability of findings. While an educational leaflet is prepared by the researchers, based on the findings from this study, and is provided to participants through schools' administration, the effectiveness of such an intervention may be evaluated. Translation of the standardized tools into the native language and assessment of their cross-cultural equivalence will be useful to determine their use for screening purposes in school or community settings. Such tools may be used in future inquiries, including all adolescents irrespective of their school enrolment.

CONCLUSION

Internet addiction is prevalent among senior secondary school students of Bhopal. Though depression, anxiety, and loneliness are not related to internet addiction, their prevalence among students invites attention from health workers to such problems at the institutional, family, and community levels.

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Primary Care in the Era of Multimorbidity: Policy Challenges for Integrated, Patient-Centred, Polypharmacy-Sensitive Care

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ABSTRACT

Background: Multimorbidity, the co-occurrence of two or more chronic conditions, is now the prevailing reality in primary care, particularly among ageing and socioeconomically disadvantaged populations. However, most health systems remain structurally oriented toward acute, single-disease management. This mismatch has contributed to fragmented care, excessive polypharmacy, and diminished patient experience.

Objectives: This review critically examines the policy and practice challenges in delivering integrated, patient-centred, and polypharmacy-sensitive care for multimorbid individuals. It identifies key barriers to implementation and outlines system-level reforms required to align primary care delivery with the complex realities of multimorbidity.

Methods: Drawing on global evidence, case studies, and health systems frameworks, this narrative review synthesises findings across domains including care integration, workforce models, financing, information infrastructure, clinical guidelines, and patient engagement.

Findings: Successful models share common elements: team-based care, interoperable digital tools, goal-oriented planning, rational prescribing, and active patient involvement. Yet, scale-up is often limited by political inertia, siloed funding streams, and capacity gaps. Structural reforms - such as payment redesign, co-produced service planning, and outcome measures aligned with patient priorities - are essential for sustainable transformation.

Interpretation: Multimorbidity must be treated as a defining feature of 21st century primary care, not as a deviation from the norm. Policy responses should prioritise integration, equity, and person-centeredness. Health systems that fail to adapt risk perpetuating inefficiencies and compromising care quality for their most vulnerable patients.

Keywords: Multimorbidity, Primary Care, Integrated Care, Health Policy, Polypharmacy, Patient-Centred Care, Health System Reform, Chronic Disease Management, Health Equity, Co-Production.

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INTRODUCTION

Multimorbidity, the presence of two or more chronic conditions in an individual, is now a defining feature of primary care, particularly in ageing and socioeconomically disadvantaged populations. It affects over one in four adults globally, with prevalence exceeding 60% among those aged over 65 in high-income countries and rising rapidly in low- and middle-income countries (LMICs).¹⁻⁴

Despite this shift, primary care systems remain largely oriented toward acute, single-disease models. Patients with multimorbidity often encounter fragmented services, conflicting treatments, and burdensome care navigation - leading to suboptimal outcomes, higher costs, and reduced quality of life.⁵⁻⁷ Challenges, such as polypharmacy and poor provider coordination, further complicate care delivery.

Although research on multimorbidity has grown, health policy responses remain limited. Most national strategies prioritise disease-specific programs, overlooking the complexity of multimorbidity in planning and evaluation frameworks.⁸

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This misalignment calls for a fundamental redesign of primary care - centred on integration, patient-centred approaches, and rational prescribing - to meet the realities of today's health needs.

The Fragmentation Problem: Health Systems Not Designed for Complexity

Primary care systems remain largely structured around single-disease management, with clinical pathways, funding, and

quality metrics tailored to vertical, condition-specific care.⁹⁻¹⁰ This design creates fragmented experiences for multimorbid patients, who often navigate multiple providers, conflicting advice, and redundant treatments.¹¹

Such fragmentation increases the risk of adverse events, therapeutic duplication, unnecessary investigations, and hospitalisations.^{12,13} It also shifts the burden of coordination onto patients and families, disproportionately affecting those with limited health literacy and compounding inequities.¹⁴

While high-income countries struggle with siloed services despite better resources, LMICs face deeper challenges due to underfunded primary care, donor-driven vertical programs, and critical workforce shortages.^{15,16}

Even as evidence mounts on the inefficiencies of fragmented care, policy responses remain largely reactive. Most systems have not adapted financing, governance, or clinical processes to reflect the complexity of ageing, multimorbid populations-leaving care delivery out of sync with current epidemiological realities.¹⁷

Beyond Guidelines: The Limits of Disease-Specific Approaches

While clinical guidelines help standardise care for single diseases, they often fail patients with multimorbidity. Most are based on trials excluding individuals with multiple conditions, cognitive decline, or polypharmacy - common features in older and disadvantaged populations.^{18,19} Applying multiple guidelines simultaneously can result in conflicting recommendations, therapeutic overload, and higher risks of adverse events or treatment burden.^{20,21}

These rigid protocols can lead to care plans misaligned with patient goals, duplicated tests, and overmedication.²² Guideline development rarely addresses functional status, quality of life, or patient preferences - essential factors in managing chronic complexity.²³ For instance, strict glycemic targets may be inappropriate or harmful in frail patients with limited life expectancy.²⁴

Despite calls for reform, few guidelines integrate tools that account for multiple conditions, treatment interactions, or person-reported outcomes.²⁵ Real-world primary care requires flexible, individualised decision-making that moves beyond disease-specific algorithms toward holistic, goal-concordant care.

Polypharmacy at the Crossroads: Between Necessity and Harm

Polypharmacy - typically defined as five or more concurrent medications - is a common consequence of multimorbidity, especially among older adults. While often necessary, it carries significant risks including adverse drug events, non-adherence, cognitive decline, and hospitalisations.²⁶⁻²⁸

In practice, polypharmacy often results from multiple prescribers and persists without regular review. Fragmented documentation, time constraints, and lack of deprescribing protocols contribute to avoidable medication-related harm, particularly in frail or high-risk patients.^{29,30}

Although tools like STOPP/START and the Beers Criteria support safer prescribing, they are rarely integrated into clinical workflows and often lack flexibility to account for patient goals, preferences, or the burden of managing complex regimens.^{31,32}

To reduce harm, structured medication reviews, deprescribing strategies, and shared decision-making must be embedded in routine primary care. This requires clinician training, team-based collaboration, and digital tools to flag high-risk prescribing.³³ A polypharmacy-sensitive approach must differentiate necessary therapeutic complexity from preventable harm- placing patient context at the centre of prescribing decisions.

Models of Integration: Lessons from Innovative Primary Care Systems

Despite widespread fragmentation, several health systems have developed integrated care models that effectively manage multimorbidity by emphasising coordination, patient-centred planning, and continuous monitoring.

The Chronic Care Model (CCM) and its U.S. adaptation, the Patient-Centred Medical Home (PCMH), promote proactive, team-based management supported by decision aids and self-management education - improving quality, satisfaction, and reducing emergency visits.^{34,35} In the UK, the House of Care model and 3D approach consolidate disease reviews and enable goal-oriented care planning, enhancing coordination and patient experience.^{23,36}

In LMICs, integration addresses the dual burden of chronic and infectious diseases. South Africa's Integrated Chronic Disease Management (ICDM) model merges services for HIV, TB, and NCDs into a nurse-led, decentralised system.³⁷ Brazil's Family Health Strategy embeds multidisciplinary teams in communities to provide longitudinal care, reducing mortality and hospitalisations.³⁸

These models share key features: continuity, multidisciplinary collaboration, robust digital infrastructure, and alignment with patient goals. Successful scale-up depends on local adaptation, political commitment, and sustained investment in primary care systems and workforce development.

Toward a Policy Blueprint: Key Components of Multimorbidity-Responsive Primary Care

Tackling multimorbidity requires structural reform in how primary care is financed, staffed, and delivered. A responsive framework should move beyond disease-focused models and embrace five foundational pillars:

Financing for complexity

Shift from fee-for-service to blended or capitation-based payment systems that incentivise continuity, coordination, and outcomes aligned with patient priorities.^{39,40}

Team-based care

Build interdisciplinary teams - GPs, nurses, pharmacists, mental health and social care professionals - with defined roles and shared care plans to manage complex needs.⁴¹

Digital infrastructure

Develop interoperable electronic health records and decision-support tools that enable data sharing, risk stratification, and safer prescribing.⁴²

Training for complexity

Equip clinicians with skills in multimorbidity management, communication, deprescribing, and shared decision-making through updated curricula and case-based learning.⁴³

Patient-centred outcomes

Replace disease-centric metrics with co-produced measures that reflect quality of life, functional ability, and treatment burden.⁴⁴

Together, these pillars create a foundation for a sustainable, person-centred primary care system. Success depends on political will, cross-sectoral collaboration, and long-term investment.

Implementation Realities: Barriers and Enablers Across Contexts

Turning policy into practice for multimorbidity-responsive care is challenging, shaped by political, infrastructural, and cultural contexts. Even well-designed models often face uneven uptake due to fragmented governance, limited resources, and systemic inertia.

Political will is a key driver. Countries with stable leadership and strong primary care mandates are more likely to implement reforms, while short policy cycles and competing priorities often stall progress - especially in LMICs.⁴⁵

Infrastructure and workforce gaps

such as understaffing, poor digital systems, and lack of training - further impede implementation.^{46,47} Clinicians are often burdened by time constraints and administrative overload, limiting their ability to innovate.

Cultural barriers also matter. Hierarchical medical norms and specialist dominance can resist team-based, patient-centred models. Patients themselves may face barriers like low health literacy or distrust in health systems, especially in marginalised communities.^{48,49}

Enablers include policy champions, local leadership, adaptive financing, and community engagement. Successful pilots show that context-sensitive, co-designed models can scale when supported by sustained investment and stakeholder buy-in.^{50,51}

Implementation must be viewed not as a technical deployment but as an adaptive, equity-focused process aligned with frontline realities.

Patient Voice and Lived Experience: Centring Care Around What Matters

Multimorbidity disrupts not only physical health but also emotional well-being, daily functioning, and identity. Yet health systems remain predominantly clinician- and disease-focused, often sidelining the lived experiences of

those navigating multiple chronic conditions. For care to be truly person-centred, policies and models must explicitly incorporate the voices, preferences, and priorities of patients and caregivers.^{52,53}

Research shows that individuals with multimorbidity value care continuity, clear communication, and being treated as a whole person - not as a sum of disconnected diagnoses.⁵⁴ Many express frustration with fragmented services, conflicting medical advice, and a lack of meaningful involvement in decisions that directly affect their quality of life.⁵⁵ This disconnect can lead to treatment fatigue, poor adherence, and avoidable harms from overmedicalization or unnecessary interventions.⁵⁶

Participatory models, such as shared decision-making and goal-oriented care, have shown promise in aligning clinical care with what matters most to patients - be it symptom relief, functional independence, or social participation.⁵⁷ Tools like patient-reported outcome measures (PROMs) and narrative medicine approaches can further ensure that care delivery is guided by patient-defined goals rather than narrowly clinical metrics.⁵⁸

Incorporating patient voices into system design also strengthens policy accountability. Co-production in service planning - where patients are equal partners in designing and evaluating services - has improved relevance, trust, and uptake of integrated care interventions in various settings.⁵⁹ For multimorbidity care to be sustainable, equity-enhancing, and humane, it must be grounded in dignity, autonomy, and the principle that the patient is not simply the subject of care, but its co-architect.

The Path Forward: Policy Recommendations for Health Systems Transformation

Meeting the challenge of multimorbidity demands a coordinated transformation across all levels of health systems - policy, practice, and financing. Fragmented and disease-focused approaches must give way to integrated, person-centred models grounded in long-term continuity, therapeutic appropriateness, and equity. Based on emerging evidence and global implementation experiences, several policy priorities stand out.

Anchor health systems in strong, integrated primary care

Governments must prioritise investment in first-contact, comprehensive primary care that is equipped to manage complex needs over time. This includes expanding multidisciplinary teams, strengthening referral pathways, and linking with social and community care.^{10,60}

Reform financing to support coordination and complexity

Transitioning from fee-for-service to blended payment models - such as capitation with quality-linked incentives - can reward longitudinal care, deprescribing, and care integration. Payers should also fund structured medication reviews and



support services such as care navigation and home-based interventions.^{61,62}

Build digital infrastructure for proactive, data-driven care

Health systems should develop interoperable electronic records, risk stratification tools, and predictive analytics that identify high-need patients and support clinical decision-making.⁶³ Digital enablers can also facilitate communication across providers and empower patients through access and engagement tools.

Invest in training for complexity and shared decision-making

Clinicians must be equipped to handle the uncertainties of multimorbidity, including managing treatment trade-offs, engaging in goals-based planning, and deprescribing safely. National training bodies should revise curricula to include multimorbidity and patient-centred practice as core competencies.⁶⁴

Embed measurement of person-centred outcomes

Health system performance frameworks should expand beyond disease-specific metrics to include patient-reported outcome measures (PROMs), care coordination indicators, and treatment burden scores. These metrics better reflect the goals of multimorbid patients and can guide quality improvement.⁶⁵

Institutionalise co-production and policy accountability

Patients, families, and community organisations must have structured roles in the design, governance, and evaluation of services. Their lived experience can guide meaningful reforms and ensure that transformation efforts address what matters most to those affected.⁶⁶

A coherent policy roadmap - centred on integration, rational use of therapies, and patient-defined outcomes - can transform primary care into a system truly responsive to the complexities of multimorbidity. However, scaling such reforms requires long-term commitment, intersectoral coordination, and inclusive leadership at all levels of the health system.

DISCUSSION

Multimorbidity is now a central challenge in global primary care, revealing a fundamental misalignment between traditional, single-disease-focused systems and the needs of patients with complex health profiles. Despite growing awareness, policy responses have been fragmented and slow to scale, leaving primary care poorly equipped to manage overlapping conditions effectively.^{67,68}

This review identifies common features of effective models: integrated service delivery, interdisciplinary teamwork, patient-centred care, proactive polypharmacy management, and digital tools to enhance coordination. However, systemic barriers—such as fragmented governance, inadequate financing, limited training, and entrenched disease-specific

norms—continue to hinder implementation.^{43,46}

Patient experiences underscore the need for transformation. Individuals with multimorbidity often face care that is confusing, duplicative, and misaligned with their goals.⁵⁵ Models like the UK's 3D approach,²³ Brazil's Family Health Strategy,³⁸ and South Africa's integrated care programs³⁷ demonstrate the value of locally adapted, person-centred innovations, particularly when patients are active in design and delivery.

Scalability remains a major challenge. Many successful models operate as pilots or donor-supported initiatives. Sustained expansion demands systemic changes: payment reforms, redefined outcome measures, and investment in integrated training and infrastructure.

Equity must be central to reform. Multimorbidity disproportionately affects socioeconomically disadvantaged groups and risks widening health disparities unless policies address underlying social determinants, health literacy, and access barriers.²

Rather than viewing multimorbidity as a deviation, health systems must treat it as a defining reality. The tools for reform already exist; what's needed is strong political will, coordinated policy action, and a commitment to aligning care systems with patient experience and complexity.

CONCLUSION

Multimorbidity is no longer an outlier but a defining feature of 21st-century primary care. Yet, global health systems remain entrenched in single-disease paradigms, resulting in fragmented care, inappropriate polypharmacy, and unmet patient needs. A system-wide shift is essential - one that embraces integrated, patient-centred, and polypharmacy-sensitive models. This transformation requires financing reforms, digital infrastructure, interdisciplinary workforce training, and performance metrics aligned with outcomes that matter to patients.

Importantly, patients must be engaged not only as recipients of care but as co-designers of services. Grounding reforms in lived experience ensures responsiveness, equity, and dignity. The evidence is clear: scalable solutions exist. What is needed now is bold leadership and sustained commitment to redesigning primary care around complexity - rather than despite it. Multimorbidity must be viewed not as a challenge to current systems, but as a catalyst for their long-overdue evolution.

CLINICAL TRIAL NUMBER

Not applicable

AUTHOR CONTRIBUTION DECLARATION

Both authors (Pragnesh Parmar, Gunvanti Rathod) contributed equally in the preparation of this manuscript.

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Forensic Medicine in the Digital Age: Navigating Challenges and Embracing Opportunities

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ABSTRACT

Forensic medicine, a critical intersection of law and science, is undergoing a profound transformation driven by rapid technological advancements. While these innovations promise enhanced diagnostic precision and efficiency, they simultaneously introduce a complex array of challenges. This review article explores the multifaceted landscape of modern forensic medicine, examining the key hurdles posed by the integration of advanced technologies and identifying the burgeoning scopes for the field. This paper delves into the ethical, legal, and financial barriers associated with sophisticated imaging, AI-driven analytics, and forensic genomics. We also highlight the growing complexities of digital and cyber forensics in an interconnected world. Concurrently, this review discusses the significant opportunities derived from these advancements, including improved investigative capabilities, enhanced diagnostic accuracy, and the emergence of new interdisciplinary specialisations. The paper provides a comprehensive overview of the current state of forensic medicine, offering a roadmap for practitioners and policymakers to navigate these complexities and leverage technological innovations to uphold justice and public safety.

Keywords: Forensic Medicine, Digital Forensics, Virtual Autopsy, Artificial Intelligence, Ethical Challenges

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INTRODUCTION

Forensic medicine has historically relied on meticulous observation and traditional scientific methodologies to provide impartial evidence in legal proceedings. The 21st century, however, has ushered in an era of unprecedented technological innovation, fundamentally altering the practice of forensic science. Technologies such as advanced radiological imaging, artificial intelligence (AI), and next-generation sequencing (NGS) have become integral tools, promising a new era of accuracy and efficiency¹⁻³. This shift, while transformative, is not without its complexities. The integration of these powerful tools has exposed significant challenges related to ethics, legal admissibility, financial feasibility, and the need for standardised protocols. This review article aims to provide a comprehensive analysis of the current landscape of forensic medicine, focusing on the primary challenges faced by the discipline and the promising new scopes that have emerged from this technological revolution.

Description

Figure 1 shows conceptual diagram showing the interplay of various advanced technologies (e.g., AI, Genomics, Virtual Autopsy) and how they influence different aspects of forensic practice (e.g., Investigation, Laboratory Analysis, Court Testimony). The arrows connect the technologies to the stages, with callouts for specific challenges or opportunities at each stage.

CHALLENGES IN THE CURRENT ERA

The adoption of advanced technologies presents a multifaceted set of challenges that forensic medicine must address to maintain its credibility and effectiveness.

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Ethical and Legal Hurdles

The introduction of new technologies into the legal system raises complex ethical and legal questions.

Admissibility of Evidence

The legal system, often slow to adapt, struggles with the admissibility of evidence derived from novel technologies. For instance, the use of AI algorithms to predict the time of death or identify injury patterns must be validated rigorously before it can be accepted in a court of law.⁴ The “Daubert standard” or similar legal precedents require that scientific evidence be reliable and based on valid methodology.⁵

Data Privacy and Security

The collection and analysis of vast amounts of sensitive data, including genetic and biometric information, raises significant privacy concerns. Ensuring the security of this data from unauthorised access or manipulation is a critical challenge.⁶

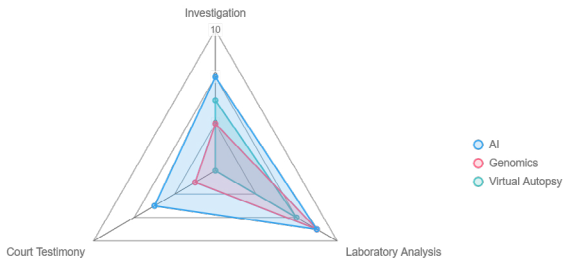


Figure 1: The forensic medicine ecosystem in the digital age

Algorithmic Bias

AI models trained on non-diverse or incomplete datasets can perpetuate and even amplify existing biases, potentially leading to discriminatory outcomes.⁷

Technological and Financial Barriers

The high cost and complexity of modern forensic tools are significant obstacles, particularly for institutions with limited resources.

High Cost of Technology

The acquisition and maintenance of state-of-the-art equipment, such as post-mortem CT and MRI scanners, advanced mass spectrometers, and high-throughput sequencers, requires substantial financial investment.⁸

Lack of Standardisation

The absence of universally accepted protocols for data acquisition and analysis across different laboratories can lead to inconsistencies and questions about the reproducibility of results.^{9,10}

Training and Expertise

The effective use of these sophisticated tools necessitates highly specialised training and a skilled workforce, which can be difficult and costly to develop and retain.^{11,12}

The Digital and Cyber Forensics Frontier

The proliferation of smart devices and the Internet of Things (IoT) has expanded the scope of forensic investigations into the digital realm, presenting unique challenges (Figure 2).

Description

An illustrative diagram showing a central crime scene with lines extending to various digital devices (e.g., smartphone, laptop, smartwatch, security camera) and cloud services

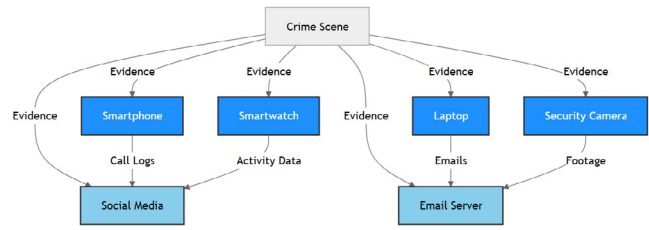


Figure 2: The digital evidence landscape

(e.g., social media, email server). This figure highlights the distributed and complex nature of modern digital evidence.

- **Data Volume and Volatility:** The sheer volume of digital data and its often-volatile nature make its collection and analysis a formidable task. This includes data from smartphones, social media, cloud services, and IoT devices.^{13,14}
- **Anti-Forensic Techniques:** Perpetrators increasingly employ sophisticated anti-forensic techniques, such as encryption, data wiping, and steganography, to obscure evidence, complicating investigations.¹⁵

SCOPES AND OPPORTUNITIES FOR THE FUTURE

Despite the challenges, the convergence of technology and forensic medicine is creating exciting new avenues for innovation and discovery.

Enhanced Diagnostic Capabilities and “Virtopsy”

Advanced imaging technologies offer non-invasive alternatives and a new level of detail in post-mortem examinations.

Virtual Autopsy (Virtopsy)

Post-mortem CT, MRI, and 3D surface scanning allow for a detailed, non-destructive examination of the body, which is particularly valuable in cases where cultural or religious beliefs preclude traditional autopsies (Table 1).¹⁶

Forensic Genomics and Molecular Diagnostics

Rapid advancements in genomics are expanding the capabilities of forensic DNA analysis beyond simple matching.

Next-Generation Sequencing (NGS)

NGS allows for the analysis of highly degraded or mixed DNA samples, and can provide information on a suspect’s ancestry and physical characteristics (forensic phenotyping).¹⁷

Table 1: Comparison of forensic autopsy methods

Method	Required equipment	Invasiveness	Time required	Key advantages	Key disadvantages
Traditional Autopsy	Scalpels, forceps, saws, and dissection tables	Highly invasive	2–4 hours	Detailed physical examination, widely accepted in courts, and comprehensive tissue sampling	Destructive, emotionally distressing for families, risk of infection to pathologists
Virtual Autopsy	CT/MRI scanners, 3D imaging software	Non-invasive	1–2 hours	Preserves body, detailed imaging, repeatable, shareable data	High equipment cost, limited soft tissue detail, and court admissibility challenges



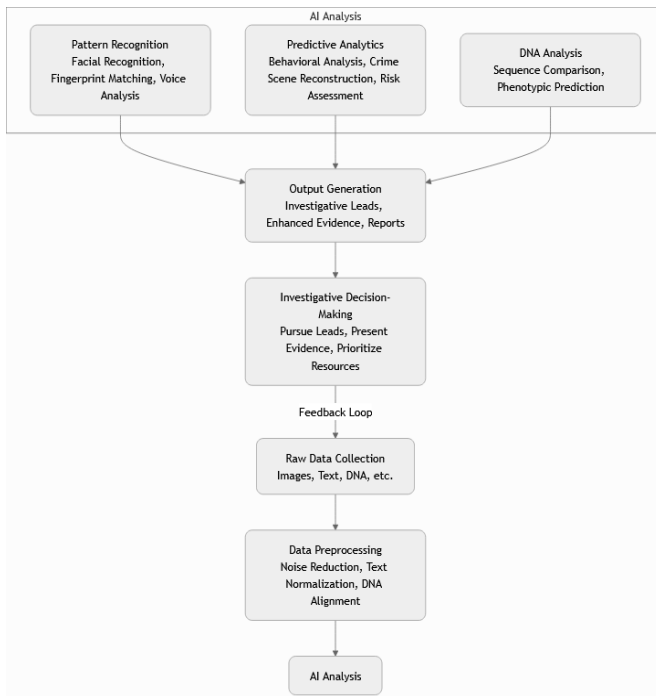


Figure 3: AI in the forensic workflow

Rapid DNA Technology

Portable DNA platforms enable on-site analysis, dramatically reducing the time required to generate investigative leads and identify individuals in mass disaster scenarios.^{18,19}

AI and Machine Learning in Forensic Science

AI and machine learning are poised to revolutionise forensic processes by automating and enhancing various tasks (Figure 3).

Description

A flow chart or diagram illustrating how AI can be integrated into a forensic investigation. This somewhat clarifies the practical applications of AI.

Predictive Analytics

AI models can be trained to predict the time of death, age of an injury, or cause of death based on large datasets of post-mortem scans and other data.^{20,21}

Digital Image and Video Analysis

AI can be used to enhance blurry images, identify individuals in surveillance footage, recognise voices of the perpetrator or analyse vast amounts of digital evidence more efficiently than human analysts.²²⁻²⁴

CONCLUSION

The future of forensic medicine is inextricably linked to technological progress. While the challenges of cost, ethics, and legal admissibility are significant, they are not insurmountable. The opportunities presented by advanced

imaging, genomics, and AI are immense, promising a future where forensic investigations are more accurate, efficient, and capable of providing unprecedented insights. The path forward requires a thoughtful, collaborative, and evidence-based approach to ensure that these powerful tools serve to uphold justice and reinforce the integrity of the legal system. By establishing standardised protocols, investing in robust ethical frameworks, and fostering interdisciplinary collaboration, the forensic community can effectively navigate these complexities and ensure the discipline remains a cornerstone of the justice system.

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Non-Therapeutic Hysterectomy in Intellectually and Physically Disabled Girls and Women- A Critical Analysis

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ABSTRACT

The non-therapeutic hysterectomy is a significant ethical and legal dilemma in healthcare systems worldwide when it is performed in intellectually or physically disabled girls and women for reasons of menstrual hygiene management or caregiver convenience. This narrative review integrates literature to critically analyse clinical justifications, inherent ethical dilemmas and increasingly related legal issues surrounding this controversial matter, particularly in relation to institutional constraints in India. We explore the inconsistencies between accepted bioethical principles of autonomy, non-maleficence, and justice and the continuing rationalisations for the procedure. The recent Maharashtra government's position in favour of the practice is read as a pivotal example of institutional betrayal. In contrast, international legal trends indicate a definite, although unreconciled, movement towards protective care, including judicial review as well as multiprofessional control. The article argues non-therapeutic hysterectomy is an ethical and human rights violation. We call for a shift in the model towards supported decision-making, to an exhaustive search for non-surgical options, and to the establishment of strong legal protection for the body and reproductive autonomy of this at-risk population.

Keywords: Non-therapeutic hysterectomy, intellectual disability, physical disability, menstrual hygiene, bioethics, human rights.

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INTRODUCTION

The history of non-therapeutic hysterectomy and involuntary sterilisation of intellectually and physically disabled girls and women has been a one of a series of very sad intersections of medicine, law, and ethics. The origins of the practice lie in early 20th-century eugenic views about curtailing the reproduction of “undesirable” people. In the 1927 U.S. Supreme Court case *Buck v. Bell*, Justice Oliver Wendell Holmes bemoaned, “three generations of imbeciles are enough,” giving his blessing to the compulsory sterilisation of women with intellectual disabilities who were institutionalised. This decision allowed for the subsequent sterilisation of tens of thousands of women in over 20 U.S. states within eugenic legislation, as Roberta Cepko explains.¹ Under these laws, more than 60,000 women were sterilised by the mid-1900s, many without their permission.

These activities were justified by arguments in the public interest for health, economic, and moral reasons, notably to prevent births to those considered incompetent to parent, and to reduce “burdens” on the state. Courts have frequently granted sterilisation applications on the grounds of sexual risk, purported promiscuity, or caregiver “convenience.” As Cepko documents, legal and judicial thinking often elevated social regulation and administrative convenience over individual rights, bodily autonomy, and dignity.

In India, the first internationally visible red flag was raised in the year 1994, in a brief report published in *The Lancet* entitled “Mass hysterectomies in India,” highlighting that women with intellectual disabilities, at least, were the subject of hysterectomy clustering (in state institutions and involving

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intellectually disabled women), which was justified by hygienic or caregiver convenience concerns. The *Lancet* report sparked widespread medical, ethical, and legal debate in India, highlighting the deep divide between institutional practices that claimed to uphold bodily autonomy and those that clearly violated it.² In connection with this incident, the Bombay High Court, in *National Addiction Research Centre v. State of Maharashtra* (1994), took suo motu cognisance of a horrendous case of 17 out of 49 mentally challenged women residing at residential schools who were subjected to hysterectomy surgeries without compelling medical justifications. The ruling set a precedent in India, highlighting the necessity for ethical oversight and human rights protections in the care of disabled women in institutional settings.³

Menstrual hygiene management for girls and women with profound intellectual or physical disabilities is challenging for caregivers, families, and healthcare providers.⁴ Yet, the therapeutic removal of the uterus (hysterectomy) to address

these challenges when no uterine disease is present raises serious ethical concerns against individual rights and bodily autonomy.⁵ The procedure, often rationalised as being in the best interests of hygiene, sterilisation, and reduced caregiver burden, directly opposes the fundamental beliefs of medical ethics and the human rights of persons with disabilities.⁶ There has been widespread international condemnation of this practice, yet it remains embedded in many institutions, particularly in developing nations like India.^{7,8}

Today, while the openly eugenic sterilisation programs have been discredited, worries linger in both first world and third-world settings about hidden or informal medical practices that amount to reproductive denial for women with disabilities. Gender, disability, and reproductive rights are still hotly contested and ethically charged issues. The discussion remains polarised between protection and autonomy, care and control, medicalisation of disability and human rights-based models. To develop policies and clinical practices that will have respect for bodily integrity, consent, and reproductive rights of intellectually and physically disabled women, it is critical to understand this history and its continuing impact.

Here, the authors review the clinical rationale, breaches of professional ethics, and international legal contexts related to non-therapeutic hysterectomy.

Ethical Dilemmas

Non-therapeutic hysterectomy is often justified on clinical grounds as menstrual flow management to control menstruation in individuals with limited self-care ability and as a part of behavioural treatment to neutralise the observed mood fluctuations related to the menstrual cycle.^{5,7} The caregivers of these physically and intellectually challenged girls accept this practice to alleviate the physical, emotional, and financial burden of caregiving. It has been seen that these practices are done as a form of birth control, based on assumptions about vulnerability to sexual abuse.⁶ While these concerns appear practical, they are unsupported by medical necessity and raise significant ethical issues.⁷

The principle of autonomy upholds the right to bodily integrity and self-determination for all persons.⁵ Because it is a permanent procedure, a non-therapeutic hysterectomy eliminates the woman's ability to make future reproductive decisions and undermines her autonomy.⁶ As a major surgery, hysterectomy carries risks such as infection, bleeding, premature ovarian failure, cardiovascular disease, osteoporosis, and psychological trauma.⁷ Performing it for non-life-threatening reasons constitutes a serious ethical breach.⁶ Conducting irreversible procedures solely based on disability violates the United Nations Convention on the Rights of Persons with Disabilities (CRPD), which guarantees autonomy, dignity, and freedom from degrading treatment.⁹

DISCUSSION

The Indian Context: Protocols and Frameworks

There was a dire need for a legal framework for this type of operation involving ethical and legal aspects of the

autonomy and dignity of the patient. Subsequently, the Indian Journal of Medical Ethics issued suitable guidelines for non-therapeutic hysterectomies in 1994.⁴ The key principles in their guidelines mention that hygiene and caregiving support should be prioritised over surgical elimination of menstruation. Hysterectomy is unwarranted for contraception or caregiver convenience; sterilisation, if needed, should be via laparoscopic ligation. IJME suggests that a Hysterectomy can only be considered in a woman with irreversible brain damage that has left her with no understanding of her bodily functions and incapable of looking after her own needs despite meticulous efforts at training her to do so.

A rights-based position was upheld in *Smt. Sangeeta Sandeep Punekar v. State of Maharashtra & Ors.*, where the Bombay High Court rejected the affidavit submitted by the Maharashtra Women and Child Development Department. The affidavit had sought to justify hysterectomy in women with an IQ below 50 on grounds of hygiene, infection risk, anaemia, and breathing difficulty. The Court found this reasoning inconsistent with the Rights of Persons with Disabilities Act, 2016, and the Mental Healthcare Act, 2017, which safeguard autonomy, dignity, and protection from degrading treatment. Rather, it states that resorting to irreversible surgery over supportive care reflects institutional and systemic failure.¹⁰ It is also important to note that the state is not the guardian of individuals residing in institutions for the handicapped or needy; it is merely a custodian entrusted with their care.²

Earlier, in *National Addictional Research Centre v. State of Maharashtra and Dr. Anant Phadke & Ors. v. State of Maharashtra*, the Bombay High Court considered the ethical and legal implications of such surgeries in state institutions. In this case, the High Court observed that it appears that the infliction by consent or otherwise of this kind of surgery on mentally retarded women or girls cannot be sufficiently supported by any logic. It may amount to serious interference with the rights of such challenged women.³

Comparative International Legal Contexts

In the United States, following the “Ashley X” case, several states require judicial review and ethics-committee oversight for the sterilisation or hysterectomy of disabled minors.^{6,11} In the United Kingdom, the Mental Capacity Act (2005) mandates Court of Protection approval for such procedures, ensuring a best-interest evaluation that incorporates the individual's prior wishes and beliefs.¹² In a landmark 1986 judgment, the Supreme Court of Canada considered a petition filed by the mother of a woman with intellectual disability, referred to as “Eve,” seeking authorisation for her daughter's sterilisation. The Court held that such an invasive and irreversible procedure, lacking any therapeutic necessity, could not be ethically or legally justified.¹³

The continued practice of non-therapeutic hysterectomy demonstrates deep societal and institutional neglect—inflicting unnecessary harm, medicalising social issues, and disregarding supportive care. Evidence indicates that, with proper training

and resources, menstrual hygiene can be managed without surgical intervention. Global legal norms now uphold bodily integrity and reproductive rights irrespective of disability status.

Non-therapeutic hysterectomy performed on persons with disabilities or mental illness, without medical necessity, violates the Mental Healthcare Act, 2017,¹⁴ and the fundamental rights to life, dignity, and bodily integrity under Article 21 of the Constitution of India.

CONCLUSION

A non-therapeutic hysterectomy for reasons of menstrual hygiene and the convenience of the caregivers of intellectually and/or physically disabled women is a gross violation of human rights and can never be justified from an ethical perspective. Suggestions of better hygiene or convenience for caregivers cannot justify perpetuating this discriminatory practice. What is needed is the replacement of the outmoded medical model by the social model, which upholds sexual, bodily and human rights, including the right to autonomy, access to respectful supported decision-making and the right to legal protection.

A preventable non-therapeutic hysterectomy must be addressed through a rights-based multidisciplinary strategy. These operations should be categorised as human rights abuses. Multi-disciplinary review panels, including ethicists, legal experts, disability advocates, and clinicians, should review each case, and that would help to ensure that every decision is ethically and medically sound. Providers must be educated in menstrual care and behavioural intervention to prevent unnecessary surgeries. There must be stronger public education about the rights of people with disabilities and ethical medical practice, and more severe punishments for violations to hold violators accountable, and to protect women's right to autonomy and dignity.

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Not applicable.

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Forensic Entomology: Applications in Time-Since-Death Estimation

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ABSTRACT

Forensic entomology—the application of arthropod biology to legal investigations—has become a cornerstone method for estimating the postmortem interval (PMI) or time since death when traditional medico-legal approaches are limited. This review synthesises classical and recent developments in entomological PMI estimation, covering insect colonisation patterns, developmental and successional approaches, sampling and laboratory protocols, thermal summation models, DNA and molecular identification, statistical and error-quantification methods, pitfalls and courtroom acceptance, and future directions. Emphasis is placed on practical application: how insect evidence is collected, interpreted, and presented, and what limitations investigators must account for (environmental variables, cadaver relocation, drugs/toxins, interspecific and intraspecific variability). Recent advances—standardised field protocols, improved developmental datasets, DNA barcoding for species identification and more robust statistical frameworks—have increased precision and reliability, but challenges remain in model validation, accounting for microclimate effects and quantifying uncertainty. This article provides investigators, pathologists, and researchers with a comprehensive and practical resource for entomology-based PMI estimation, cites key literature and recommends best practices to increase evidentiary value.

Keywords: Forensic entomology, Postmortem interval (PMI), Blowflies, Larval development, Insect succession, Thermal summation, DNA barcoding, Sampling protocols.

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INTRODUCTION AND HISTORICAL CONTEXT

Forensic entomology applies insect ecology, development, and behaviour to medico-legal questions—chiefly the estimation of time since death (postmortem interval, PMI). Insects have predictable developmental patterns tied to temperature and exhibit reproducible successional assemblages on decomposing remains, making them effective biological clocks when human tissues are no longer amenable to classical postmortem changes. Although observations of insects on corpses date back centuries, systematic scientific application began only in the 20th century and has matured rapidly with methodological standardisation and molecular advances. The principal modern applications are:

- estimation of the *minimum* PMI based on the age of the oldest necrophagous insects (developmental method)
- estimation of PMI based on the successional stages of insect communities (successional method)
- ancillary uses such as detection of body movement, presence of wounds or toxins, and geographic origin.

The literature emphasises that entomology frequently provides a minimum bound for PMI and—when applied carefully—yields highly valuable temporal information in investigations.¹

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Biological Basis: Necrophagous Insects and their Life Cycles

Major arthropod groups

The primary taxa relevant to PMI estimation are necrophagous Diptera (blowflies — *Calliphoridae*, flesh flies *Sarcophagidae*, and muscid flies *Muscidae*), Coleoptera (silphids, dermestids, staphylinids), Hymenoptera (parasitic wasps affecting larval mortality) and other arthropods (mites, beetle predators). Among these, blowflies (*Calliphoridae*) are often the first colonisers and thus central to developmental PMI estimation. Different species vary in attraction timing, oviposition behaviour, developmental rates and ecological preferences (e.g.,

open vs sheltered environments), which must be accounted for in PMI reconstructions.²

Life cycle fundamentals

Most forensic models rely on the holometabolous life cycle of flies: egg → larval instars (L1, L2, L3, including feeding and post-feeding “wandering” stages) → pupa → adult. Developmental timing is largely temperature-dependent and can be modelled using thermal summation (accumulated degree days/hours), but species-specific developmental datasets are required. Oviposition timing is affected by accessibility of the body, time of day, weather and local insect fauna. Larval aggregations generate metabolic heat (maggot mass effect), accelerating development relative to ambient temperature—an important consideration in modelling.³

Entomological Approaches to PMI Estimation

Developmental (age-estimation) methods

Developmental methods estimate a minimum PMI (PMI) by determining the age of the oldest immature insects collected from remains. The essential steps are:

- accurate species identification
- measure developmental stage/size of specimens
- apply species-specific developmental data (growth curves at known temperatures) to estimate age
- Reconstruct thermal exposure (ambient temperature, microclimate, and maggot mass effects) to convert physiological age into calendar time.

Common analytical frameworks include thermal summation models (degree-days/hours), isomegalen diagrams (size/time at given temperatures), and modern statistical models (e.g., generalised additive models, Bayesian approaches) that integrate variability and uncertainty.³

Successional (assemblage) methods

Successional methods use predictable patterns of species arrival and community turnover through decomposition stages. When a robust, region-specific succession calendar exists (based on carrion studies), the presence or absence of particular taxa can inform PMI across longer intervals (weeks to months). Successional approaches are particularly useful for advanced decomposition or skeletonised remains where larval development provides little information. However, successional inferences are region and habitat-specific and require local validation.²

Pre-appearance interval (PAI) and colonisation delays

A crucial concept is the pre-appearance interval (PAI) — the period between death and first colonisation by necrophagous insects. PAI can be influenced by body concealment, season, weather, diurnal patterns, chemical masking and presence of scavengers. Accurate PMI reconstruction must consider potential delays; some modern studies recommend explicitly estimating PAI from field experiments and integrating it into PMI models to reduce bias.²

Practical procedures: scene sampling and laboratory processing

Good forensic practice requires standardised sampling at the scene with chain-of-custody documentation. Typical scene protocol includes:

- Photographing insect activity and larval aggregations in situ.
- Collecting representative samples of all life stages: eggs, larvae (both killed/preserved and live for rearing), pupae and adults. Standard practice preserves a subset in ethanol for morphological and molecular ID and keeps live specimens to rear to adulthood for confirmatory identification and age determination.
- Taking substrate/soil samples and environmental measurements: ambient temperature, humidity, sun exposure and immediate microhabitat notes (sheltered, submerged, indoors/outdoors). Place data loggers or obtain nearest reliable meteorological data and adjust for microclimate (e.g., shade, maggot mass heat).
- Documenting any interfering factors: insect repellents, insecticide use, body concealment, wounds, belongings and presence of drugs.

Laboratory procedures include species identification (morphology and/or molecular), measurement and staging of larvae (instar determination, cephalopharyngeal skeletons, spiracular plates), rearing of live samples for adult confirmation and comparison to species-specific developmental datasets obtained under controlled temperatures. Standardised preservation (e.g., hot water killing followed by ethanol storage) prevents shrinkage artefacts in larvae. These standard practices are set out in forensic entomology manuals and contribute to admissible evidence.⁴

Thermal Models: Degree-days, Accumulated Degree-hours and Advanced Modelling

Thermal summation basics

Because insect development is temperature dependent and roughly linear between species-specific lower and upper thresholds, thermal summation (accumulated degree days, ADD or accumulated degree hours, ADH) is widely used. $ADH = \sum (T_{\text{mean}} - T_{\text{base}})$ for time increments where $T_{\text{mean}} > T_{\text{base}}$. Species-specific developmental thresholds (T_{base}) and required thermal totals for each stage are empirically determined through laboratory rearing. Converting insect physiological age into calendar time requires reconstructing the thermal history experienced by the insects—including ambient temperatures, microclimate offsets and maggot mass heating.³

Accounting for maggot mass and microclimates

Maggot masses can drastically increase local temperatures (commonly 5–15°C above ambient), accelerating development. Investigators must, where possible, measure maggot mass temperature at the scene or estimate it based on laboratory or field studies. Microhabitat features (sun exposure, burial, clothing) alter insect access and temperature exposure;



modelling must incorporate such conditions. Some advanced approaches use mechanistic microclimate models or numerical simulations to reconstruct plausible temperature histories and then apply Bayesian frameworks to integrate uncertainty. Recent research emphasises the importance of field validation of these models.²

Modern statistical and mechanistic models

Beyond simple thermal sums, statistical approaches (regression, generalised additive models and Bayesian inference) and mechanistic models (developmental rate models, physiologically based models) better account for nonlinearities, seasonal effects and parameter uncertainty. Papers argue for reporting PMI as a probability distribution or credible interval rather than a single value. This advances forensic utility by explicitly communicating uncertainty in court.⁵

Species Identification: Morphology and Molecular Methods

Morphology

Morphological identification remains fundamental—especially adult flies and pupal cases—but early life stages (eggs, first-instar larvae) are often morphologically cryptic and easily misidentified. Specialist taxonomic keys are used by trained forensic entomologists, and rearing immature specimens to adults remains a gold standard for confirmatory ID.⁶

Molecular methods and DNA barcoding

Molecular identification (e.g., COI mitochondrial DNA barcoding) allows species identification from tiny remains (eggs, partial larvae) and overcomes morphological ambiguity. DNA methods are increasingly used in routine forensic workflows to validate morphological IDs or when rearing is impossible. Recent regional studies (including work from India and other biodiverse regions) demonstrate DNA barcoding's power to distinguish cryptic species and improve PMI accuracy. However, the utility of molecular approaches relies on comprehensive reference libraries and quality-controlled protocols.⁴

Statistical approaches and expressing uncertainty

Modern forensic entomology emphasises rigorous uncertainty quantification:

- Use of confidence/credible intervals (not point estimates) for PMI.
- Cross-validation of multiple evidence lines (developmental age + succession + scene context).
- Bayesian frameworks to combine prior information (e.g., known local colonisation phenology) with observed insect evidence, producing probabilistic PMI estimates.
- Sensitivity analyses to demonstrate how PMI estimates shift with changes in assumed temperatures, species identification, or maggot mass heating.

The forensic community increasingly recommends presenting PMI as a range with stated assumptions and

probabilities this is more scientifically honest and more defensible in court. Statistical validation using controlled field experiments and “blind” trials is encouraged to quantify real-world error rates.⁵

Factors that Complicate PMI Estimation (Environmental, Biological, Anthropogenic)

Environmental and ecological factors

- Temperature fluctuations and microclimates: inaccuracy if ambient meteorological records do not reflect the corpse microenvironment.
- Substrate and accessibility: bodies buried, submerged, or enclosed may experience delayed colonisation or different fauna.
- Seasonality: species availability varies regionally and seasonally, affecting both developmental and successional approaches.³

Biological and interspecific factors

- Species misidentification: species vary in growth rates; misidentification can produce large PMI errors.
- Intraspecific variability: populations from different climatic zones may have different developmental thermal requirements. Local developmental datasets are therefore preferable.
- Maggot mass effect and density dependence: higher densities accelerate development; models must account for that.²

Anthropogenic and chemical influences

- Drugs and toxins: ingestion of drugs (e.g., cocaine, opioids) can accelerate or retard larval development depending on the compound and concentration. Toxicological profiling of larvae can inform this, but it introduces complexity.
- Insecticides or coverings: topical insecticides, body coverings, or embalming can delay colonisation.
- Animal scavenging and concealment: can remove or redistribute evidence, altering successional signatures.³

Case examples and courtroom considerations

Entomological evidence has been admissible in courts worldwide; successful forensic application depends on methodological transparency, expert qualifications, and clear communication of uncertainty. High-profile cases show both the power and pitfalls: precise developmental PMI estimates have supported timelines of disappearance and corroborated other evidence, whereas misapplied data (wrong species, unadjusted temperatures) have been contested. Modern judicial guidance expects entomologists to (1) document the chain of custody and field methods, (2) use validated developmental data (preferably local), (3) report PMI as a range with clear assumptions, and (4) explain limitations in nontechnical language.⁷

Current Challenges and Future Directions

Challenges

- Data gaps many forensically relevant species lack comprehensive, region-specific developmental datasets across temperature ranges.
- Microclimate reconstruction: accurately modelling site-specific temperatures and maggot mass heating remains difficult.
- Standardisation and validation: need for standardised protocols and larger blind validation studies to quantify real-world error rates.
- Species complexity and cryptic taxa: cryptic species complexes require molecular resolution and expanded reference libraries.²

Emerging solutions and research directions

- DNA barcoding and genomic tools: improving species ID, enabling identification from eggs or fragmented material, and potentially allowing population assignment. Recent studies show that DNA barcoding can distinguish closely related blowfly species, aiding rapid identification.
- Integrated probabilistic models: Bayesian frameworks and ensemble statistical models better capture uncertainty and integrate multiple evidence lines.
- Improved field validation: larger, multi-site cadaver and carrion field studies to develop regionally robust succession calendars and validate developmental models under real conditions. Recent literature calls for such experiments and better reporting standards.^{8,9}
- Standard operating procedures: international and national guidelines for insect sampling and laboratory processing to ensure forensic admissibility. Books and manuals (textbooks and procedural guides) remain central educational resources.^{4,10}

CONCLUSION

Forensic entomology is a mature and rapidly advancing forensic discipline that provides one of the few reliable biological clocks for estimating time since death when human tissues no longer offer precise information. Developmental and successional approaches—grounded in species-specific biology, thermal modelling, and rigorous field/lab protocols—can yield defensible PMI estimates when applied by trained experts and reported with transparent uncertainty. Ongoing improvements in molecular identification, statistical modelling,

and field validation will continue to increase precision, but investigators must remain vigilant of limitations caused by microclimates, chemical effects, regional species differences, and data scarcity. Forensic entomology's greatest current needs are expanded, high-quality developmental datasets across regions, robust microclimate modelling protocols, integrated probabilistic frameworks for reporting PMI, and continued standardisation of sampling and analytic methods.

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Fatal Equine-Induced Blunt Abdominal Trauma: A Medico-Legal Case Report

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ABSTRACT

Equine-related blunt abdominal trauma is an uncommon but potentially fatal mechanism of injury, particularly in rural and agrarian settings. The high kinetic energy imparted by an equine kick can cause severe internal organ damage despite minimal external manifestations, leading to delayed diagnosis and adverse outcomes. We report a fatal case of a 35-year-old male who sustained blunt abdominal trauma following an equine kick, resulting in ileal perforation, generalised peritonitis, septic shock, and acute kidney injury despite emergency surgical intervention. This case underscores the clinical progression, autopsy findings, and medico-legal importance of establishing a clear and continuous causal relationship between the initial trauma and death.

Keywords: Abdominal Injuries, Blunt Injuries, Intestinal Perforation, Peritonitis, Sepsis, Autopsy, Accidental Injuries

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INTRODUCTION

Equine-related injuries constitute a distinct subset of large animal trauma and are associated with significant morbidity and mortality worldwide. Although falls from horses account for most equine-related injuries, direct kicks represent a particularly dangerous mechanism due to the focal and high-energy transfer involved. Epidemiological studies have demonstrated that equine kicks, while less frequent than falls, are associated with more severe injury patterns, especially when the trunk or abdomen is involved.¹⁻³

Rural population-based studies highlight that large animal-related injuries affect economically active males and are commonly accidental in nature.^{4,5} Abdominal involvement, although less common than extremity or head injuries, carries a disproportionately substantial risk of complications, delayed presentation, and mortality.³⁻⁶

Blunt hollow viscus injuries pose a well-recognised diagnostic challenge. Classical surgical literature has emphasised that small bowel and duodenal injuries following blunt trauma may present with subtle or nonspecific early symptoms, resulting in delayed surgical intervention and increased risk of peritonitis and septic shock.^{7,8} Recent case reports continue to document severe gastrointestinal injuries caused by equine kicks, ranging from lacerations to complete transections, with outcomes closely linked to the timing of diagnosis and intervention.⁹⁻¹¹

From a forensic perspective, fatal equine-induced abdominal trauma requires meticulous clinicopathological correlation to establish causation, manner of death, and to distinguish traumatic injuries from therapeutic interventions.

Case Report

A 35-year-old unmarried male, with no known comorbidities and no history of previous abdominal surgery, was referred

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to a tertiary care teaching hospital following blunt abdominal trauma sustained after being kicked by an equine animal (donkey).

The patient presented with severe abdominal pain, progressive abdominal distension, a single episode of vomiting, and the absence of bowel movements since the time of injury. The symptoms gradually worsened over the ensuing hours, prompting referral to a higher centre.

On admission, the patient was ill-appearing and hemodynamically unstable. Abdominal examination revealed diffuse tenderness with guarding and rigidity, suggestive of generalised peritonitis. Systemic examination showed features consistent with evolving septic shock.

Based on clinical evaluation and available investigations, a provisional diagnosis of perforation peritonitis complicated by septic shock and secondary acute kidney injury was made. In view of the acute abdomen and rapidly deteriorating clinical status, emergency surgical intervention was undertaken.

An emergency exploratory laparotomy was performed. Intraoperatively, a perforation involving the ileum was identified and surgically repaired. Extensive peritoneal contamination was noted, and thorough peritoneal lavage was carried out. Abdominal drains were placed. Postoperatively,

the patient received aggressive resuscitation, broad-spectrum antibiotics, and intensive supportive care.

Despite timely surgical intervention and intensive medical management, the patient's condition continued to deteriorate. He developed refractory septic shock with worsening renal function and succumbed during treatment on the same day as surgery.

Post-Mortem Findings

The deceased was an adult male of average build, measuring approximately 67 inches in length. Rigor mortis had passed off, and post-mortem lividity was fixed over dependent areas. No ligature marks or significant external traumatic injuries were identified. A vertically oriented, sutured midline abdominal incision measuring approximately 15 cm was present, along with two small lateral incised wounds corresponding to surgical drainage sites. Multiple needle puncture marks were noted on both forearms.

The peritoneal cavity contained approximately 500 mL of purulent fluid. The intestines were congested, inflamed, and dilated. A sutured perforation measuring approximately 7 cm was identified in the ileum, with purulent exudate present at the wound margins. Both kidneys were congested with distortion of the cortico-medullary junction, consistent with acute kidney injury secondary to septic shock. The brain was congested and oedematous. Other thoracic and abdominal organs were unremarkable.

Death was attributed to complications of blunt abdominal trauma, namely, perforation peritonitis leading to septic shock with acute kidney injury. The injury was ante-mortem in nature and sufficient to cause death in the ordinary course of nature.

DISCUSSION

Equine-induced blunt abdominal trauma is a deceptively severe injury mechanism. Equine kicks generate concentrated, high-velocity force over a limited surface area, resulting in internal injuries that are often disproportionate to external findings.¹⁻³ Prospective and retrospective studies have shown that equine kicks are associated with higher injury severity compared to other equine-related mechanisms, particularly when the abdomen is involved.^{2,3}

The biomechanical mechanism underlying hollow viscus injury in equine kicks involves sudden compression of mobile bowel loops against rigid posterior structures such as the vertebral column. This mechanism has been likened to handlebar or spear-type injuries and explains the occurrence of bowel perforation without overt external trauma.^{6,12} In the present case, this mechanism adequately accounts for the ileal perforation identified surgically and at autopsy.

Hollow viscus injuries following blunt trauma are notoriously difficult to diagnose early. Classical surgical series have emphasised that delayed recognition of bowel injury significantly increases the risk of peritonitis, septic shock, and mortality.^{7,8} Although emergency laparotomy was performed

in the present case, the advanced septic state at presentation likely contributed to the fatal outcome.

Recent literature documents a spectrum of equine-related gastrointestinal injuries, including duodenal lacerations and complete transections, some of which have been successfully managed with early surgical intervention.⁹⁻¹¹ These reports highlight that survival is strongly dependent on early diagnosis and timely surgical repair, in contrast to fatal outcomes associated with delayed presentation and established sepsis.

Population-based studies from rural settings further contextualise the present case. Large animal-related injuries in agrarian populations predominantly affect working-age males and are commonly accidental, with abdominal injuries associated with higher complication rates and prolonged hospitalisation.^{4,5} These findings closely mirror the demographic and clinical features of the present case.

From a forensic standpoint, the present case demonstrates a clear and uninterrupted pathological sequence: equine kick → blunt abdominal trauma → ileal perforation → generalised peritonitis → septic shock → acute kidney injury → death. The autopsy findings corroborate the clinical course and establish causation beyond a reasonable doubt.

Equine-related blunt abdominal trauma poses specific medico-legal challenges due to the frequent absence of conspicuous external injuries. In deaths occurring after surgical intervention, questions may arise regarding the mechanism of injury, adequacy of treatment, and possible iatrogenic contribution. Thorough documentation and careful clinicopathological correlation are therefore essential.

In the present case, clear differentiation between therapeutic surgical wounds and primary traumatic injury was achieved through meticulous autopsy examination. The findings establish an accidental manner of death due to blunt force trauma and its complications, excluding assault or iatrogenic causation. Such clarity is crucial for judicial scrutiny, insurance claims, and compensation proceedings.

CONCLUSION

Equine-induced blunt abdominal trauma is a rare but potentially fatal injury, particularly in rural populations. The absence of significant external injury should not obscure the possibility of catastrophic internal damage. Early recognition and intervention are critical; however, once septic shock and multi-organ dysfunction develop, prognosis remains poor. Forensic autopsy plays a pivotal role in establishing the cause of death, medico-legal causation, and manner of injury in such cases.

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Fatal Thoracic Stab Injury with a Retained Weapon: Forensic Significance of Mechanical Entrapment and Hemorrhagic Shock

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ABSTRACT

Background: Sharp-force injuries remain a leading cause of homicidal death worldwide. Although penetrating chest stab injuries are frequently encountered in forensic practice, recovery of the weapon of offence *in situ* is uncommon and carries distinct medico-legal significance.

Case Details: We report a fatal single stab injury to the left anterior chest in a 31-year-old male, in whom the weapon was recovered embedded within the wound tract at autopsy. The injury caused cut fractures of the third and fourth ribs, laceration of the upper lobe of the left lung, hemothorax, and hemorrhagic shock. Mechanical entrapment of the blade within fractured ribs accounted for retention of the weapon.

Conclusion: Recovery of a weapon *in situ* allows direct wound–weapon correlation, facilitates accurate reconstruction of injury mechanics, and strengthens determination of homicidal manner of death. This case highlights the exceptional forensic value of such findings in medico-legal autopsy practice.

Keywords: Sharp-force injury, Stab wound, *In situ* weapon, Homicide, Mechanical entrapment, Hemorrhagic shock

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INTRODUCTION

Sharp-force injuries remain a major cause of violent death worldwide, with stab wounds constituting the predominant mechanism in homicidal assaults. Large retrospective studies from Europe and North America consistently demonstrate that homicidal sharp-force fatalities differ from suicidal injuries with respect to wound location, depth, direction, associated skeletal damage, and injury dynamics.^{1–4} Penetrating chest stab injuries are associated with particularly high fatality rates due to involvement of vital intrathoracic organs and rapid exsanguination.⁵

Forensic differentiation between homicidal and suicidal sharp-force injuries relies on systematic evaluation of wound morphology, trajectory, multiplicity, associated injuries, and scene findings. Multivariate and comparative analyses have shown that factors such as force of penetration, rib or cartilage injury, and weapon characteristics are strongly associated with homicidal manner of death.^{2,3,6}

Recovery of the weapon of offence *in situ* is an uncommon finding in homicidal stab injuries, as assailants typically withdraw the weapon after infliction. When present, however, an *in situ* weapon provides exceptional forensic value by permitting direct wound–weapon correlation and objective reconstruction of injury mechanics. The present case documents a fatal penetrating chest stab injury with the weapon retained *in situ*, highlighting its medico-legal significance in establishing cause and manner of death.

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Case History

A 31-year-old male of robust build was brought dead to a tertiary care hospital following an alleged assault with a sharp weapon. The body was recovered from a public urban location with the handle of a knife protruding from the left anterior chest. To preserve evidentiary integrity and prevent artefactual injury, the body was transported to the mortuary with the weapon secured *in situ*. A medico-legal autopsy was performed approximately 24–36 hours after death.

External Examination

The deceased measured approximately 172 cm in height and was well built. Clothing examination revealed corresponding cut defects in the maroon jacket and red T-shirt, precisely aligned with the anatomical injury, confirming that the clothing was worn at the time of assault (Figure 1).



Figure 1: Clothing defect corresponding to the stab entry site



Figure 2: Anterior chest stab wound with exposed underlying tissues

A single wedge-shaped stab-incised wound measuring approximately 3.5×1.8 cm was present over the left anterior chest, about 10 cm inferior to the left shoulder joint. One angle of the wound was sharp and clean-cut, while the opposite end was irregular. Surrounding contusion and ecchymosis indicated antemortem infliction.

Internal Examination

The wound tract was directed upward and from lateral to medial. Cut fractures were present at the anterior end of the left third rib and along the superior margin of the fourth rib. The blade traversed the intercostal musculature and lacerated the upper lobe of the left lung.

Approximately 200 mL of dark, unclotted blood was present in the left pleural cavity. Both lungs were collapsed. The heart and pericardium were intact. The liver, spleen, and kidneys were pale and exsanguinated, consistent with acute hypovolemic shock (Figure 2).

Wound–Weapon Correlation

The weapon of offence was recovered embedded within the wound tract (*in situ*). It was a metallic knife with a blade measuring 21 cm in length and 4 cm at maximum width. One edge of the blade was sharp, while the opposite edge bore irregular ornamental features. Blood staining was present on both the blade and handle (Figure 3).

The wedge-shaped wound configuration and asymmetry of wound margins corresponded closely with the blade characteristics. The irregular wound margin matched the ornamental spine, while the sharp margin corresponded to the cutting edge. The blade length exceeded the depth of penetration, indicating partial insertion due to skeletal resistance. Mechanical interlocking between the fractured rib margins and the blade accounted for retention of the weapon.

Cause of Death

Death was due to hemorrhagic shock resulting from a single penetrating stab injury to the chest, causing rib fractures, laceration of the left lung, and intrathoracic haemorrhage. The injury was antemortem and sufficient to cause death in the ordinary course of nature.

DISCUSSION

Thoracic stab injuries are a leading cause of homicidal mortality due to the proximity of vital organs such as the heart and lungs. Comparative population-based studies consistently show that homicidal sharp-force injuries are characterised by deeper penetration, involvement of vital anatomical regions, and a higher incidence of skeletal injury than suicidal sharp-force deaths.^{1,3,7} Thoracic stab wounds associated with rib fractures and deep penetration are strong predictors of homicidal manner of death in studies from Denmark, Italy, and the United States.^{1,4,8}

A critical yet uncommon finding in forensic pathology is the recovery of the weapon retained within the body (*in situ*). While weapon retention is a relatively frequent feature in

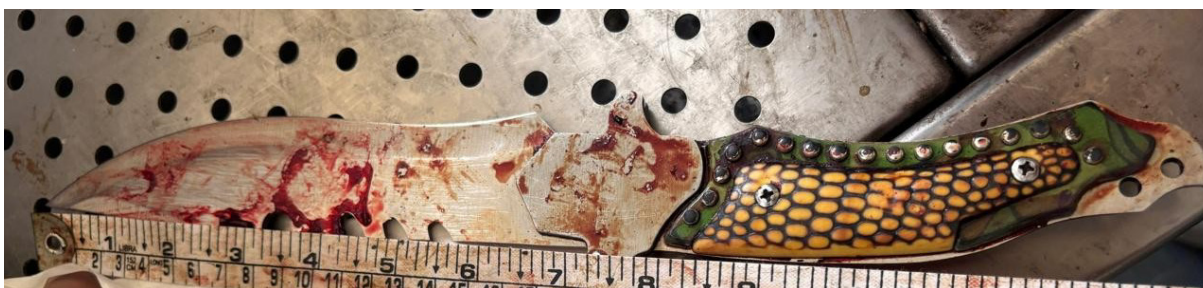


Figure 3: Knife recovered *in situ* during autopsy

suicidal sharp-force deaths, it remains atypical in homicides. Published forensic series indicate that the sharp object is found *in situ* in only a small minority of homicidal cases—generally below 10%—whereas substantially higher proportions are reported in suicide, ranging from approximately 25–30% in different cohorts.^{5,9} This marked disparity reflects differences in injury dynamics, as assailants in homicidal assaults usually withdraw the weapon, whereas in suicide, the weapon is often deliberately left in place.

When a weapon is retained *in situ* in homicide, it is typically attributable to specific mechanical circumstances, including forceful penetration with impaction against bone, blade geometry that promotes interlocking, or abrupt interruption of the assault.^{6,10} In the present case, mechanical entrapment occurred due to interlocking between the fractured margins of the third and fourth ribs and the irregular spine of the blade. The associated rib fractures objectively demonstrate the application of considerable force and strongly support a homicidal manner of death. Recovery of the weapon *in situ* enabled direct wound–weapon correlation, preserved the exact trajectory of penetration, and reduced interpretative ambiguity, thereby strengthening medico-legal conclusions.

This case exemplifies the exceptional evidentiary value of *in situ* weapon recovery in homicidal stab injuries and reinforces the importance of meticulous autopsy documentation in judicial proceedings.

CONCLUSION

Although uncommon, recovery of the weapon *in situ* in homicidal stab injuries carries substantial forensic significance. Direct wound–weapon correlation facilitates accurate reconstruction of injury mechanics and strengthens determination of cause and manner of death. This case

underscores the critical role of detailed medico-legal autopsy in providing robust, defensible forensic evidence for the justice system.

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To Establish the Forensic Toxicology Laboratory and Poison Information Centre in the Department of Forensic Medicine & Toxicology at a Tertiary Care Centre

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INTRODUCTION

Poisoning is a significant global public health problem. According to the World Health Organisation (WHO), in 2004, an estimated 0.35million people died worldwide from unintentional poisoning. Nearly a million people die annually as a result of suicide, and chemicals (poisons) account for a good number of deaths due to poisoning. It is estimated that deliberate ingestion of agrochemicals causes 370,000 deaths each year. In India, poisoning is more common and is also one of the significant causes of death, intentional or otherwise. In developing countries, pesticides are frequently used for suicidal poisoning. Increased mortality and morbidity could be due to a lack of access to information for the nearest relatives, a lack of a toxicological laboratory for clinical purposes, first-aid measures, attending physicians treating the patients, and awareness about prevention related to exposure and the management of different poisoning cases. A Toxicology Lab & Poison Information Centre (PIC) can play a vital role in the prevention and management of poisoning cases by providing preliminary and basic information to the general public and healthcare professionals.

The Analytical Toxicology Lab and the Poison Information Centre (PCC), also known as the poison control centre, is a specialised unit that provides immediate information on early diagnosis, treatment, prevention of exposure, and management of poisoning cases presenting to the hospital, through well-trained poison information specialists. Poison information (PI) is a specialised area of drug information that covers the toxic effects of chemicals, hazardous material spills, household products, overdose of therapeutic medicines, plants (including mushrooms), and animal toxins from bites by snakes, spiders, and other venomous creatures. Poison information and lab services primarily focus on providing timely and relevant poisoning management information tailored to the enquirer's needs. The poison information service also deals with risk assessment, diagnosis, management, and prevention of exposure to any poison in patients of all ages, regardless of the type (intentional or accidental) and route of exposure. The primary aim of PIC is to reduce morbidity and mortality due to poisoning and improve patients' health-related quality of life. PICs help reduce the cost of poisoning treatment for patients and public healthcare facilities by preventing unnecessary visits, admissions, and prolonged hospitalisations.

CURRENT SCENARIO

To date, there are only four WHO-recognised centres in India. Additionally, there are a few other centres that provide poison information through clinical pharmacy services. The first National Poison Information Centre was established in February 1995 at the All India Institute of Medical Sciences (AIIMS), New Delhi. Other centres were subsequently established at the National Institute of Occupational Health, Ahmedabad; Government General Hospital, Chennai; and the Forensic Medicine Department of Amrita Institute of Medical Sciences and Research, Cochin. Other centres are also in the process of establishing PICs only or Toxicology Labs alone. Considering the incidence rate of poisoning cases in India, these centres may not be able to meet the demand for poison information, particularly in the eastern and north-eastern sectors of India. Hence, there is a need for well-equipped laboratories and poison information centres with well-trained personnel in this area of our country.

This will be an asset and integral part of the institution, marking the first of its kind in this part of India. The required information about poisoning will be provided to the general public and also to healthcare professionals throughout India.

Objectives

- Provision of poison information services
- Outline the Management protocol of poisoning cases
- Conducting education and training of healthcare professionals and facilitating advanced research in the field of toxicology.
- Conducting education and awareness programs for the public regarding the prevention of accidental poisoning
- To do screening tests to detect poisons consumed by the patients coming to the hospital.
- To provide qualitative and quantitative analysis of various common poisons
- To assess the morbidity and mortality due to chronic poisoning exposure

Implementation and Management Plan

- To have a fully functioning Poison Control Centre and Laboratory services
- To reduce the morbidity and mortality among poisoning cases.

- To reduce referral costs.

Activities and Work Plan

Standardised recording of enquiries, including those relating to clinical cases, will allow the centre to

- Maintain its own clinical and other data registry.
- Attend calls 24 hours a day from all parts of the state & other parts of our country.
- Providing information regarding the diagnosis and treatment of poisoning cases.
- Support epidemiological and statistical studies.
- Validate new techniques of patient management.
- Provide data for scientific reports.
- Exchange information with other poison information centres.
- Contribute to the fund of knowledge on human toxicology.

Procedure of the Functioning of Pic

When a call is received in the poison information centre, the caller has to provide the following basic information-

- Name of Caller
- Relationship to the victim
- Address
- Patient details
- History of poisoning
- Toxic substance
- Signs & Symptoms

Scientist /Faculty refer to the toxicology database & make the differential diagnosis.

The toxidromes are compared/corroborated with the database, reference manuals/books & journals]

Information Given

- The possible diagnosis
- How to proceed for emergency management
- The possible antidote
- The source of the antidote, if possible

When a patient presents to an emergency department with a history of poisoning, samples such as vomitus, blood, and urine can be taken and analysed at our toxicology lab.

- We will provide any active patient management
- Antidote will be supplied.
- The Chemical Analysis, in the form of reports, will be provided and can be used for any legal purpose.

Requirements

Workforce

- Faculty in charge
- Assistant Faculty in charge

- Toxicologist
- Receptionist
- LDC
- Data entry operator
- Lab Attendants

Equipment

- Major Instruments for Analysis
- Small equipment & Glassware
- Chemicals

Infrastructure

- Space – 2 blocks of 900 sq ft/ or one block, also for the initial phase. Area will be arranged from the designated area of the Department of Forensic Medicine and Toxicology/hospital premises & Civil & Electrical construction.
- Expendable equipment: items of equipment, supplies, or training materials are
- Telephones -3 (1 Land line with toll-free number, 1 Intercom & 1 Smart phone)
- Desktop, UPS with a printer, Laptop-1
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- Projector & Screen: for education and training.
- Refrigerator-1
- Lockable cabinets for storing pharmaceutical agents
- Cloud Storage: Automated systems may replace manual storage, retrieval, and processing systems.
- Printer-scanner-photocopy-fax [4in1]-1
- Toxicology database (software) MICROMEDEX 2.0 (a database of more than 8,00,000 household products, chemicals, and medications)
- Tables, Chairs,
- Computer table-1

The total expected cost of establishing a toxicology laboratory depends on several factors, including the phase-wise approach, basic equipment, advanced techniques, and the number of samples to be processed. We can start with 1-2 crores or even less.

CONCLUSION

There is a need for well-equipped laboratories and poison information centres with well-trained personnel in all states of our country, or at least at the main tertiary centres. This will be an asset and integral part of the institution. The required information about poisoning will be provided to the general public and also to healthcare professionals throughout India. This lab will provide qualitative and quantitative analysis of various common poisons promptly and help reduce the morbidity and mortality due to poisoning exposure



Impact of Vaping: A Growing Public Health Concern

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INTRODUCTION

Through this letter, I wish to bring to attention the implications of the recent increase in the use of e-cigarettes or vapes. E-cigarettes are devices that heat a liquid until it becomes vapor, which is inhaled. Typically, e-cigarettes contain nicotine, propylene glycol and flavouring agents. They were initially developed as a smoking substitute to help with smoking cessation, but are now used by both adults and teens for recreational purposes. In this letter, I will go over the effectiveness of e-cigarettes as a smoking cessation tool, the possible health issues related to vaping and the popularity of vaping amongst adolescents.

Smoking Cessation Tool

A study published by the European Respiratory Society examined e-cigarettes as a tool for smoking cessation. They assessed the effect of vaping in the treatment context and on the overall population level. As a smoking cessation tool in the treatment context, the early models of e-cigarettes helped in long-term smoking cessation when compared to placebo e-cigarettes. Although the evidence for e-cigarettes is not strong when compared to licensed stop-smoking medications (such as Nicotine Replacement Therapies), due to the quality of studies done and the number of studies done being low. On the population level, they used data from the Eurobarometer Survey, which indicated that approximately 6% of ex-smokers in Europe quit with the help of e-cigarettes. In the UK, France and the USA, where data on both smoking and vaping exist, the rise in vaping has been accompanied by a decline in smoking.¹

The WHO, on the other hand, in a recent article have stated that e-cigarettes are ineffective for cessation at the population level and that evidence for adverse health effects on the population level is mounting. In conclusion, while there is some evidence to support the use of e-cigarettes as a smoking cessation aid, the research is at this point inconclusive, with the WHO recommending against it as NRTs have a similar success rate, whilst having more evidence of effectiveness and knowledge of side effects and relative safety of NRTs.²

Health Issues

The health-related concerns associated with vaping are being reported with increasing frequency. With studies reporting that vaping weakens the neutrophils, lung macrophages and airway epithelium, thus causing impaired phagocytosis. This can cause an increase in pathogenicity of common pathogens

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such as the influenza virus.³ A paper from NEJM in 2022 detailed a case series where chronic vaping had led to small airway fibrosis and constrictive bronchitis. In addition to this, 40% of e-cigarette users are reported to use normal cigarettes too, which can cause a higher risk of diseases when compared to normal smoking.⁴ There have also been physical injuries caused due to E Cigarettes explosion (53%), 24% by respiratory issues, and 12% by poisoning reported by the CDC. The biggest cause of concern, though, is that most long-term effects of Vaping have not yet been identified due to the recent rise in popularity.³

Popularity Amongst Adolescents

E-cigarettes have become increasingly popular amongst teenagers. This is thought to be due to aggressive marketing campaigns, which paint vaping as less harmful compared to cigarettes. They are also encouraged by social media, which allows them to be easily popularised. It is also aided by an awareness gap where most adolescents do not know the harmful effects of vaping, or that it is banned under the Prohibition of Electronic Cigarettes Act of 2019. Adolescents using vapes are also at an increased risk of starting traditional smoking. The nicotine in the e-cigarettes can lead to long-term impact on brain development, thus making adolescent use more dangerous. It also leads to anxiety, mood disorders and sleep disturbance.⁴

In Conclusion, I would like to summarise that e-cigarettes have little evidence to be beneficial as a smoking cessation when compared to proven methods like NRTs, and cause health issues which are rapidly being discovered, with the long-term effects still unknown. Finally, it is gaining an increasing amount of popularity amongst adolescents, raising cause for concern. While they are officially banned in India, they are

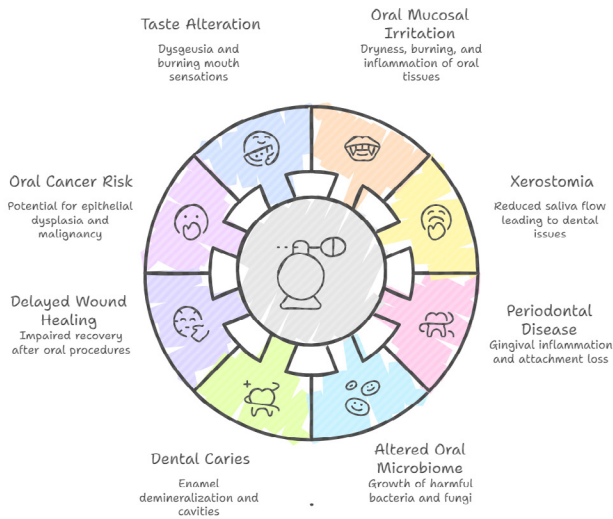


Figure 1: Harmful effect of vaping on oral cavity⁵⁻¹⁰

still easy to obtain and require greater monitoring, along with awareness programs to decrease the number of users (Figure 1).

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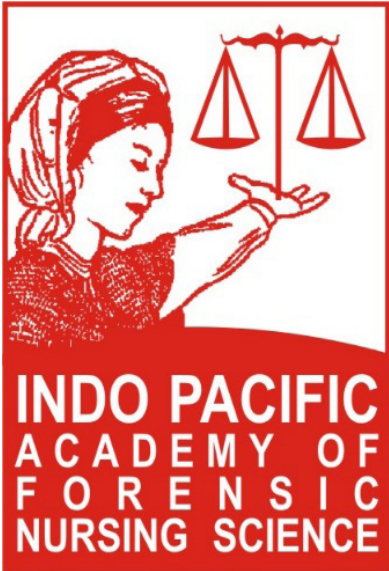


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