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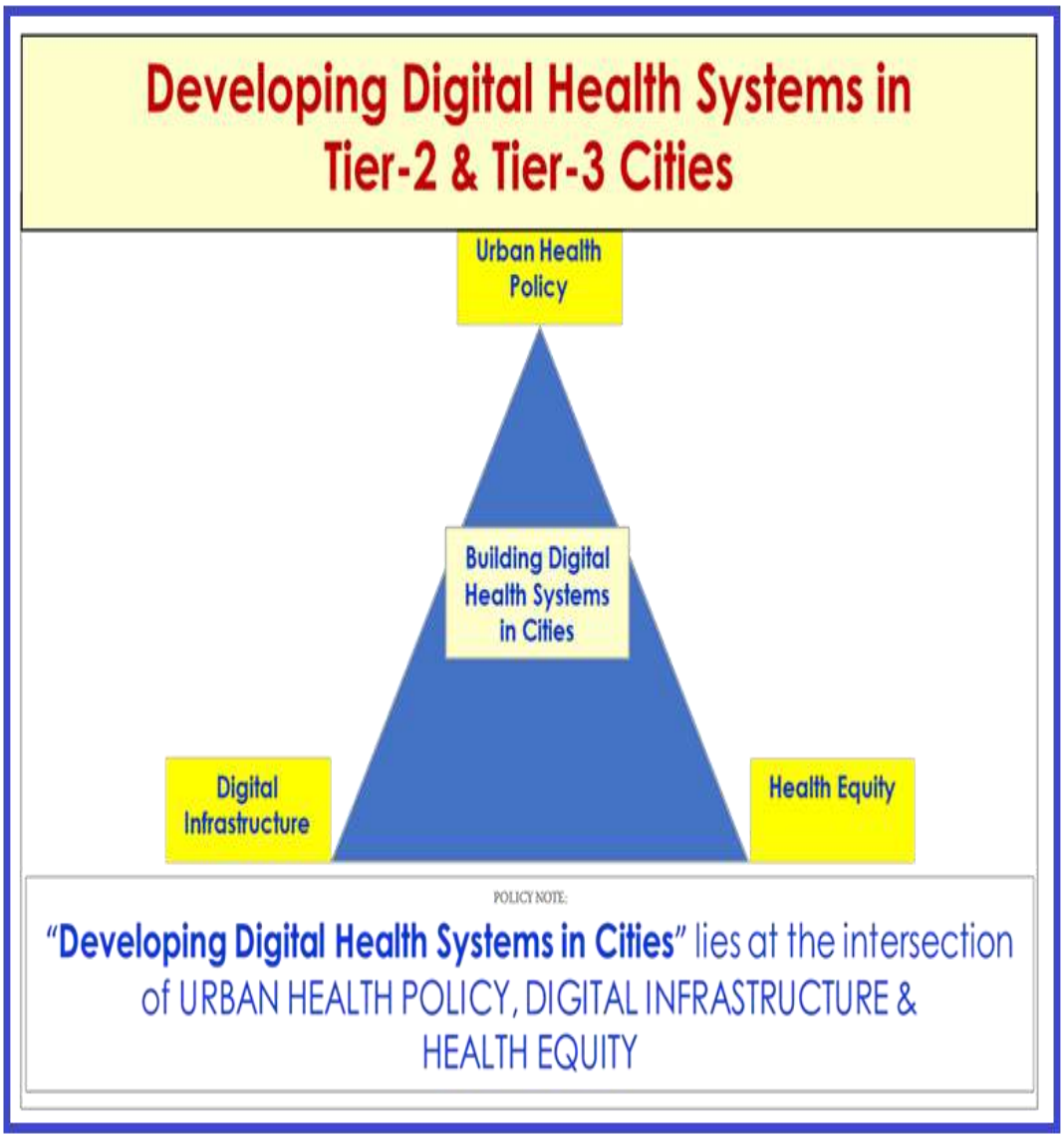

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EDITORIAL

Universal Health Coverage & Digital Healthcare in Tier-2 & Tier-3 Cities

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Urban areas are rapidly expanding — by 2030, nearly **60% of the world's population** will live in cities. Health systems in these dense, complex environments face challenges such as:

- Rising non-communicable diseases (NCDs)
- Infectious disease outbreaks
- Air pollution and environmental stressors
- Fragmented care and poor data integration

Digital health offers the backbone for coordinated, efficient, and equitable urban health management.

These challenges could be met by establishing an **integrated, citywide digital health ecosystem** that ensures:

- Real-time health intelligence
- Interoperable patient records
- Predictive analytics for disease surveillance
- Accessible, inclusive digital services for all citizens

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- The next phase of India's digital health transformation will be led by Tier-2 and Tier-3 cities, where demand for accessible, affordable, and high-quality healthcare is at an all-time high.
- With the right mix of policy support, technological innovation, and strategic partnerships, India's digital health revolution will continue to break barriers and redefine healthcare for millions beyond metro regions.
- As digital health solutions gain momentum, the true impact will be measured in numbers and in lives transformed, ensuring healthcare is no longer a privilege but a right for every Indian, regardless of location.

Expected Outcomes

- Improved continuity of care through interoperable digital records.
- Equitable access to specialist care via telemedicine.
- Early detection and response to local outbreaks.
- Strengthened urban health resilience and digital inclusion.

Universal health coverage (UHC) is the principle that all people have access to the full range of quality health services they need, when and where they need them, without facing financial hardship. This includes health promotion, prevention, treatment, rehabilitation, and palliative care. UHC is built on three pillars: ensuring everyone is included (population coverage), providing a comprehensive range of quality services (service coverage), and minimizing out-of-pocket costs to prevent financial hardship (financial protection).

Key aspects of UHC

- **Comprehensive services:** UHC aims to cover the full spectrum of essential health services, from promoting health to providing palliative care.
- **Accessibility:** Services should be available to everyone, regardless of their location, and barriers to access, such as non-financial barriers, should be removed.
- **Financial protection:** It's crucial to protect people from the financial consequences of seeking healthcare. This means ensuring that paying for needed services doesn't lead to poverty, forcing them to sell assets or go into debt.
- **Quality and workforce:** The delivery of services relies on a workforce with the right skills who are well-supported and equipped with quality-assured products.
- **Equity:** UHC seeks to prioritise those who are most vulnerable or left behind to ensure equitable access to care.

Importance of UHC:

- ***Sustainable Development Goals*:** Achieving UHC is one of the targets set by the United Nations for the 2030 Sustainable Development Goals.
- **Poverty reduction:** By preventing people from falling into poverty due to healthcare costs, UHC is key to boosting prosperity and ending extreme poverty.
- **Health outcomes:** It leads to better health outcomes by ensuring people can access the care they need without delay.

Figure 1. Ayushman Bharat Pradhan Mantri Jan Arogya Yojna

Universal health coverage (UHC) in India

India is working toward UHC primarily through the Ayushman Bharat program (Figure 1), which includes the Pradhan Mantri Jan Arogya Yojana (PMJAY) and the transformation of sub-health centres into Ayushman Arogya Mandirs (AAMs). PMJAY offers health insurance up to ₹5,00,000 per family annually for secondary and tertiary care, while AAMs provide comprehensive primary healthcare services, including preventive, promotive, and basic curative care. These initiatives aim to achieve the goal of affordable, accessible, and quality healthcare for all citizens.

Achieving Universal Health Coverage is one of the targets the nations of the world set when adopting the SDGs in 2015. Countries reaffirmed this commitment at the United Nations General Assembly High Level Meeting on UHC in 2019. The inclusion of UHC in the SDGs presents an opportunity to promote a comprehensive and coherent approach to health, focusing on health systems strengthening. Countries that progress towards UHC will make progress towards the other health-related targets, and towards the other goals. Universal health coverage has therefore become a major goal for health reform in many countries and a priority objective of WHO.

Role of wearables in building Digital Health Systems in Cities

Wearable devices play a transformative and essential role in building **Digital Health Systems in Cities** by connecting individual health data with city-wide healthcare infrastructure.

The primary roles of wearables are:

1. **Continuous, Real-time Health Data Collection**
   - **Remote Patient Monitoring (RPM):** Wearables (smartwatches,

fitness trackers, patches, smart jewellery) continuously collect a rich, real-time stream of physiological data (e.g., heart rate, sleep patterns, steps, ECG, blood oxygen, temperature).
- **Beyond the Clinic:** This data is collected in the user's natural environment (home, work, commute), providing a much richer picture of their health than sporadic clinical check-ups.
- **Immediate Alerts:** Some devices can detect and alert users and/or emergency contacts to critical events, like falls or irregular heart rhythms.

2. **Proactive and Preventive Healthcare**
   - **Early Detection:** Continuous monitoring allows AI and machine learning algorithms to analyse trends and subtle changes in vital signs, potentially identifying early warning signs of developing health issues (e.g., infections, atrial fibrillation) before they become severe.
   - **Lifestyle Interventions:** By tracking activity and sleep, wearables empower city dwellers to take charge of their well-being, promoting proactive health management and reducing the future burden on city hospitals.

3. **Personalised Medicine and Chronic Disease Management**
   - **Tailored Treatment:** The vast, personalised data collected by wearables can be integrated with Electronic Health Records (EHRs) to allow healthcare providers to create and adjust treatment plans that are highly customised to an individual's specific needs and daily life.
   - **Chronic Condition Support:** For residents with chronic diseases (like diabetes or hypertension), specialised wearables (e.g., continuous glucose monitors, wearable blood pressure cuffs) enable continuous tracking, helping them manage their condition and allowing remote supervision by city health services.

4. **Public Health and Epidemiological Insights**
   - **Population Health Dynamics:** Aggregate, anonymised data from thousands of wearable users across a city can provide health officials with a snapshot of population health, including general activity levels, sleep quality, and even the spread of contagious illnesses (by monitoring fever or resting heart rate changes).
   - **Resource Planning:** This data can inform city health planning, helping to allocate resources, predict outbreaks, and design effective public health campaigns tailored to the needs of different neighbourhoods or demographics.

5. **Increased Patient Engagement**
   - **Empowerment:** Wearables provide users with direct, understandable feedback and data visualization about their own health metrics, motivating them to adopt healthier behaviors and become active participants in their own care journey.

- **Adherence:** Features like medication reminders and personalized goal setting can significantly improve patient adherence to treatment and exercise plans.

In essence, wearables act as the **sensor layer** of a city's digital health ecosystem, collecting the granular, individual data that feeds the larger system, shifting the focus from reactive, episodic care to proactive, continuous, and personalized well-being for all urban residents.

The Digital Health development in Tier-2 & Tier-3 cities (Figure 2)

Recent data highlights the rapid pace at which digital health infrastructure evolves beyond urban centers. Rural India now accounts for *53%* of the country's internet users, with over 442 million smartphone users, making mobile health solutions more accessible. The telemedicine market is projected to grow at a *CAGR of 20.7%*, reaching $15.1 billion by 2030. These numbers underscore the potential of digital health solutions in bridging the urban-rural healthcare divide.

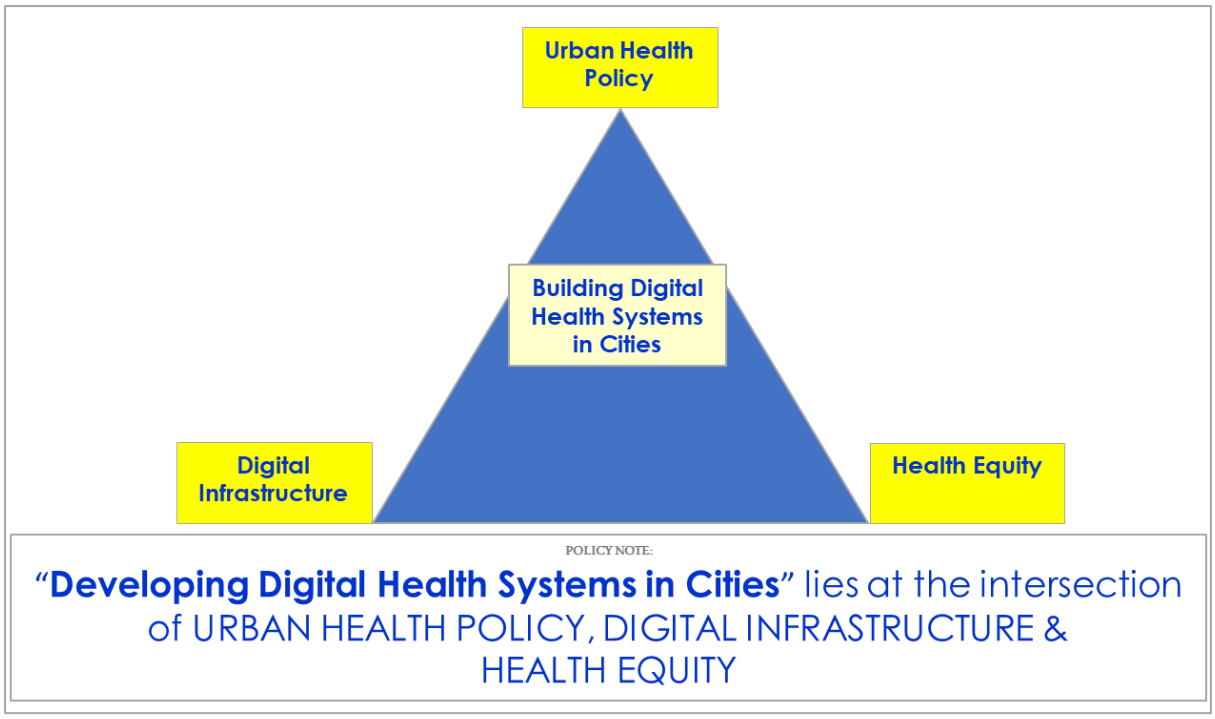

Figure 2. Developing Digital Health Systems in Cities

Key Drivers of Digital Health Expansion

1. Growing Internet & Smartphone Adoption— With increased connectivity, healthcare services are now available to millions in non-metro areas.
2. *Telemedicine* Expansion— Virtual consultations, *tele-ICUs*, and digital diagnostics are breaking location barriers and allowing patients to access specialist care remotely.
3. Government Digital Health Initiatives – Programs like *Ayushman Bharat Digital Mission (ABDM)* and eSanjeevani are strengthening telehealth services.
4. Affordable Health Solutions – Cost-effective digital consultations reduce the financial burden of travel and hospital visits.

5. Health Education & Awareness – Digital platforms enhance preventive healthcare through better patient awareness.
6. AI & Data-Driven Healthcare – *Artificial intelligence* streamlines diagnostics, predictive analytics, and personalized treatment plans.
7. Public-Private Collaborations- Healthcare providers and tech firms are collaborating to scale digital solutions in smaller cities and rural areas.

The Aarogya Setu app (Figure 3)

The Aarogya Setu app has been pivotal in developing India's digital health system by acting as an initial mass-adoption platform for digital health services and later integrating into the broader **Ayushman Bharat Digital Mission (ABDM)** national health infrastructure. Its role has evolved from a pandemic response tool to a comprehensive digital health hub for citizens in cities and rural areas.

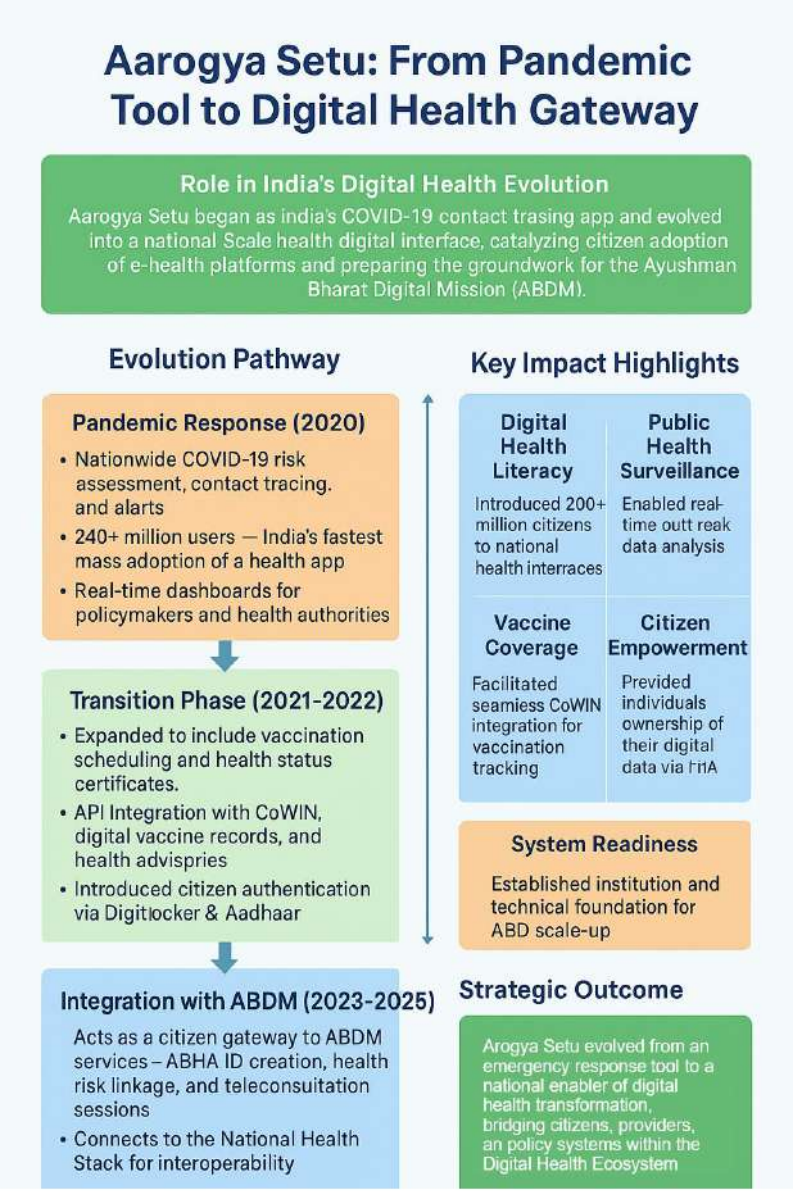

Figure 3. Role of Aarogya Setu in India's Digital Health Evolution

Telemedicine: The Backbone of Healthcare Access in Non-Metro India

Telemedicine is at the heart of India's digital health revolution. In a country where 65% of the population lives in rural areas but 80% of healthcare infrastructure is concentrated in cities, telemedicine is crucial in addressing the doctor-patient ratio gap (1:1,511, below WHO's 1:1000 recommendation).

Impact of Telemedicine:

- 30% cost savings on healthcare expenses.
- 40% reduction in hospital readmissions due to improved remote monitoring.
- 50% lower consultation costs, making quality healthcare more affordable.
- 15-20% decline in ICU mortality rates with remote patient monitoring.
- 160 million+ teleconsultations conducted through eSanjeevani, demonstrating its growing acceptance.

Telemedicine optimizes specialist availability, improves critical care through Tele-ICUs, and reduces hospital infrastructure burdens. Leading healthcare organizations actively invest in these areas to ensure that high-quality specialist care is accessible to remote communities.

Bridging the Urban-Rural Healthcare Divide

Digital health is not just an alternative but necessary for India's rural and semi-urban regions. Limited healthcare infrastructure, fewer skilled professionals, and accessibility challenges have long plagued smaller cities and villages. Emerging digital health technologies are actively bridging these gaps, including AI-powered diagnostics, IoT-enabled patient monitoring, and seamless Electronic Medical Records (EMR).

Transformative Digital Health Solutions:

- Tele-ICUs and Teleradiology – Critical care services are now available remotely, reducing dependency on physical infrastructure.
- AI-powered Diagnostics – Faster, more accurate diagnosis ensures better treatment outcomes.
- Internet of Things (IoT)-driven Health Monitoring – Continuous tracking of vital signs reduces emergency visits and enhances preventive care.
- Mobile Health Apps – Providing easy access to consultations, prescriptions, and health records.

Overcoming digital healthcare challenges in 2- tier & 3-tier cities in India

Overcoming Digital Healthcare Challenges in Tier-2 & Tier-3 Cities

India's smaller cities and towns (Tier-2 & Tier-3) represent the next frontier for digital health transformation.

While metro cities are advancing rapidly under ABDM and Smart Cities initiatives, smaller urban centers are increasingly overcoming **gaps in digital infrastructure, health workforce capacity, and citizen adoption**.

Strategic Solutions & Steps undertaken:
Infrastructure Enablement:

- Expansion of **BharatNet** and **5G Health Zones** for hospitals and PHCs.

- Establishing **City Health Data Centres** interoperable with the **National Digital Health Grid (NDHG)**.
- Promotion of solar-backed data hubs and health kiosks for continuity in low-resource areas.

Capacity Building

- **Digital Health Fellows** and **Telemedicine Training Programs** for district hospitals.
- D**igital health modules** into nursing and paramedical curricula.
- Provisions for incentivising private sector and startup participation in capacity-building partnerships.

Service Delivery Innovation

- **Telemedicine & e-Clinic Hubs** in district and sub-district hospitals.
- **AI-based triage tools** and remote diagnostics for underserved populations.
- M**obile health vans** with IoT connectivity for remote consultations and screening.

Data & Analytics Empowerment

- **Regional Health Data Hubs** with predictive analytics for local outbreak monitoring.
- **GIS-based dashboards** for mapping disease hotspots and service coverage.

Citizen Engagement & Trust

- Expanding **ABHA ID registration drives** via Common Service Centres (CSCs).
- Offering **multilingual, voice-based health apps** for low-literacy users.
- Implementing robust **data privacy frameworks** and awareness campaigns.
- Creating a **Tiered Digital Health Mission (TDHM)** focusing on scalable, modular adoption in smaller cities.
- Leveraging **public–private partnerships (PPP)** for telehealth and data analytics infrastructure.
- Providing **performance-linked grants** for cities achieving ABDM integration benchmarks.
- Promoting **inter-state learning networks** to replicate successful Tier-2 city models.

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ORIGINAL ARTICLE

Safety and Feasibility of Early versus Interval Laparoscopic Cholecystectomy for Acute Calculus Cholecystitis

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Abstract

Background: Early versus interval laparoscopic cholecystectomy is a key consideration in managing acute calculus cholecystitis. The timing of surgery impacts both patient outcomes and healthcare resource use. Evaluating the safety and feasibility of each approach helps guide optimal treatment strategies. **Aim and objective:** To assess and compare the safety and practical viability of performing early versus interval laparoscopic cholecystectomy in patients diagnosed with acute calculus cholecystitis. **Materials and methods:** A prospective, comparative, interventional study was carried out between July 2023 and December 2024. A total of 100 patients diagnosed with acute calculus cholecystitis were enrolled. Among them, 46 patients were randomly allocated to undergo early laparoscopic cholecystectomy, while 54 were assigned to the interval surgery group. Patient selection and randomization were done following predefined inclusion and exclusion criteria. **Results:** The comparison between the early and interval laparoscopic cholecystectomy groups revealed no statistically significant variations in conversion rates to open surgery, operative duration, the incidence of postoperative complications, or the length of postoperative hospitalization. However, the early laparoscopic cholecystectomy group showed significantly intraoperative complications and required intraoperative modifications. Additionally, patients in the early surgery group had a notably shorter overall hospital stay. **Conclusion:** The findings of this study indicate that performing laparoscopic gallbladder removal at an early stage is both safe and practical for patients with acute calculous cholecystitis, even in cases where intraoperative challenges are more pronounced. Both groups had similar operative times and postoperative stays, with no major complications or conversions. Early surgery significantly reduced total hospital stay, supporting it as the preferred approach.

Keywords: Acute calculus cholecystitis, early laparoscopic cholecystectomy, interval laparoscopic cholecystectomy, cholelithiasis

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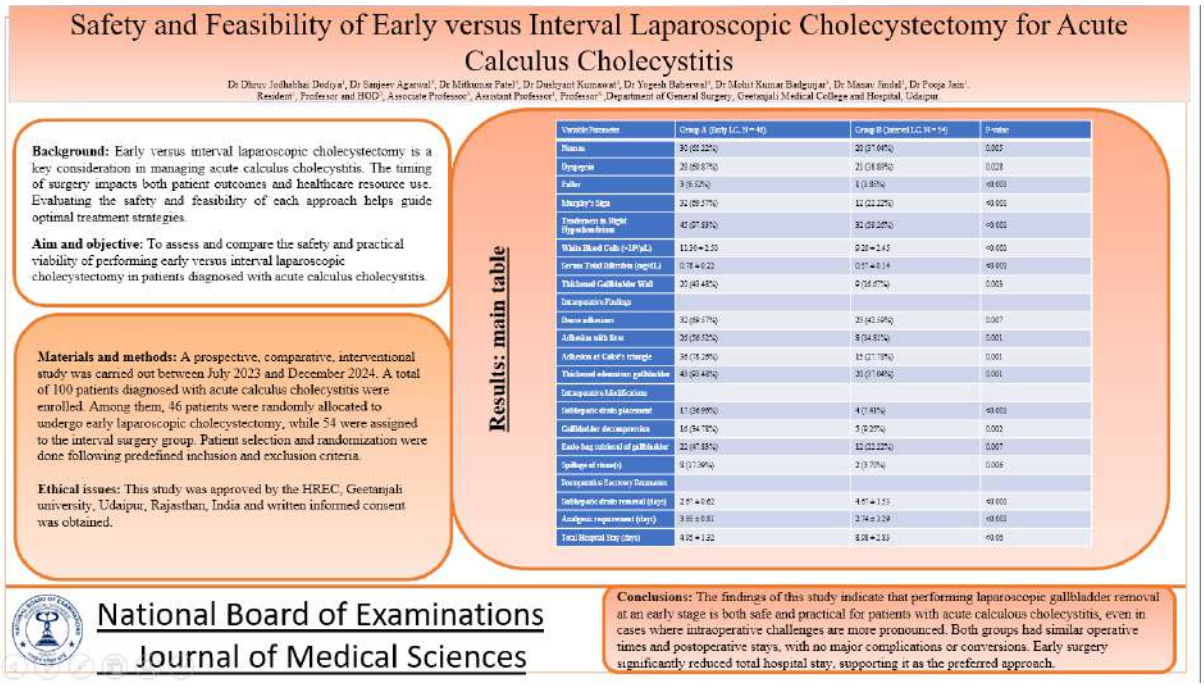
Graphical Abstract



Introduction:

Acute calculus cholecystitis is one of the most frequent emergencies in gastrointestinal and hepatobiliary surgery, especially affecting older populations [1]. Cholecystectomy remains the definitive treatment, with laparoscopic cholecystectomy (LC) now widely accepted as the standard surgical approach [8]. However, the optimal timing of LC whether early (within 5 to 7 days of symptom onset [12]) or delayed (after 6–8 weeks of conservative management) continues to be a topic of clinical debate [4,-10,13].

Early LC offers the advantage of definitive treatment during the same hospital admission, potentially reducing complications, recurrence, and total hospital stay. On the other hand, technical difficulties such as inflammation, edema, and distorted anatomy may increase the risk of intraoperative complications during early surgery [2,3]. Delayed LC allows inflammation to resolve but carries the risk of recurrent symptoms, failed conservative therapy, and longer overall treatment duration [11].

This research is designed to evaluate both the safety and practical feasibility of performing laparoscopic cholecystectomy either at an early stage or after a delay (interval) in patients diagnosed with acute calculus cholecystitis and help guide optimal surgical timing.

Materials and Methods

The research employed a prospective, comparative approach at the General Surgery Department and Surgical Gastroenterology, GMCH, Udaipur, after secure permission from the Institutional Research Ethics Committee. One hundred patients diagnosed with acute calculus cholecystitis and scheduled for laparoscopic cholecystectomy were enrolled following informed written consent.

Patients aged 18 years or older of both genders are admitted with acute

calculus cholecystitis were included. Those presenting after 7 days of symptom onset with complicated cholecystitis, patients with choledocholithiasis or those who had undergone ERCP were excluded from the research.

Eligible participants were randomly divided into two groups using a randomization technique. Group A (early laparoscopic cholecystectomy) comprised 46 patients who underwent surgery within 5 to 7 days after the onset of symptoms. Group B (interval laparoscopic cholecystectomy) included 54 patients who first received conservative management and then had surgery roughly six weeks later.

All patients underwent thorough preoperative evaluation, including clinical examination and investigations such as CBC, KFT, LFT, coagulation profile, abdominal ultrasound and additional tests as required. Intraoperative findings such as adhesions, bile leaks, additional port use, operative time, and conversion to open operation were documented. Postoperative outcomes including analgesic needs, complications, drain removal timing, and hospital stay duration, were also documented using a standardized data collection form.

Data analysis was conducted using SPSS version 16. Categorical variables were summarized as frequencies and percentages and compared using the Chi-square test. Continuous variables were reported as mean ± standard deviation and assessed with the unpaired t-test following normality verification. A p-value below 0.05 was deemed statistically significant.

Results

The research involved 100 patients accompanied by acute calculous cholecystitis, randomly allotted to early laparoscopic cholecystectomy (46 patients) or interval laparoscopic cholecystectomy (54 patients). Both groups were analogous in standings of average age 49.07 ± 15.55 years in the early group and 49.17 ± 14.87 years in the interval group with no statistically notable gap. Gender distribution was also similar, with females making up 58.7% in the early group and 74.1% in the interval group (p = 0.63) (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants.

Variable	**Group A (Early LC) (N = 46)**	**Group B (Interval LC) (N = 54)**	**P-value**
Age Group (years)			
21 to 40	17 (36.96%)	17 (31.48%)	> 0.05
41 to 60	19 (41.30%)	24 (44.44%)	
61 to 80	10 (21.74%)	13 (24.07%)	
Mean Age (years)	49.07 ± 15.55	49.17 ± 14.87	
Sex			
Female	27 (58.70%)	40 (74.07%)	0.63
Male	19 (41.30%)	14 (25.93%)	
Male: Female ratio	1:2.03		
Comorbidities			

Hypertension	11 (23.91%)	9 (16.67%)	0.37
Previous Abdominal Surgery	8 (17.39%)	13 (24.07%)	0.41
Diabetes Mellitus	4 (8.70%)	6 (11.11%)	0.68

Values are displayed as numbers alone, as mean ± standard deviation and number (%).

The prevalence of comorbid conditions such as hypertension, prior abdominal operation and diabetes did not vary suggestively between groups, indicating balanced baseline characteristics. (Table 1).

All patients in both groups presented with abdominal aching, Nausea, dyspepsia and vomiting were more frequent in the early surgery group, with nausea showing a statistically significant difference ($p = 0.005$). Murphy's sign and right upper quadrant tenderness were significantly frequent in Group A ($p < 0.001$). Laboratory values showed higher WBC counts and bilirubin (total) levels in the early group ($p < 0.001$), indicating a more acute inflammatory response. Ultrasound revealed more cases of gallbladder wall thickening in the early group ($p = 0.003$), while the quantity of gallstones and pericholecystic fluid presence did not differ significantly (Table 2).

Table 2. Preoperative Clinical Features, Laboratory Parameters, and Ultrasonographic Findings

Parameter	**Group A (Early LC) (N = 46)**	**Group B (Interval LC) (N = 54)**	**P-value**
Presenting Symptoms			
Pain	46 (100%)	54 (100%)	–
Nausea	30 (65.22%)	20 (37.04%)	0.005
Dyspepsia	28 (60.87%)	21 (38.89%)	0.028
Vomiting	24 (52.17%)	18 (33.33%)	0.057
Clinical Signs			
Pallor	3 (6.52%)	1 (1.85%)	<0.001
Murphy's Sign	32 (69.57%)	12 (22.22%)	<0.001
Tenderness in Right Hypochondrium	45 (97.83%)	32 (59.26%)	<0.001
Laboratory Investigations			
Haemoglobin (g/dL)	12.89 ± 1.15	12.45 ± 1.17	0.543
White Blood Cells ($\times 10^3/\mu L$)	11.30 ± 2.50	9.20 ± 2.45	<0.001
Serum Total Bilirubin (mg/dL)	0.78 ± 0.22	0.57 ± 0.14	<0.001
SGOT (IU/L)	46.66 ± 18.28	36.96 ± 11.41	0.090
SGPT (IU/L)	47.92 ± 19.97	38.16 ± 14.14	0.071
ALP (IU/L)	101.32 ± 45.42	104.62 ± 52.53	0.737
Serum Amylase (IU/L)	55.16 ± 22.12	36.58 ± 8.79	0.081

Ultrasonographic Findings			
Single Calculus	18 (39.13%)	16 (29.63%)	>0.05
Multiple Calculi	28 (60.87%)	38 (70.37%)	>0.05
Thickened Gallbladder Wall	20 (43.48%)	9 (16.67%)	0.003
Pericholecystic Fluid	5 (10.87%)	1 (1.85%)	0.06

Values are displayed as numbers alone, as mean ± standard deviation and number (%).

Dense adhesions, subhepatic collections, and adhesions at Calot's triangle and the liver surface were significantly frequent in the early surgery group ($p < 0.05$). A thickened and edematous gallbladder was also notably more frequent in this group (93.48% vs. 37.04%; $p = 0.001$). The critical view of safety was achieved in most patients across both groups (Table 3).

Table 3. Intraoperative Findings, Modifications, Complications, and Operating Time.

Parameter	**Group A (Early LC) (N = 46)**	**Group B (Interval LC) (N = 54)**	**P-value**
Intraoperative Findings			
Dense adhesions	32 (69.57%)	23 (42.59%)	0.007
Subhepatic collection	12 (26.09%)	6 (11.11%)	0.050
Adhesion with liver	26 (56.52%)	8 (14.81%)	0.001
Adhesion at Calot's triangle	36 (78.26%)	15 (27.78%)	0.001
Thickened edematous gallbladder	43 (93.48%)	20 (37.04%)	0.001
Contracted gallbladder	0 (0.0%)	2 (3.70%)	0.187
Critical view of safety achieved	41 (89.13%)	50 (92.59%)	0.547
Turbid bile/pus	4 (8.70%)	1 (1.85%)	0.118
Intraoperative Modifications			
Subhepatic drain placement	17 (36.96%)	4 (7.41%)	<0.001
Epigastric port enlargement	28 (60.87%)	19 (35.19%)	0.186
Use of fifth port	0 (0.0%)	1 (1.85%)	0.354
Gallbladder decompression	16 (34.78%)	5 (9.25%)	0.002
Endo-bag retrieval of gallbladder	22 (47.83%)	12 (22.22%)	0.007
Conversion to open cholecystectomy	0 (0.0%)	0 (0.0%)	–
Subtotal cholecystectomy	0 (0.0%)	0 (0.0%)	–
Intraoperative Complications			
Bile duct injury	0 (0.0%)	0 (0.0%)	–
Cystic artery bleeding	10 (21.74%)	6 (11.11%)	0.148
Liver bed bleeding	6 (13.04%)	2 (3.70%)	0.086
Spillage of bile	16 (34.78%)	10 (18.52%)	0.065
Spillage of stone(s)	8 (17.39%)	2 (3.70%)	0.006
Bowel injury	0 (0.0%)	0 (0.0%)	–
Mean Operating Time (minutes)	120.22 ± 27.78	119.26 ± 30.37	–

Values are displayed as numbers alone, as mean ± standard deviation and number (%).

More intraoperative adjustments were needed in the early group, including subhepatic drain placement ($p < 0.001$), gallbladder decompression ($p = 0.002$), and endo-bag retrieval ($p = 0.007$). No conversions to open operation were reported in either group (Table 3).

Stone spillage occurred more in early cases ($p = 0.006$), while other complications like bleeding and bile spillage were higher but not statistically significant. Operating times were nearly similar among the two groups (Table 3).

Postoperative complications were minimal in both groups. Fever occurred in a few patients (6.52% in early LC vs. 1.85% in interval LC), with no cases of wound infection, ileus, or respiratory issues in either group. Recovery indicators showed significantly earlier subhepatic drain removal in the early group (2.67 ± 0.62 days) compared to the interval group (4.67 ± 1.53 days; $p < 0.001$). The early group also required more postoperative analgesics ($p < 0.001$). VAS pain scores on postoperative Days one and two were similar between groups (Table 4).

Table 4. Postoperative Outcomes and Recovery Parameters.

Parameter	**Group A (Early LC) (N = 46)**	**Group B (Interval LC) (N = 54)**	**P-value**
Postoperative Complications			
Fever	3 (6.52%)	1 (1.85%)	0.235
Wound infection	0 (0.0%)	0 (0.0%)	–
Ileus	0 (0.0%)	0 (0.0%)	–
Lung-related complication	0 (0.0%)	0 (0.0%)	–
Postoperative Recovery Parameters			
Subhepatic drain removal (days)	2.67 ± 0.62	4.67 ± 1.53	<0.001
Analgesic requirement (days)	3.65 ± 0.81	2.74 ± 1.29	<0.001
Postoperative VAS Pain Score			
Day 1	3.80 ± 0.67	3.74 ± 0.52	0.623
Day 2	1.52 ± 0.86	1.40 ± 0.96	0.511
Postoperative Hospital Stay			
Postoperative stay (days)	2.30 ± 0.79	2.20 ± 0.83	0.539
Total Hospital Stay			
Total hospital stays (days)	4.95 ± 1.32	8.98 ± 2.83	<0.05

Values are displayed as numbers alone, as mean ± standard deviation and number (%).

Although the duration of postoperative stay was nearly the same, the early surgery group had a significantly minuscule total hospital stay (4.95 ± 1.32 vs. 8.98 ± 2.83 days; $p < 0.05$), indicating a more efficient recovery course (Table 4).

Discussion

This research aimed to assess the safety and feasibility of early versus interval LC in the management of acute calculus cholecystitis. The results propose that early LC is a safe and effective approach, offering several clinical

advantages without accelerating the risk of substantial complications.

Demographic data, including age and sex distribution were analogous between the both groups, indicating that both early and delayed operating interventions were performed on similar patient populations. The overall male to female ratio in the present study was 1:2.03, Janjic G et al. and Gupta G et al. et al. reported the same results [20,22]. The early LC group presented with more severe clinical symptoms and laboratory abnormalities, including significantly higher WBC counts and serum bilirubin (total) levels, reflecting a more pronounced acute inflammatory response. Lal S et al. and Agarwal R et al. reported higher WBC counts and serum total bilirubin levels elevated in group A as compared to group B [16,23].

Intraoperative findings showed that dense adhesions, pericholecystic fluid, and a thickened, edematous gallbladder were significantly more common in the early group, which is expected in the acute phase. Due to acute phase intraoperative findings are more in group A as compares to group B [18,19,21]. Despite these challenges, the rate of achieving the critical view of safety was parallel in both groups and there were no conversions to open surgery or cases of bile duct injury, underscoring the safety of early intervention in experienced hands.

Intraoperative modifications, such as subhepatic drain placement, gallbladder decompression, and use of retrieval bags, were more frequently required in the early group. it can be concluded that fewer intraoperative modifications were required in group B compared to group A, likely due to the more significant intraoperative findings observed in group A [14,15]. These adaptations reflect the surgical difficulty encountered in acute settings but did not translate into increased morbidity.

The mean operating time was almost similar in both groups, with 120.22 minutes in group A and 119.26 minutes in group B ($p > 0.05$), which does not align with the results described by Lal S et al. and Bhattacharya et al. [16,24]. This discrepancy may be attributed to the fact that surgeries in both groups were performed by younger surgeons and experienced surgeons. Younger surgeons despite their skill, may require more time compared to the more experienced surgeons. The greater experience and familiarity of senior surgeons often contribute to shorter operative times, whereas less experienced surgeons may take longer due to cautious technique and less operative efficiency.

Postoperative outcomes further support early LC. Although analgesic use was slightly higher in the early group, the difference in postoperative VAS pain scores was minimal and statistically insignificant. Importantly, early LC led to significantly shorter total hospital stay, making it not only clinically effective but also economically advantageous.

Overall, this study aligns with previous research suggesting that early LC, when carried out during the initial seven days after symptoms begin, is safe and reduces the need for repeated hospital admissions, delays in definitive treatment, and potential complications of conservative management. The findings reinforce current international guidelines that advocate for early surgical intervention in suitable patients.

Conclusion

This research demonstrates that performing laparoscopic cholecystectomy

early is both a safe and feasible approach for treating acute calculous cholecystitis, even with more challenging intraoperative conditions. While it may involve more modifications and minor complications, major risks and conversion rates remain low. With comparable operative outcomes and a significantly less total hospital stay. early surgery offers clinical and economic benefits, making it a favorable approach for timely and effective management.

Statements and Declarations

Ethics declarations

Ethics approval and consent to participate

This study was approved by the HREC, Geetanjali university, Udaipur, Rajasthan, India and written informed consent was obtained.

Consent for publication

Written informed consent was obtained from the patients.

Availability of data and material

Data and material are collected and available in Geetanjali medical college and hospital, Udaipur.

Competing interests

The authors declare that they have no competing interests.

Conflict of interest

The authors declare no potential conflicts of interest concerning research, authorship, and/or publication of this article.

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ORIGINAL ARTICLE

Knowledge of Palliative Care and Attitude towards Advance Medical Directives in Medical Community: A Cross Sectional Study in a Tertiary Care Center

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Abstract

Background: Palliative care focuses on relieving symptoms and stress from serious illnesses, aiming to improve the quality of life for both patients and their families. It is appropriate at any stage of illness and can be provided alongside curative treatment. Advance Medical Directives (AMDs) are legal documents that allow individuals to outline their medical treatment preferences if they become unable to communicate. This study was intended to evaluate the perception of the Medical Community in this institution about Advance Medical Directives and End of Life Care, generating novel insights. **Objectives:** The primary objective was to evaluate the attitude and knowledge of the medical community (including faculty, interns, and undergraduates) regarding palliative care and Advance Medical Directives (AMDs). The secondary objective was to explore perceptions about implementing palliative care into the Competency-Based Medical Education (CBME) curriculum. **Methods:** A cross-sectional study was carried out for a period of one week in a tertiary care Centre after securing approval from the Institutional Human Ethics Committee. A total of 204 participants including faculty members, Interns, and undergraduates (from Phase 2 MBBS onwards were enrolled. Data were collected using a pre-designed, pre-validated questionnaire administered as Google Form for analysed using Statistical Package for Social Sciences (SPSS) software. Association between categorical variables was assessed by Chi-square test. The knowledge and attitude scores were correlated by Pearson correlation test. **Results:** Of the participants, 78% were females. Fear of death was identified as their greatest concern in terminal illness by 47.09% of participants. 77.67% of the participants believed that once an AMD is signed it remains valid for life. 28.16% of the participants were of the impression that AMDs are a legal form of euthanasia. Integration of palliative care into Phase 1 of the CBME curriculum was supported by 37%. There was no statistical significance in the correlation of knowledge with attitude which was weak negative ($r = -0.108$; $p = 0.124$). **Conclusion:** The medical community had a positive attitude towards AMDs despite having poor understanding. This emphasizes the necessity of creating more mindfulness and integration of AMD in curriculum.

Keywords: Palliative care, Advance Medical Directive, Medical Community, Power of Attorney

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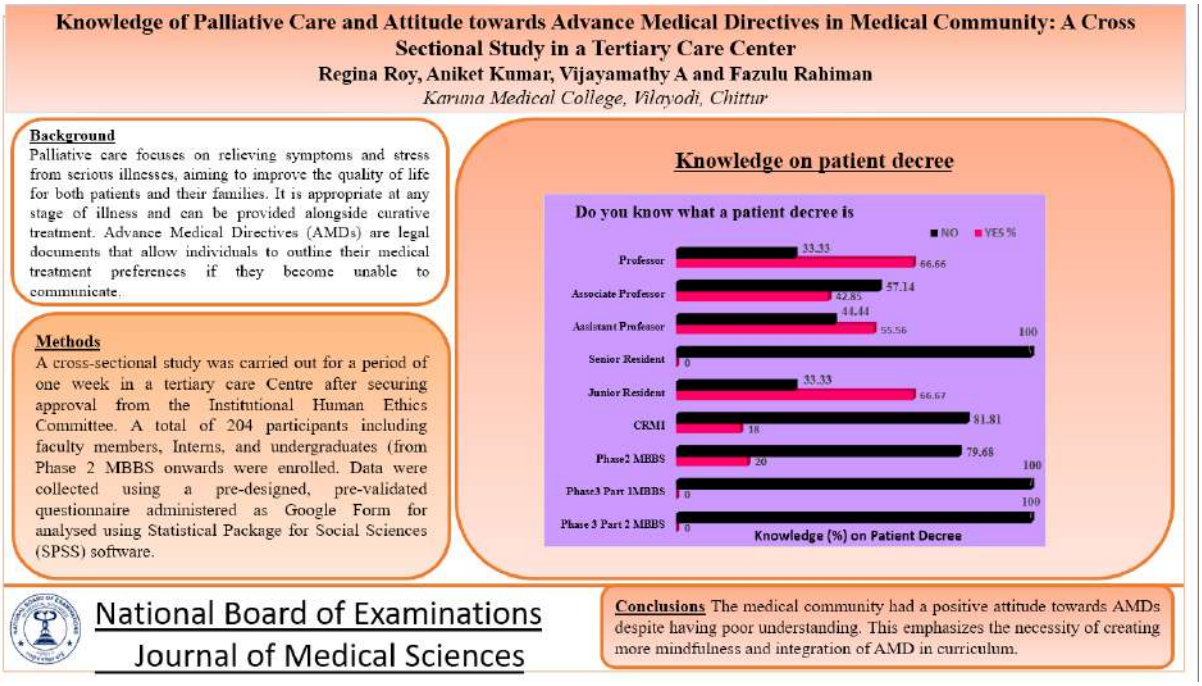
Graphical Abstract



Introduction

"Advance Medical Directive" is a healthcare document which is a type of "living will.". It is a common term for a document which articulates in advance your choices in the event you are physically and mentally incapacitated. Various types of directives are available such as living wills, powers of attorney for health care, etc. [1].

Advance directives are legal documents which empower people to disclose their decisions in advance as to what must be done or who will take decisions on their behalf, if a time comes when they are physically or mentally incapacitated [2]. Advance directives enable them to have more control over future care than is ordinarily possible [3]. Advance directives, particularly living wills, significantly improve the possibilities of getting healthcare according to the concerned patients' preferences when they lack decision-making capacity [4]. Danis et al. in the research concluded that advance directives for life-sustaining care are effective when followed, but their effectiveness is limited by inattention and prioritization of other factors [5]. Advance Care Directives, as per Kermel-Schiffman and Werner bestow several benefits for the incapacitated person as well as his/her family and attending professionals [6]. The autonomy of the person is preserved ensuring respect for his value and treatment preferences. This leads to improved quality of life and life satisfaction at End-Of-Life stage (EOL). It also facilitates patient-centred EO care [6].

Palliative care concentrates on ameliorating symptoms and stress during serious illnesses, leading to improvement in the quality of life for both patients and their family members. Palliative care can be provided during the course and management of the illness. Palliative care teams are multidisciplinary, including doctors, nurses, social workers, and chaplains, who work in tandem to address physical, emotional, spiritual, and social needs [7]. AMDs, particularly during

palliative care, are essential for facilitating the values and preferences of the patient concerned [8]. Our study aimed to compile data about the attitude towards, knowledge about and preferences of a sample of health community regarding EOL care and AMD.

Objectives

To assess the knowledge and attitude of Medical Community in a tertiary care hospital regarding palliative care and Advance Medical Directives and to assess the Medical Community's perspectives on implementing palliative care in CBME curriculum.

Methods

A cross-sectional study was carried out over a period of one week from 19.11.2024 to 25.11.2024 in a tertiary care Centre after securing approval from the Institutional Human Ethics Committee (KMC/IHEC/36/2024 dated 30.10.2024) and only the participants who gave consent were included in the study. The study population included 204 participants from the medical community, consisting of Faculty members, Interns and Undergraduate MBBS students. STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist was adhered while designing the study.

Data on attitude towards and knowledge about palliative care and Advance Medical Directives (AMDs) was collected using a pre-validated, predesigned questionnaire distributed through Google Forms (Annexure 1). Data on knowledge about palliative care of Palliative Care was collected using 12 questions addressing various aspects of palliative care and its effectiveness. Data on knowledge regarding Advance Medical Directives (AMDs) was compiled by means of 2-point Likert scale questions, 7 in number. Attitude towards AMDs was gauged using 10 items. Questionnaire was constructed based on previous literature [9,10].

Additionally, opinion of participants was compiled regarding the inclusion of palliative care in the CBME (Competency Based Medical Education) curriculum, specifically the initiation of training from Phase 1 of the MBBS course.

Data were analysed using SPSS software. Categorical variables were summarized using frequency distribution and Chi-square test was used to examine the association between them. Pearson's correlation coefficient was used to correlate the relationship between attitude and knowledge. The results were considered statistically significant if the p-value < 0.05.

Results

Table 1. Sample Characteristics

Professional status	n=204 (Percentage)
Phase 3 Part 2	5 (2.43)
Phase3 Part 1	1 (0.49)
Phase2	128 (62.14)
CRMI	44 (21.36)
Junior Resident	3 (1.46)
Senior Resident	1 (0.49)
Assistant Professor	9 (4.37)
Associate Professor	7 (3.40)
Professor	6 (2.91)
Gender	**Percentage**
Male	54 (26.21)
Female	150 (77.82)

The study involved 204 participants consisting of mostly Phase 2 MBBS students 127 (62.14%). 78% of the total participants were females (Table 1).

Table 2. Knowledge on Palliative Care

Awareness and Knowledge of Palliative Medical Care	Most Common response	Awareness n (%)
In your opinion, what are the greatest fears of a patient who has been diagnosed with a terminal illness	Fear of death.	97 (47.09)
How much do you think people generally speak about death and dying?	About the right amount.	74 (35.92)
If you had a terminal illness, where would you like to spend the final stage of your life?	Home	160 (77.67)
If you had a terminal illness, where would you like to spend the final stage of your life?	Do not know	23 (11.17)
How do you rate your knowledge and awareness of palliative care in your state	Moderate	97 (47.09)
If you have already heard of palliative care, where did you find out about it?	Heard -work with patients on palliative	66 (32.04)

Please select the following sentence that in your opinion best describes palliative care	Improve quality of Life	105 (50.97)
Where and by whom do you think care is best provided to patients with a terminal illness	Family/Relatives	84 (40.78)
Among patients with the illnesses listed, who do you think should receive palliative care -	Cancer-Fully Agree	158 (76.70)
	Kidney failure-agree	80 (38.83)
	Heart Failure-Fully Agree	58 (28.16)
	HIV AIDS-Fully Agree	74 (35.92)
	Chronic Lung Disease-Partly agree	66 (32.04)
	Dementia-Fully Agree	88 (42.72)
	Stroke-Fully Agree	79 (38.35)

Most of the participants (77.67%) said that they preferred to spend the final stage of their life at home if they had a terminal illness.

A sizable number of participants (76.70%) responded that patients with Cancer should receive palliate care (Table 2).

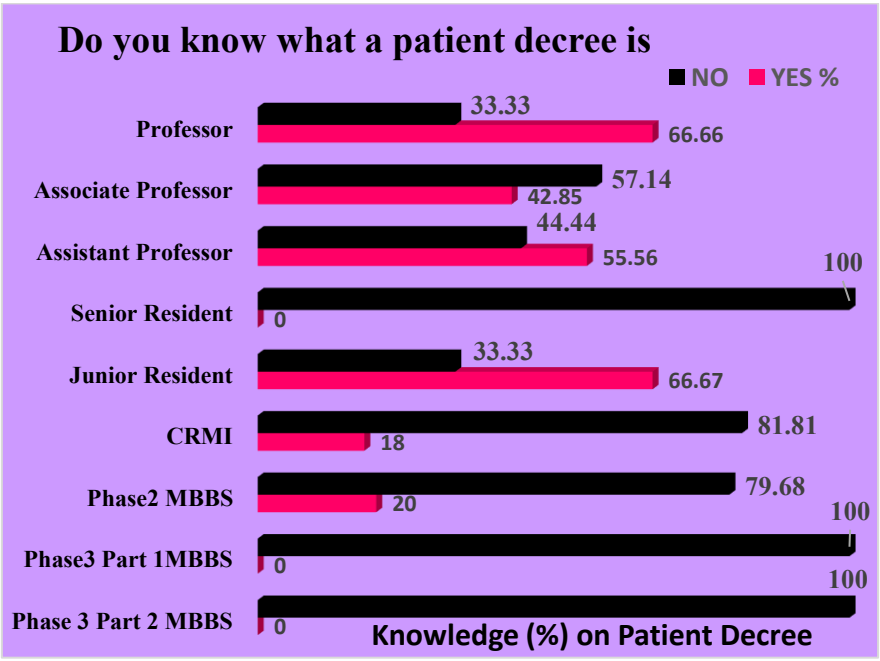


Figure 1. Knowledge on patient decree

Of the participants from the Medical Community, Professors (66.66%) and Junior Residents (66.67%) were most aware about patient decree.

The knowledge about patient decree was nil among Phase 3 Part 2 MBBS Students and Senior Residents (Figure 1).

A very high number of the participants (70.87%) did not consider AMD as the same as euthanasia (Table 3).

Table 3. Knowledge on Advance Medical directive

Knowledge on Advance Medical directive	Correct n(%)	Incorrect n(%)
Once signed Valid for life	160 (77.67)	44 (21.36)
AMD is the same as euthanasia	58 (28.16)	146 (70.87)
AMD reflects the values and preferences of citizens	177 (85.92)	27 (13.11)
AMD not be subjected to experimental treatments	161 (78.16)	43 (20.87)
family has to agree with the content of the AMD statement	154 (74.76)	50 (24.27)
family's opinion overrides that of the health care prosecutor.	125 (60.68)	79 (38.35)
If patient is unconscious, their family can change or cancel the content of the AMD.	102 (49.51)	102 (49.51)

Table 4. Descriptive statistics of the Attitude towards Advance Medical Directives

	Mean *SD[i] (Standard Deviation)		Agree	Disagree
1	AMDs are a useful tool for healthcare professionals when making decisions about EOL patients.	3.50(1.34)	66 (32.04)	23 (11.17)
2	AMDs are a legal form of euthanasia.	2.88(1.40)	39 (18.93)	49 (23.79)
3	Legalization of the vital testament did not contribute to human dignity.	2.70(1.25)	21 (10.19)	52 (25.24)
4	Death must be postponed, regardless of the person's condition.	2.50(1.32)	22(10.68)	66 (32.04)
5	EOL care should be provided based on the opinion of the health professional.	3.49(1.17)	49 (23.79)	16 (7.77)
6	EOL care should not be provided based on the patient's opinion.	2.75(1.31)	27 (13.11)	49 (23.79)
7	EOL care should be provided based on the opinion of the family.	2.93(1.27)	28 (13.59)	39 (18.93)
8	The vital testament is only important for elderly and sick people. *	2.65(1.32)	25 (12.14)	57 (27.67)
9	I do not make a Vital Testament because there is still little information available	3.09(1.27)	39 (18.93)	32 (15.53)

10	My family will make the EOL decisions for me, when necessary	3.05(1.25)	36 (17.48)	29 (14.08)

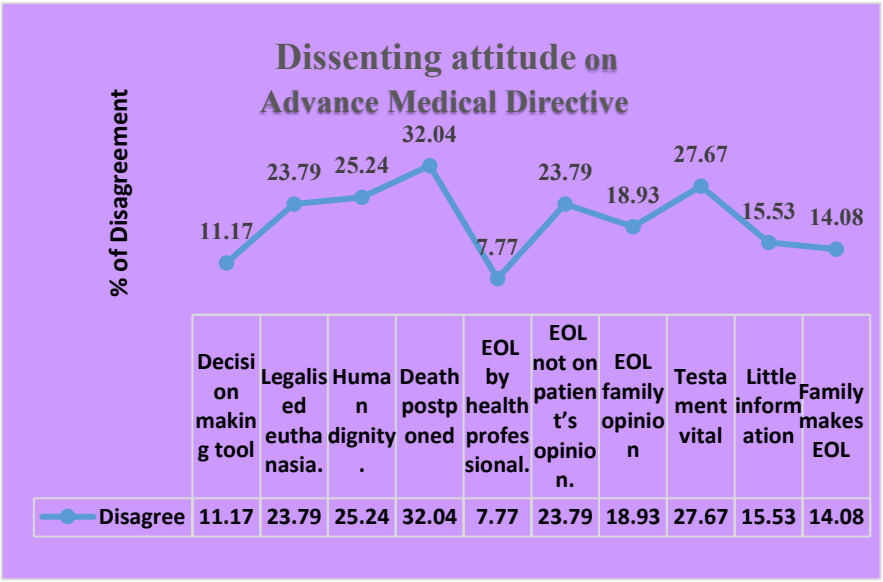


Figure 2. Dissenting attitude on Advance Medical Directive

Table 5. Correlation between knowledge and attitude (n=204)

Variable	Pearson correlation (r)	p value
Knowledge vs. Attitude	–0.108	0.124

Attitude and knowledge were not significantly correlated (Table 5).

AMDs have been perceived as useful for healthcare professionals in EOL decisions (M = 3.50, SD = 1.34), although some misconceptions persisted, such as equating AMDs with euthanasia (M = 2.88, SD = 1.40) or viewing them as undermining dignity (M = 2.70, SD = 1.25). Respondents were neutral in opinion about postponing death regardless of condition (M = 2.50, SD = 1.32). They expressed mixed views on whether EOL care should be given by professionals (M = 3.49, SD = 1.17), whether EOL care should exclude patient opinion (M = 2.75, SD = 1.31), or whether it should involve families (M = 2.93, SD = 1.27). The belief that vital testaments apply only to elderly or sick individuals was weak (M = 2.65, SD = 1.32), while for lack of information (M = 3.09, SD = 1.27) and reliance on families for decisions (M = 3.05, SD = 1.25) (Table 4).

The study found that a participant's designation was statistically related to their opinion on two specific topics. The first is the belief that AMDs are a form of legal euthanasia (p = 0.0036). The second is the conviction that a patient's death should be delayed regardless of their condition (p = 0.0299). This indicates that professional level influenced attitudes towards ethical and decision-making aspects of EOL care.

The analysis showed significantly association between professional designation and attitudes toward several aspects of Advance Medical Directives. Different designations held distinct

viewpoints on end-of-life topics like euthanasia, extending life, the involvement of patients and their families in making decisions, and the importance of living wills. In contrast to this the usefulness of AMDs for healthcare professionals was acknowledged across various designations. They also held the belief that legalisation of vital testaments compromises human dignity.

Figure 3 depicts the perceptions of participants regarding the addition of palliative care in the CBME program. A majority of them (37.38%) agreed that palliative care should be introduced, while 24.27% partly agreed. An equal proportion (24.27%) remained neutral which showed indecisiveness. Only a minor portion of participants disagreed: 5.83% partly disagreed and 7.28% strongly disagreed. Overall, more than 60% of participants supported or partly supported the incorporation of palliative care into the CBME curriculum, reflecting positive inclination towards early exposure.

Discussion

The study was based on responses from 204 participants. Gender wise, females predominated (77.82%), while male participants constituted 26.21% of the total.

None of the Phase 3 Part 2 MBBS students and Phase 3 Part 1 MBBS students knew what is a patient decree. Regarding this, only 20% of Phase 2 MBBS students were aware, while 79.68% were not, while among CRMIs, 18% knew, and 81.81% did not. A higher proportion of Junior Residents (66.67%) knew about a patient decree, compared to 33.33% who did not. All Senior Residents reported non-awareness. More than half of the Assistant Professors (55.56%) were aware, while 44.44% were not. Among Associate Professors, 42.85% knew, and 57.14% did not. Two-thirds of Professors (66.66%) were aware, while 33.33% were not (Figure 1). Thus, awareness about patient decree was very low among MBBS students and CRMIs but higher awareness was seen among Junior Residents and Professors.

In this study, 47.09% of participants identified fear of death as their greatest concern in terminal illness, a finding consistent with prior reports that highlighted death-related anxiety as a major psychosocial worry in palliative care [11]. Only 35.92% felt that people speak about death and dying the "right amount," indicating communication barriers similar to those documented by who noted that cultural reluctance often creates a barrier in EOL discussions Brighton & Bristowe [12]. A large proportion (77.67%) expressed preference to spend their final stage at home, aligning with global evidence that most patients value home-based care over institutional care [13]. However, 75.73% of the participants expressed unawareness about patient decrees or advance directives, reflecting poor awareness. This has been also reported in other Indian and international studies [14].

Knowledge about palliative care in this state was rated as "moderate" by 47.09%, while only 32.04% had prior exposure through direct patient care, suggesting limited training opportunities; which is similar to the findings of Rhee JY et al. [15]. The question on the purpose of palliative care was responded with "improving quality of life" by 50.97%. 40.78% of the participants opined that family/relatives are best able to provide care, reflecting the cultural expectation of family-centred caregiving in India [16]. With regard to disease-specific need for

palliative care, agreement was highest for cancer (76.70% fully agree), while for non-malignant conditions the responses were: kidney failure (38.83% agree); heart failure (28.16% fully agree); HIV/AIDS (35.92% fully agree); chronic lung disease (32.04% partly agree); dementia (42.72% fully agree); and stroke (38.35% fully agree). These results are similar in international literature, where palliative care is often perceived as cancer-focused, despite strong evidence supporting its benefits in non-cancer illnesses [17,18].

With regard to AMD, 77.67% of participants believed that once an AMD is signed it remains valid for life (Table 3). This shows that there is some understanding of its legal nature, but it also shows that it is not complete since revisions or updates of AMD are possible and recommended according to changing circumstances [19]. Misconceptions were also evident as 28.16% equated AMD with euthanasia, but 70.87% identified them as different concepts. This is in alignment with previous reports of confusion between end-of-life directives and assisted dying [20]. Similar to the findings of Song et al. [21], 85.92% of the participants felt that AMDs reflect the values and preferences of citizens which supports AMDs as a tool for patient autonomy.

The majority of the participants (78.16%) recognised that AMDs can protect patients from unwanted experimental treatments, consistent with the ethical principle of non-maleficence. Of the participants 74.76% felt that the family must agree with the content of an AMD and 60.68% believed that the opinion of the family can override the decision of the healthcare provider. This matches Indian studies where family-centric decision-making often over-rides individual autonomy [14] in contrast to Western studies where patient directives are given legal priority [21]. Furthermore, 49.51% believed that families can change or cancel an AMD if the patient is unconscious, while an equal 49.51% disagreed, reflecting significant uncertainty and lack of clarity regarding legal authority.

Taken together, these findings show that while respondents broadly recognize AMD as a tool for autonomy, misconceptions still persist regarding its validity, distinction from euthanasia, and the legal authority of families. Similar challenges in public and professional understanding have been reported globally [21] underscoring the need for educating the stake holders to clear the policy in the Indian context.

In this study, only 11.17% did not agree that AMDs are a useful tool for healthcare professionals in decision making regarding end of life, indicating that their utility is broadly recognised (Table 4 and Figure 2). 23.79% of the participants mistakenly considered AMDs as a legal form of euthanasia which reflects the same misconception documented in other studies where the concepts of euthanasia and advance care planning were found confused [19]. Disagreement was found from 25.24% on the statement that legalizing the vital testament contributes to human dignity, suggesting the prevalence of ethical uncertainties around its perceived value.

In answer to the questions pertaining to life-prolonging measures, 32.04% believed death must always be postponed regardless of condition, reflecting a tendency toward aggressive treatment approaches, which has also been reported in other Indian contexts where cultural and religious beliefs emphasize life preservation [14]. Only 7.77% disagreed

that EOL care should be guided by healthcare professionals, showing trust in medical expertise. Conversely, 23.79% disagreed with the statement that patient opinion should not guide EOL care, reflecting that there is no proper understanding about the role of patient autonomy. This is consistent with other studies showing family- and physician-dominated decision-making in Asian societies [22].

Family involvement was evident, with only 18.93% disagreeing that decisions regarding end-of-life care should be determined by the family's wishes. A number of participants (14.08%) endorsed the family as the ultimate decision-makers, emphasising the cultural dominance of family-centred care in India [16]. A sizable proportion (27.67%) felt that AMDs were only important for the elderly or sick, showing limited understanding of their broader applicability across all ages. About 15.53% admitted they would not make a vital testament due to lack of adequate information. This points to educational gaps, also reported in other low- and middle-income settings [23].

Overall, these findings suggest that while AMDs are generally viewed as useful and dignity-preserving, some misconceptions prevail regarding their link with euthanasia, their relevance beyond the elderly and the role of family versus patient autonomy. International studies also highlight cultural factors, unclear laws, and insufficient awareness are major impediments to using AMDs, consistent with these trends [24].

The correlation coefficient ($r = -0.108$) shows a very weak negative relationship between attitude and knowledge suggesting that as knowledge scores increased, attitude scores tended to decrease slightly, but the association was minimal. The observed relationship is not considered statistically significant because its p-value of 0.124 exceeds the commonly accepted significance threshold of $p < 0.05$.

The study found that participants' knowledge of palliative care did not significantly change their attitudes. Past research has indicated that awareness and attitudes towards palliative care are influenced more strongly by cultural beliefs, personal history, and experience with end-of-life care than by factual knowledge [11,14]. In this scenario, improving knowledge through education alone may not be sufficient to change attitudes. Interventions targeting the misconceptions employing communication skills, and cultural sensitivities are also essential.

In Germany, a questionnaire-based study among final-year medical students revealed that despite lacking sufficient knowledge and confidence in the field, the majority were in strong favor of including palliative care in their required medical curriculum [25]. A survey at Kasturba Medical College found that although students displayed good theoretical awareness, they lacked confidence in applying palliative care skills in practice, highlighting the need for early and experiential training [26]. Comparable gaps were observed in the United Arab Emirates, where more than half of recent graduates reported no formal palliative care teaching, but almost all considered such education essential in medical training [27]. Similar findings from other contexts affirms the importance of incorporating palliative care into the early stages of a medical education curriculum, as supported by the perceptions of the participants in the present study also.

Strengths

This was a pioneering study in this institution, addressing perceptions of AMDs and EOL care, generating novel insights. The study offers practical directions for integrating AMDs into medical education and public health strategies.

Limitations

The study was conducted in a single center which reduces wider applicability and the modest sample size reduces the strength of generalization.

Conclusion

This is the first comprehensive assessment from this tertiary care centre regarding views on advance medical directives (AMDs) and end-of-life (EOL) care. Its strength lies in addressing an underexplored area within a culturally sensitive context, offering baseline data that can guide both institutional practices and community initiatives. By identifying gaps in understanding and engagement with AMDs, the study provides actionable insights for curriculum development, policy planning, and health promotion. The study findings highlight opportunities to integrate AMDs into education and practice, ultimately supporting patient autonomy and dignified EOL care.

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Conflicts of interest

The authors declare that they do not have conflict of interest.

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ANNEXURE 1

Knowledge and attitude towards Palliative care and Advance Medical Directives among health professionals a cross sectional study.

QUESTIONNAIRE ON THE AWARENESS AND KNOWLEDGE OF PALLIATIVE MEDICAL CARE

1. In your opinion, what are the greatest fears of a patient who has been diagnosed with a terminal illness? (Please select three of the following options and rank them in order of relevance—1st, 2nd, 3rd)

___ Fear of pain.
___ Fear of death.
___ Fear of no longer being independent.
___ Fear of losing mental capabilities.
___ Fear of loneliness.
___ Fear of becoming disabled/immobile.
___ Fear of financial burdens.
___ Fear of being a burden to someone.
___ I don't know.

2. What services do you think should be provided to people with a terminal illness and their families

(a) Help at home in case of pain and other symptoms.
(b) Domestic care for the patient during the day.
(c) Domestic care for the patient at night.
(d) Complementary therapies.
(e) Pastoral care.
(f) A social worker that the patient and family could reach on the phone if necessary.
(g) Assistance with household tasks, shopping, transportation etc.
(h) Additional support at home to allow the family caregivers to have some free time and time for themselves.
(i) Information and advice on financial aid.
(j) Medical care in a hospice.
(k) Medical care in hospital

3. How much do you think people generally speak about death and dying?

(a) Too little.

(b) About the right amount.

(c) Too much.

4. If you had a terminal illness, where would you like to spend the final stage of your life?

(a) At home.

(b) In a hospital.

(c) In a nursing home.

(d) I don't know.

5. Do you know what a patient decree is?

(a) Yes.

(b) No.

6. How do you rate your knowledge and awareness of palliative care in our federal state?

(a) I know nothing about palliative care.
(b) I have heard about palliative care.
(c) I know a fair amount about palliative care.
(d) I know a great deal about palliative care.

7. If you have already heard of palliative care, where did you find out about it?

(a) I have received palliative care myself.

(b) A close friend/relative has received palliative care.

(c) A distant relative/acquaintance has received palliative care.

(d) A neighbour has received palliative care.

(e) A friend or relative has told me about it.

(f) I work with patients that receive palliative care.

8. Please select the following sentence that in your opinion best describes palliative care.

(a) Palliative care hastens death.

(b)

Palliative care delays death.

(c)

Palliative care permits the patient to continue living an active life.

(d)

Palliative care calms the patient.

(e)

Palliative care improves the patient's quality of life.

(f)

I don't know.

9. What do you think are the greatest needs of patients with a terminal illness that have reached the end of their lives? (Please select the following options and rank them in order of relevance—1st, 2nd, 3rd)

____ Reduction in physical suffering.
____ Specialist medical care.
____ Home nursing care (medical and nursing services).
____ Support for home-based caregivers.
____ Professional psychological support.
____ Spiritual support.
____ I don't know.

10. What do you think are the greatest needs of family members that provide care to a patient with a terminal illness? (Please select the following options and rank them in order of relevance—1st, 2nd, 3rd)

____ 24-hour specialist care.
____ Home nursing care.
____ Access to and availability of voluntary caregivers.
____ Specially adapted residential facilities/hospices.
____ Psychological care.
____ Grief counseling.
____ I don't know.

11. Where and by whom do you think care is best provided to patients with a terminal illness?

(a)

At home by family/relatives.

(b)

At home by professional care workers.

(c)

In a hospice.

(d)

In hospital.

(e)

I don't know.

12. Among patients with the illnesses listed in the table below, which do you think should receive palliative care? (Please mark one of the options for each illness.)

	5 (I fully agree.)	**4 (I agree.)**	**3 (I partly agree.)**	**2 (I don't agree.)**	**1 (I don't agree at all.)**	**I don't know anything about this illness**
Cancer						
Kidney failure						
Dementia						
Stroke						
Heart failure						
HIV/AIDS						

Chronic lung diseases

Advance Medical directives (AMD)
Correct/Incorrect

Knowledge on AMD

1. The AMD, once signed, is valid for life
2. AMD and euthanasia mean the same thing
3. The AMD reflects the values and preferences of citizens when making therapeutic decisions at the end of their lives.
4. The AMD guarantees the citizen's choice to not be subjected to experimental treatments that are in experimental phase
5. The patient's family has to agree with the content of the AMD statement so it can be applied.
6. The family's opinion overrides that of the health care prosecutor.
7. When the patient is unconscious, their family can change or cancel the content of the AMD.

Attitude towards AMD **2 point Likert Scale**

1. AMDs are a useful tool for healthcare professionals when making decisions about EOL patients.
2. AMDs are a legal form of euthanasia.
3. Legalization of the vital testament did not contribute to human dignity.
4. Death must be postponed, regardless of the person's condition.
5. EOL care should be provided based on the opinion of the health professional.
6. EOL care should not be provided based on the patient's opinion.
7. EOL care should be provided based on the opinion of the family.
8. The vital testament is only important for elderly and sick people.
9. I do not make a Vital Testament because there is still little information available
10. I don't want to think that I will eventually die or become disabled, to the point of not being able to make decisions.
11. My family will make the EOL decisions for me, when necessary

Please rate your opinion regarding in implementation of Palliative care in CBME curriculum and the commencement of the training from Phase 1of MBBS course onwards

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ORIGINAL ARTICLE

A Clinical Study on Comparing Topical Steroid Cream vs Compressive Dressing for Management of Hypergranulation Tissue in Residual Raw Area Post Skin Grafting in Burn Patients

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Abstract

Introduction: Hypergranulation tissue is an excessive proliferation of immature granulation tissue that rises above the wound surface, delaying re-epithelialization. It frequently occurs in post-burn residual raw areas after skin grafting and impedes wound healing. Various management options exist, but there is limited comparative evidence between topical steroid application and compressive dressing. **Materials and Methods:** A prospective cohort study was conducted at the Department of Burns, Plastic and Reconstructive Surgery, Government Kilpauk Medical College, Chennai, from January to August 2025. Fifty patients with hypergranulation tissue following split-thickness skin grafting were randomly assigned into two groups of twenty-five each. Group A received 0.1% betamethasone with fusidic acid ointment, and Group B received saline compressive dressings. **Results:** The topical steroid group showed a significantly greater reduction in wound dimensions and pain, with mean raw area decreasing from 34.2 cm^2 to 7.2 cm^2 compared to 26.3 cm^2 to 17.2 cm^2 in the compressive group ($p < 0.01$). Mean healing time was 21.6 ± 7.4 days versus 32.7 ± 10.5 days, and no complications were observed in the steroid group. **Conclusion:** Short-term topical steroid therapy effectively reduces hypergranulation tissue, accelerates epithelialization, and minimizes hospital visits compared to compressive dressing, with no adverse effects.

Keywords: Hypergranulation, Burn wounds, Topical corticosteroid, Betamethasone, Epithelialization

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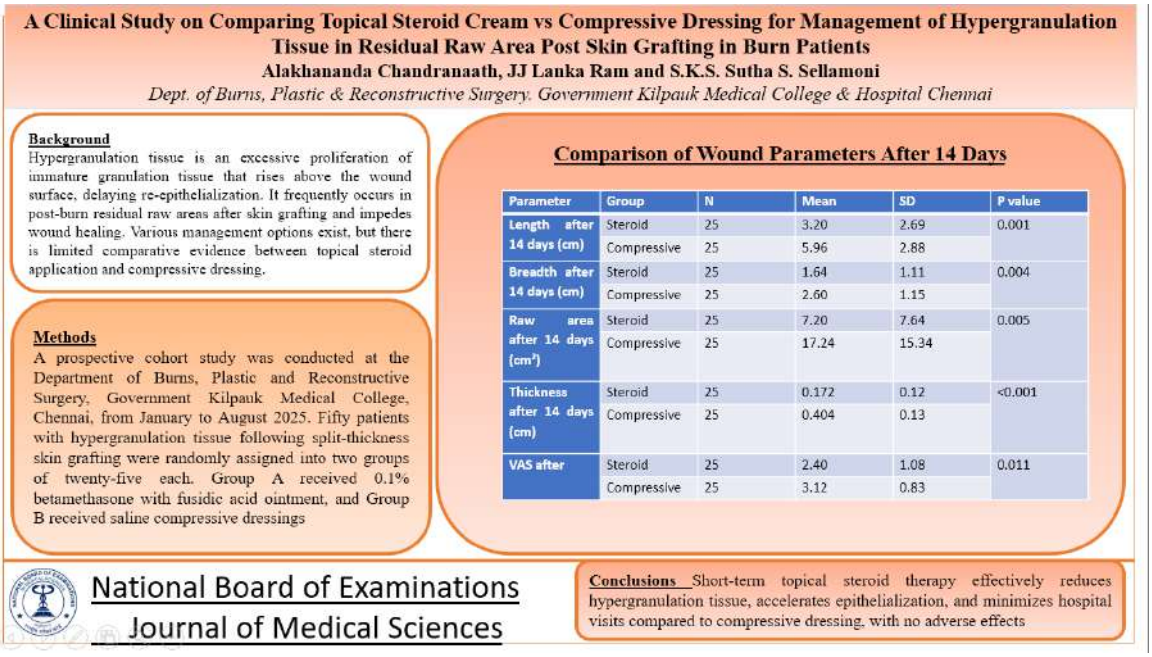
Graphical Abstract



Introduction

Hypergranulation tissue is an overgrowth of granulation tissue that rises above the surface level of a wound and is characterized by excessive fibroblast proliferation, abundant extracellular matrix deposition, and persistent angiogenesis. It appears as a raised, moist, friable, reddish mass that prevents epithelial migration and delays wound closure. Hypergranulation is frequently encountered in post-burn wounds and residual raw areas following split-thickness skin grafting, posing a significant challenge to wound healing and aesthetic outcomes [1].

The development of hypergranulation tissue is multifactorial, often resulting from chronic inflammation, persistent moisture, infection, frictional trauma, or excessive mechanical stress on the wound bed. On a cellular level, an imbalance between matrix metalloproteinases (MMPs) and collagenase activity has been implicated, leading to impaired remodeling and uncontrolled fibroplasia [2]. This abnormal wound response interferes with keratinocyte migration and epithelialization, resulting in delayed healing, recurrent breakdown, and hypertrophic scarring. Therefore, timely and effective management of hypergranulation tissue is essential to optimize wound outcomes in burn patients.

Several therapeutic modalities have been described for the management of hypergranulation tissue, including surgical excision, sharp debridement, chemical cauterization with silver nitrate, laser ablation, topical antibiotics, foam dressings, and pressure dressings [3,4]. Among these, silver-based agents have historically been popular due to their antimicrobial properties; however, they may cause local pain, tissue necrosis, and cytotoxicity, potentially delaying epithelialization [5]. Conservative approaches such as compressive dressings provide a simple, low-cost method by applying uniform pressure that limits

capillary overgrowth, decreases exudate, and promotes tissue flattening [6]. Nevertheless, their efficacy in rapidly resolving established hypergranulation remains limited and largely supportive rather than curative [7].

In recent years, topical corticosteroids have gained attention as a targeted therapy for hypergranulation tissue due to their anti-inflammatory, anti-proliferative, and anti-angiogenic properties. These agents help suppress fibroblast activity, reduce vascular proliferation, and accelerate re-epithelialization [8]. When applied locally, corticosteroids minimize systemic absorption and associated adverse effects, making them a safe alternative to systemic therapy. Studies by Lam et al. [2] demonstrated complete regression of hypergranulation within 1–2 weeks using topical hydrocortisone 1% combined with chloramphenicol, without major side effects. Similarly, Saleem et al. [5] reported faster wound healing and improved epithelialization with short-term topical steroid use in burn wounds.

Despite the growing evidence for topical steroids, comparative clinical data directly evaluating their efficacy against traditional conservative approaches such as compressive dressings in burn wounds remain limited. Moreover, standardized protocols regarding steroid potency, duration, and frequency of application are yet to be universally defined.

Hence, the present study was conducted to compare the efficacy of topical steroid cream versus compressive dressing in the management of hypergranulation tissue in residual raw areas following skin grafting in burn patients. The study specifically evaluated reduction in wound size, time to complete epithelialization, pain control, and need for regrafting, aiming to establish evidence-based recommendations for clinical practice.

Materials and Methods

This was a prospective cohort study conducted in the Department of Burns, Plastic and Reconstructive Surgery, Government Kilpauk Medical College and Hospital, Chennai, India. The study aimed to compare the efficacy of topical steroid cream with compressive dressing in the management of hypergranulation tissue that developed over residual raw areas following split-thickness skin grafting in burn patients. The study was carried out over a period of six months, from January 2025 to August 2025, and included continuous recruitment and follow-up of patients until complete epithelialization or occurrence of complications.

The study population consisted of both in-patients and out-patients with residual raw areas after skin grafting for post-burn wounds. A total of fifty eligible patients were enrolled and randomly divided into two groups of twenty-five each. Group A received local application of 0.1% betamethasone ointment combined with fusidic acid once daily over the hypergranulation tissue. Group B was managed conservatively with tight saline-soaked gauze or crepe bandage compressive dressings. Randomization was performed by an independent resident not involved in the treatment or data analysis.

Patients aged above two years and below seventy years with post-skin grafting residual raw areas were included after obtaining consent. Those in sepsis or shock, patients with multiple comorbidities, pregnant or breastfeeding

women, individuals with known hypersensitivity to corticosteroids, and non-compliant patients were excluded.

All procedures were performed in accordance with the ethical standards of the Declaration of Helsinki (2013 revision). Written informed consent was obtained from all adult participants after explaining the nature and purpose of the study in their local language. For children between 7 and 18 years, written assent was obtained along with parental or guardian consent. For participants below seven years, oral assent was taken and documented in the study record, accompanied by written consent from the parent or legally authorized representative.

Baseline data were recorded at the time of enrollment. Pretreatment photographs were taken to document the appearance and extent of hypergranulation tissue. The wound was assessed for length and breadth using a transparent graph sheet, and the total surface area was expressed in square centimeters. The thickness of the hypergranulation tissue was measured using a sterile needle. The level of pain was assessed using the Visual Analogue Scale (VAS) at the time of presentation. Subsequent wound assessments were performed by a different plastic surgeon during follow-up visits on days 3, 6, 9, 12, and 15. Changes in wound dimensions, thickness, and pain scores were recorded during each visit.

All patients were followed up until complete epithelialization or the occurrence of complications. The total number of hospital visits and the duration of healing were noted. Complications such as infection, persistence of raw area, or need for regrafting were documented.

For the purpose of data uniformity, a structured proforma was maintained for each patient. The proforma recorded demographic details (name, age, sex, occupation, inpatient number, and date of admission), wound characteristics (initial and final size, surface area, and thickness), pain score (VAS), number of dressing changes or hospital visits, time taken for complete healing, and complications if any.

All data were entered into Microsoft Excel and analyzed using IBM SPSS software. Descriptive statistics such as frequency and percentage were used for categorical variables, and mean and standard deviation were used for continuous variables. Comparisons between the two groups were made using independent sample t-tests for continuous data. A p-value of <0.05 was considered statistically significant (Figure 1)

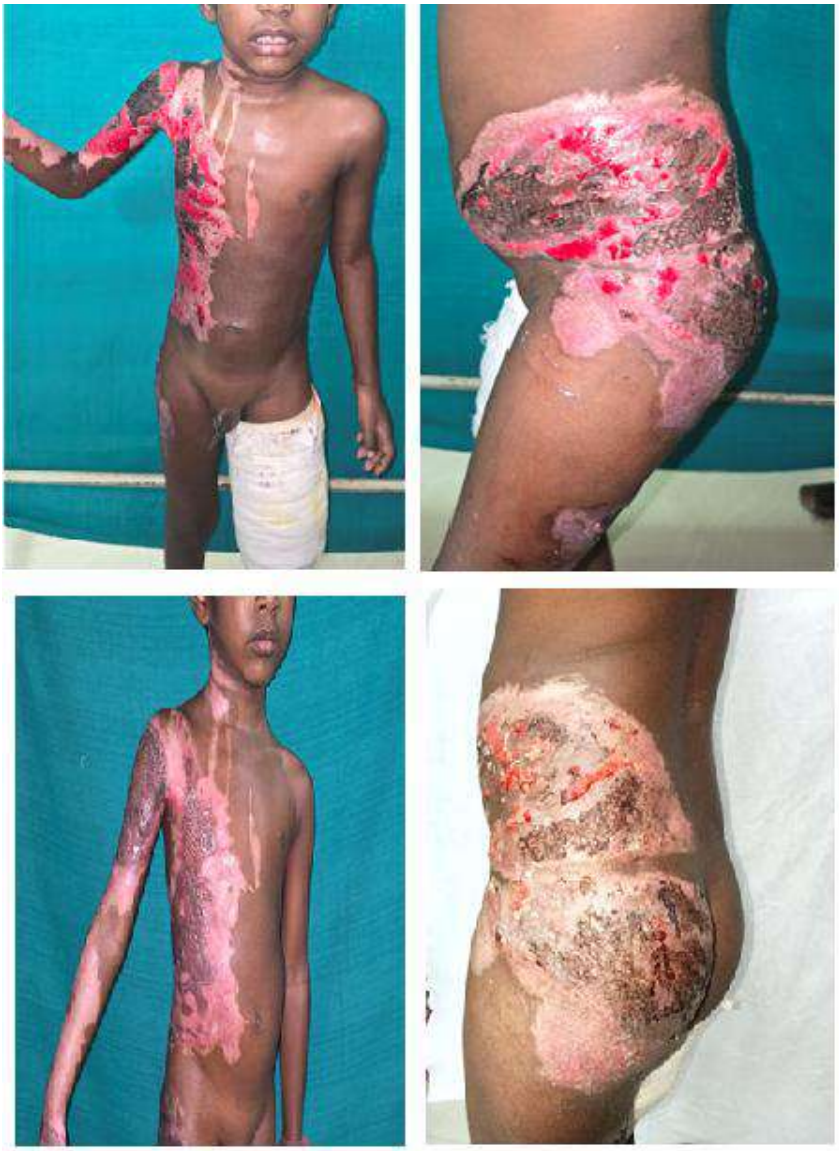


Figure 1. Comparative healing response between steroid cream and compressive dressing groups at Day 0 and Day 14

Results

A total of 50 patients were included in the study, with 25 patients each in the topical steroid group and the compressive dressing group. The study population consisted of 31 males (62%) and 19 females (38%). The majority of patients (38%) were between 20–40 years of age, followed by 30% in the 40–60 years category. The mean age of the population was 32.8 ± 16.6 years.

Baseline characteristics were comparable between the two groups ($p > 0.05$) across all parameters, confirming effective randomization. Pre-treatment wound parameters were similar between groups — mean wound length (8.3 ± 4.6 cm), breadth (3.0 ± 1.4 cm), and raw area (30.3 ± 34.1 cm^2). The mean pre-treatment wound thickness was 0.60 ± 0.17 cm, and average VAS score for pain was 6.4 ± 1.05, indicating moderate to severe pain before intervention (Table 1).

Table 1. Baseline Characteristics of the Study Population

Parameter	Group	N	Mean	SD	P value
Age (years)	Steroid	25	28.72	16.25	0.076
	Compressive	25	36.96	15.91	
Initial wound length (cm)	Steroid	25	8.48	5.39	0.786
	Compressive	25	8.12	3.81	
Initial wound breadth (cm)	Steroid	25	3.12	1.72	0.627
	Compressive	25	2.92	1.12	
Raw area before treatment (cm^2)	Steroid	25	34.20	43.05	0.420
	Compressive	25	26.32	22.25	
Thickness before (cm)	Steroid	25	0.552	0.18	0.722
	Compressive	25	0.596	0.15	
VAS before	Steroid	25	6.24	1.09	0.230
	Compressive	25	6.60	1.00	

After 14 days of treatment, there was a significant reduction in wound size, thickness, and pain scores in both groups, with the topical steroid group showing superior outcomes. The mean wound length reduced to 3.2 ± 2.7 cm in the steroid group compared to 5.96 ± 2.9 cm in the compressive dressing group ($p = 0.001$). The raw wound area significantly reduced from 34.2 ± 43.1 cm^2 to 7.2 ± 7.6 cm^2 in the steroid group, compared to 26.3 ± 22.3 cm^2 to 17.2 ± 15.3 cm^2 in the compressive group ($p = 0.005$). Mean wound thickness and VAS pain scores were also significantly lower in the steroid group ($p < 0.05$). These findings highlight the anti-inflammatory and fibroblast-modulating effects of steroids, leading to faster wound remodeling (Table 2).

Table 2. Comparison of Wound Parameters After 14 Days

Parameter	Group	N	Mean	SD	P value
Length after 14 days (cm)	Steroid	25	3.20	2.69	0.001
	Compressive	25	5.96	2.88	
Breadth after 14 days (cm)	Steroid	25	1.64	1.11	0.004
	Compressive	25	2.60	1.15	
Raw area after 14 days (cm^2)	Steroid	25	7.20	7.64	0.005
	Compressive	25	17.24	15.34	
Thickness after 14 days (cm)	Steroid	25	0.172	0.12	<0.001
	Compressive	25	0.404	0.13	
VAS after	Steroid	25	2.40	1.08	0.011
	Compressive	25	3.12	0.83	

The mean time to complete epithelialization was significantly shorter in the topical steroid group (21.6 ± 7.4 days) compared to the compressive dressing group (32.7 ± 10.5 days, $p < 0.001$). Similarly, the mean number of hospital visits was lower among patients receiving topical steroids (5.5 ± 2.5) than those managed conservatively (9.7 ± 2.9, $p < 0.001$). No complications were reported in the steroid group, whereas four patients in the compressive dressing group required regrafting due to persistent raw areas. These findings indicate that topical steroid therapy not only hastened healing but also reduced hospital visits and prevented complications, improving cost-effectiveness and patient comfort (Table 3).

Table 3. Healing Outcome and Follow-Up Comparison

Parameter	Group	N	Mean	SD	P value
Total days taken to heal	Steroid	25	21.60	7.44	<0.001
	Compressive	25	32.68	10.47	
Total hospital visits	Steroid	25	5.52	2.49	<0.001
	Compressive	25	9.72	2.87	

Although both groups demonstrated clinical improvement, the magnitude of healing was greater in the steroid-treated wounds. The absolute reduction in raw area was 27.0 cm^2 in the steroid group compared to 9.1 cm^2 in the compressive group. VAS scores decreased by 3.8 points in the steroid group versus 3.5 in the compressive group.

Discussion

Hypergranulation is a common yet often under-recognized impediment in the wound healing process, particularly in burn patients. It represents an excessive proliferation of immature granulation tissue that extends above the wound surface and interferes with re-epithelialization. The underlying pathogenesis is multifactorial, involving persistent inflammation, infection, mechanical irritation, and excessive moisture. On a molecular level, an imbalance between matrix metalloproteinases (MMPs) and collagenase activity has been identified as a key driver of uncontrolled fibroblast proliferation and angiogenesis, resulting in exuberant tissue growth [1,2]. These enzymes play a central role in extracellular matrix remodeling, and their dysregulation contributes to delayed epithelialization and chronic wound formation [9,10].

Such exuberant granulation tissue not only delays healing but may also lead to hypertrophic scars and contractures if left untreated. Various therapeutic strategies have been attempted to manage hypergranulation, including sharp or surgical debridement, chemical cauterization with silver nitrate, laser ablation, topical antimicrobials, and foam or hydrocolloid dressings [3,4]. Although silver nitrate has historically been used for chemical cauterization, several studies have shown that it may cause local pain, necrosis of healthy tissue, and delayed epithelialization due to cytotoxic effects [11]. In contrast, compressive dressings are non-invasive and act by applying uniform pressure, thereby inducing localized ischemia, reducing exudation, and limiting angiogenesis [5]. However, the process is slow, requires frequent dressing changes, and may not effectively regress well-established hypergranulation [6,7].

In the present study, topical corticosteroids demonstrated superior outcomes compared to compressive dressings in terms of wound size reduction, thickness regression, pain control, and overall healing time. After 14 days of treatment, the mean wound surface area in the steroid group reduced significantly from 34.2 cm^2 to 7.2 cm^2, compared to 26.3 cm^2 to 17.2 cm^2 in the compressive group. Wound thickness and pain scores also improved more prominently in the steroid group ($p < 0.01$). The mean time taken for complete epithelialization was 21.6 ± 7.4 days in the steroid group versus 32.7 ± 10.5 days in the compressive group. Similarly, the average number of hospital visits was fewer (5.5 vs. 9.7). These findings establish that short-term topical steroid application not only accelerates epithelialization but also decreases hospital visits and dressing frequency, improving patient comfort and cost-effectiveness.

The beneficial effects of topical corticosteroids in hypergranulation control are attributed to their anti-inflammatory, anti-proliferative, and anti-angiogenic properties [6]. Steroids inhibit the production of inflammatory cytokines such

as interleukin-1 (IL-1), tumor necrosis factor-α (TNF-α), and vascular endothelial growth factor (VEGF), thereby reducing fibroblast activity and angiogenesis [7,12]. They also limit macrophage infiltration and myofibroblast differentiation, preventing contraction and hypertrophic granulation [13]. The significant reduction in wound thickness and vascularity observed in our study corroborates these molecular mechanisms.

Our findings are consistent with earlier reports. Lam et al. [2] observed complete regression of hypergranulation tissue within one to two weeks using topical hydrocortisone 1% with chloramphenicol, without any adverse reactions. Saleem et al. [5] demonstrated complete healing in 70% of burn patients within two weeks following short-term topical steroid therapy. Similarly, Margulies et al. (3) reported excellent outcomes using potent corticosteroids for pediatric burn wounds, highlighting their safety and efficacy. A systematic review by Mujahid et al. [14] confirmed that topical corticosteroids significantly accelerate hypergranulation regression compared to non-steroidal modalities, particularly in burns and trauma-related wounds. Jaeger et al. [4] also emphasized that short cycles of steroid application achieved faster flattening of granulation tissue compared to conservative pressure dressings alone.

Compressive dressings, though beneficial for exudative wounds, require prolonged use to show tangible improvement. In our study, 16% of patients in the compressive group required regrafting due to persistent raw areas, whereas no complications were observed in the steroid group. Similar results were noted by Shoham et al. [1], who reported that topical steroid application significantly reduced healing time in post-burn hypergranulation compared to conventional approaches.

Concerns regarding the adverse effects of topical corticosteroids, such as skin atrophy, telangiectasia, or secondary infections, are largely associated with prolonged or high-potency usage. When used short term and at appropriate potency, these complications are rare (8). In our study, no adverse events were observed during the two-week follow-up, confirming the safety of localized, time-limited steroid application.

Recent mechanistic evidence further supports the role of corticosteroids in regulating inflammatory mediators and growth factors that drive excessive granulation [12,13]. Institutional wound care guidelines now recommend short-term use of low- to moderate-potency topical steroids (hydrocortisone 1%, betamethasone 0.05–0.1%) in refractory hypergranulation, with close monitoring for infection or delayed healing [15,16]. These recommendations align with our findings, emphasizing the therapeutic value of topical corticosteroids as a safe, effective, and accessible option in burn wound management.

From a practical perspective, the regimen used in this study—daily application of betamethasone 0.1% with fusidic acid—offered several advantages, including ease of use, reduced pain during dressing changes, antimicrobial protection, and fewer hospital visits. The combination of anti-inflammatory and antibacterial action makes it particularly suitable for managing exudative post-graft wounds prone to infection.

Conclusion

The present study demonstrates that short-term topical steroid therapy is significantly more effective than compressive dressings in treating hypergranulation tissue after split-thickness skin grafting in burn patients. It provides faster epithelialization, better pain control, fewer complications, and improved patient compliance. Further multicentric randomized controlled trials with larger cohorts and longer follow-up are recommended to validate these findings and optimize steroid formulations, potency, and duration protocols for broader clinical use.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Knowledge, Attitude, and Practice of Mobile Health (mHealth) Among Healthcare Providers in Puducherry, India: A Facility-Based Cross-Sectional Study

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Abstract

Introduction: Mobile health (mHealth) promises to enhance healthcare delivery in resource-constrained settings, yet provider adoption remains suboptimal. This study assessed knowledge, attitudes, and practices (KAP) related to mHealth among healthcare providers in a tertiary care hospital in Puducherry, India. **Methods:** A cross-sectional survey was conducted from September to November 2024 among 410 randomly selected providers. A face-validated, semi-structured questionnaire captured demographics, digital device ownership, information-seeking behavior, and mHealth KAP. Descriptive statistics summarized responses; associations with awareness were analyzed using chi-square tests, with $p<0.05$ considered significant. **Results:** Universal smartphone ownership (100%) contrasted with low mHealth awareness (34.9%, 95% CI: 30.4%–39.6%) and minimal clinical use (16.1%, 95% CI: 12.9%–20.0%) of mHealth applications. While 82.0% (95% CI: 77.9%–85.4%) were willing to use mHealth, only 13.4% (95% CI: 10.5%–17.1%) had prescribed apps to patients. Medical (OR: 2.89, p=0.004) and dental (OR: 3.66, p=0.002) professionals exhibited higher awareness than pharmacists. Computer/laptop ownership (OR: 4.02, $p<0.0001$), combined mobile data and Wi-Fi access (OR: 3.78, $p<0.001$), and frequent health information seeking (OR: 42.73, p=0.0028) were strong predictors of awareness. Colleagues served as the primary information source (69.2%). **Conclusion:** Targeted digital literacy programs, institutional support, and streamlined integration of mHealth into clinical workflows are essential to bridge the gap between willingness and practice in resource-limited settings.

Keywords: mHealth, digital health, Health care workers, Telemedicine, Digital literacy

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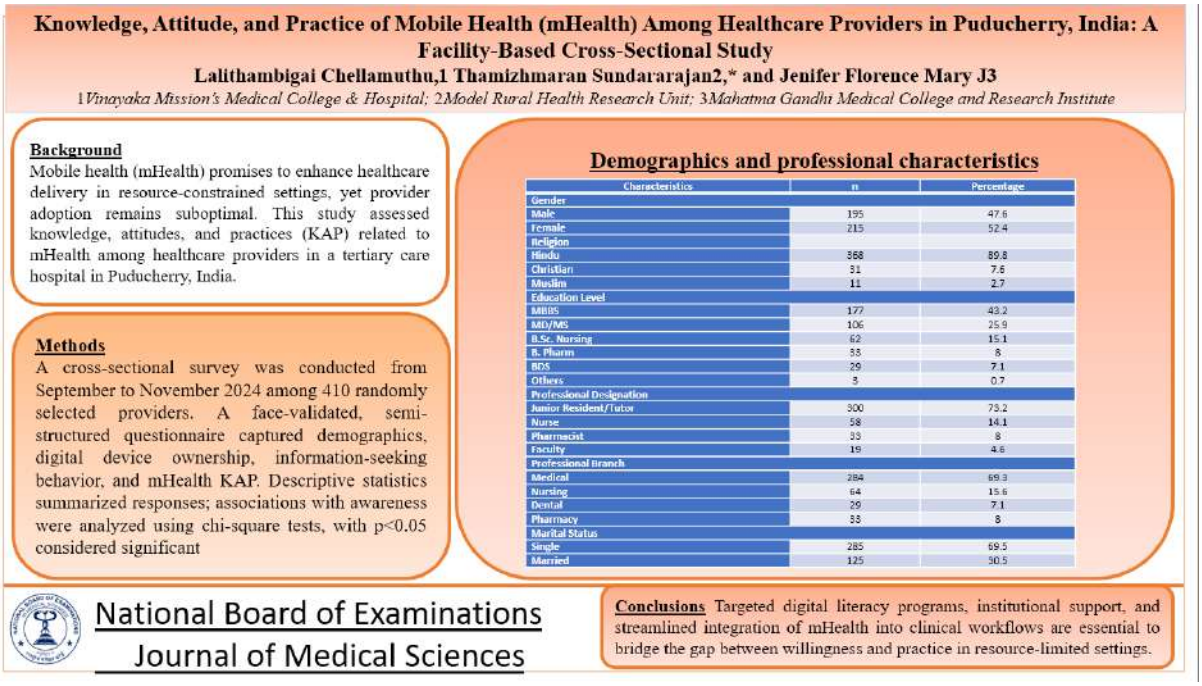
Graphical Abstract



Introduction

The global healthcare landscape is undergoing unprecedented digital transformation, with mobile health (mHealth) emerging as a cornerstone of modern healthcare delivery systems. Defined by the World Health Organization as "the practice of medicine and public health supported by mobile devices," mHealth encompasses a broad spectrum of technologies including smartphones, wearable devices, and health applications that facilitate healthcare information exchange, remote monitoring, and clinical decision support [1,2]. The global mHealth market, valued at $17.92 billion in 2019, is projected to expand at a compound annual growth rate of 45% through 2027, reflecting its increasing integration into healthcare systems worldwide [3]. Healthcare providers play a pivotal role in mHealth adoption and implementation, serving as key intermediaries between digital health technologies and patient care delivery.

However, substantial barriers persist in healthcare professional adoption of mHealth solutions, particularly in resource-limited settings. Systematic reviews have identified technological, individual, and organizational factors as primary determinants influencing healthcare provider acceptance of mobile health technologies. Key barriers include inadequate technical infrastructure, privacy and security concerns, limited digital literacy, time constraints, and insufficient organizational support [4,5]. In India, the government's Ayushman Bharat Digital Mission (ABDM), launched in 2021, represents a landmark initiative to create an integrated digital health ecosystem supporting universal health coverage. Despite registering over 400 million beneficiaries and 190,000 healthcare professionals by 2023, significant implementation gaps remain, particularly regarding healthcare provider engagement and adoption patterns [6]. Knowledge,

attitude, and practice (KAP) studies provide essential insights into healthcare provider readiness for digital health integration, informing targeted interventions to enhance adoption rates. Understanding healthcare providers' mHealth KAP is crucial for successful digital health transformation, particularly in developing countries where infrastructure challenges and resource constraints may impede implementation [7,8]. While several studies have examined mHealth adoption globally, significant knowledge gaps remain regarding healthcare provider readiness in Indian Union Territories, particularly within the Ayushman Bharat Digital Mission (ABDM) framework. This study assessed mHealth knowledge, attitudes, and practices among healthcare providers in Puducherry, India, contributing evidence to optimize digital health strategies in similar resource-constrained settings.

Methodology

A Facility-based analytical cross-sectional study was conducted at a health care facility in Puducherry, India, over three months (September–November 2024), among the healthcare providers, who were employed at the study site during the study period were eligible, and willingness to participate and provision of written informed consent were included in the study and those uncontactable after three departmental visits were excluded. Using a simple random sampling approach, 393 participants were targeted based on the World Health Organization's sample size formula ($n= Z^2_{1-\alpha/2}\ pq/d^2$), considering that 58.5% of healthcare providers would recommend m-health, and assuming a 95% CI, and absolute precision of 5%, adjusted for 5% nonresponse. The study involved a stratified random sampling approach. Healthcare Worker Selection required stratification by professional branch (Medical, Dental, Nursing, Pharmacy), utilizing simple random sampling within these categories.

A pre-tested, semi-structured, face-validated questionnaire—developed through literature review and expert consultation—captured demographics, digital device ownership, information-seeking behaviour, and mHealth KAP. The instrument was pilot-tested among 20 healthcare providers outside the study population and refined for clarity and content validity.

Primary outcomes included awareness of mHealth applications, attitudes toward their use in patient management, and self-reported usage for clinical care. Digital device ownership, information sources, and frequency of health information seeking were recorded as explanatory variables. Data integrity and participant confidentiality were rigorously maintained throughout the study.

Questionnaires were assigned unique identifiers and direct personal identifiers were stored separately from the research data. All electronic data were secured on encrypted, password-protected drives with access restricted exclusively to the core research team based on role-based access protocols. Following entry and validation, a fully de-identified analysis dataset was created for all subsequent statistical procedures.

Data were entered into Microsoft Excel 2021 and analysed using R software (ver. 4.3.2) Descriptive statistics summarized categorical variables as counts and percentages. Continuous variables were reported as means ± standard deviation. Associations between categorical variables and mHealth awareness were examined

using Chi-square or Fisher's exact tests as appropriate. A p-value <0.05 was considered statistically significant.

The Institutional Ethics Committee approved the study protocol. Participants received information on study objectives, and confidentiality was assured. Written informed consent was obtained prior to participation, and data were anonymized during analysis. Continuous monitoring and regular data audits ensured adherence to the study protocol and minimized measurement bias.

Results

The study successfully recruited 410 healthcare providers achieving the target sample size with universal smartphone ownership among participants.

Participant Characteristics

The mean age of the study population was 27 years (±4.79 SD). The cohort was nearly balanced in terms of gender, comprising 52.4% females and 47.6% males. The cohort was predominantly composed of medical practitioners, with junior residents and tutors constituting the largest group (73.2%). A significant portion of the participants held an MBBS degree (43.2%), followed by MD specialists (21.0%) and B.Sc. Nursing graduates (15.1%). The demographic and professional details are provided in Table 1.

Table 1. Demographics and professional characteristics

Characteristics	n	Percentage
Gender		
Male	195	47.6
Female	215	52.4
Religion		
Hindu	368	89.8
Christian	31	7.6
Muslim	11	2.7
Education Level		
MBBS	177	43.2
MD/MS	106	25.9
B.Sc. Nursing	62	15.1
B. Pharm	33	8
BDS	29	7.1
Others	3	0.7
Professional Designation		
Junior Resident/Tutor	300	73.2
Nurse	58	14.1
Pharmacist	33	8
Faculty	19	4.6
Professional Branch		
Medical	284	69.3

Nursing	64	15.6
Dental	29	7.1
Pharmacy	33	8
Marital Status		
Single	285	69.5
Married	125	30.5

Digital Technology Adoption and Information-Seeking Behaviour

All participants were found to own a smartphone, demonstrating 100% mobile device penetration among the healthcare providers surveyed. A significant majority of participants had extensive mobile usage experience, with the primary means of internet access being mobile data, either alone or in combination with Wi-Fi. A high frequency of mobile phone use for seeking health information was reported, with internet search engines, books and pamphlets, and online medical forums being the most frequently accessed channels. Further details on the digital technology ownership, mobile usage patterns, and health information-seeking behaviours are provided in Table 2.

Table 2. Digital Technology Adoption and Information-Seeking Behavior

Variable	n	Percentage
Digital Device Ownership		
Smartphone	410	100
Computer/Laptop	224	54.6
Smart Watch	129	31.5
iPad/Tablet	182	44.4
Mobile Phone Usage Duration		
> 5 years	153	37.3
5-10 years	166	40.5
> 10 years	91	22.2
Internet Access Method		
Mobile data only	212	51.7
Both mobile data and Wi-Fi	185	45.1
Wi-Fi only	13	3.2
Health Information Seeking Frequency		
High	244	59.5
Low	161	39.3
Never	5	1.2
Information Channels Used		
Internet search engines	303	73.9
Books/Information pamphlets	255	62.2
Online medical forums	192	46.8
Social networking sites	184	44.9
Media	173	42.2

mHealth Knowledge Assessment

More than one third (34.88, n= 143, 95% CI: 30.4%-39.6%) of surveyed healthcare providers were aware of mHealth applications. Among this group, knowledge varied in depth, with 63.6% aware of free apps, 49.0% of paid apps, and 56.6% familiar with Government of India-approved applications. The primary source of this information was colleagues (69.2%), followed by media (42.7%) and scientific sessions (15.4%). The most recognized application area was health promotion (68.5%), followed by health service delivery (56.6%) and human resources (24.5%).

Attitudes Toward mHealth Integration

A significant majority, 82.0% (95% CI: 77.9%-85.4%), were willing to use mobile devices for patient management. Similarly, 74.6% (95% CI: 70.1%-78.7%) agreed that mobile devices could be utilized for transmitting symptom data, which could potentially reduce the need for in-person hospital visits. Notably, only a small percentage, 28.5% (95% CI: 24.3%-33.1%), supported patients using these devices for self-diagnosis without professional oversight, indicating a prudent and professionally cautious approach to clinical care.

mHealth Practice Implementation

Within the last year, only 16.1% (95% CI: 12.9%-20.0%) of providers had used mHealth in their patient care, and a smaller percentage, 13.4% (95% CI: 10.5%-17.1%), had prescribed mHealth applications to patients. Of the providers who did use mHealth, over half (51.5%) engaged with the applications at least once daily, with an additional 16.7% using them multiple times a day. Usage patterns were dominated by health promotion activities (81.8%), while other applications, such as health service delivery (27.3%) and human resources (9.1%), saw minimal adoption.

Findings from the bivariate analysis indicated that several factors significantly influence mHealth awareness (***Table 3***). Notably, professionals in the Medical and Dental branches were significantly more aware of mHealth than those in Pharmacy, with odds ratios of 2.89 ($p=0.004$) and 3.66 ($p=0.002$) respectively. Similarly, individuals with senior designations, specifically Assistant/Associate Professors (OR: 7.71, $p=0.001$) and Junior Residents/Tutors (OR: 4.27, $p<0.001$), showed a much higher awareness compared to pharmacists.

Digital device ownership also played a crucial role, with those owning computers/laptops (OR: 4.02, $p<0.0001$) and smartwatches (OR: 2.18, $p=0.0004$) being significantly more aware of mHealth. Furthermore, access to the internet via both mobile data and Wi-Fi (OR: 3.78, $p<0.001$) and a high frequency of using mobile phones for health information (OR: 42.73, $p=0.0028$) were strong predictors of awareness. The use of certain channels for health information, such as Internet search engines (OR: 4.92, $p<0.001$) and online medical forums (OR: 1.54, $p=0.0372$), also correlated with higher mHealth awareness.

Table 3. Factors associated with the mHealth awareness among the study population

Variable	mHealth Awareness		OR (95% CI)	p-value
	Yes n (%)	No n (%)		
Gender				
Female	79 (36.74)	136 (63.26)	1.19 (0.79-1.79)	0.4051
Male	64 (32.82)	131 (67.18)		
Branch				
Medical	111 (39.08)	173 (60.92)	2.89 (1.16-7.21)	0.004
Dental	13 (44.83)	16 (53.17)	3.66 (1.16-11.52)	
Nursing	13 (20.31)	51 (79.69)	1.3 (0.44-3.82)	
Pharmacy	6 (18.18)	27 (81.82)	1	
Designation				
Asst./Asso. Professor	12 (63.16)	7 (36.84)	7.71 (2.13-27.88)	0.001
JR/Tutor	112 (37.33)	188 (62.67)	4.27 (1.70-10.73)	
Nurse	13 (22.41)	45 (77.59)	1.3 (0.44-3.82)	
Pharmacist	6 (18.18)	27 (81.82)	1	
Digital Device Ownership				
Computers/laptops				
Yes	108 (48.21)	116 (51.79)	4.02 (2.56-6.31)	<0.0001
No	35 (18.82)	151 (81.18)		
Smart watch				
Yes	61 (47.29)	68 (52.71)	2.18 (1.42-3.35)	0.0004
No	82 (29.18)	199 (70.82)		
Ipad/Tablets				
Yes	63 (34.62)	119 (65.38)	0.9794 (0.65-1.47)	0.9206
No	80 (35.09)	148 (64.91)		
Duration of mobile phone usage				
>10 years	34 (37.36)	57 (62.64)	1.19 (0.69-2.05)	0.8153
5-10 years	58 (34.94)	108 (65.06)	1.07 (0.68-1.71)	
>5 years	51 (33.33)	102 (66.67)		
Internet access				
Both	92 (49.73)	93 (50.27)	3.78 (2.43-5.86)	<0.001
Wifi	7 (53.85)	6 (46.15)	4.46 (1.43-13.92)	
Mobile data	44 (20.75)	168 (79.25)	1	
Frequency of mobile phone usage for health information				
High	101 (41.39)	143 (58.61)	42.73 (10.33-176.8)	0.0028
Low	40 (24.84)	3 (60)		

Never	2 (40)	121 (75.16)	1	
Channels of Health care information				
Internet search engines				
Yes	129 (42.57)	174 (57.43)	4.92 (2.69-9.03)	<0.001
No	14 (13.08)	93 (86.92)		
Social Networking sites				
Yes	67 (36.14)	117 (63.59)	1.13 (0.75-1.70)	0.5562
No	76 (33.63)	150 (66.37)		
Online medical forum				
Yes	77 (40.1)	115 (59.9)	1.54 (1.03-2.32)	0.0372
No	66 (30.28)	152 (69.72)		
Books/pamphlets				
Yes	100 (39.22)	155 (60.78)	1.68 (1.09-2.59)	0.0181
No	43 (27.74)	112 (72.26)		
Media				
Yes	77 (44.51)	96 (55.49)	2.08 (1.38-3.14)	0.0005
No	66 (27.85)	171 (72.15)		
Willing to use mHealth in the management of patients				
Yes	127 (37.8)	209 (62.2)	2.203 (1.21-3.1)	0.0082
No	16 (21.62)	58 (78.38)		
Mobile devices can be used in sending data to doctors about certain physical symptoms in place of direct hospital visits				
Yes	106 (34.64)	200 (65.36)	0.960 (0.60-1.53)	0.8626
No	37 (35.58)	67 (64.42)		
Used mHealth in past 12 months for patient care				
Yes	35 (53.03)	31 (46.97)	2.47 (1.45-4.21)	0.0007
No	108 (31.40)	236 (68.6)		
Prescribed mHealth applications for the patients				
Yes	21 (38.18)	34 (61.82)	1.258 (0.70-2.27)	0.4454
No	109 (32.93)	222 (67.07)		
Self-usage of mHealth applications in past 1 year				
Yes	30 (81.08)	7 (18.92)	10.78 (4.85-25.35)	<0.0001
No	99 (28.45)	249 (71.55)		
Chi-square test was applied				

Discussion

The study's finding that only 34.88% of healthcare providers were aware of mHealth applications aligns with the existing literature from developing countries. This suggests that the study's population, despite positive attitudes, mirrors a broader trend of limited mHealth literacy in resource-constrained settings, where awareness levels typically remain below 40%. The finding is also consistent with the results of a systematic review by Kasaye et al. [9], who reported a pooled digital health literacy rate of 56.0% among health professionals, which, while higher than this study's findings, still indicates a significant portion of the workforce lacks such literacy.

However, the study's results contrast sharply with findings from more developed nations, where awareness is substantially higher. The low awareness rate is particularly striking when juxtaposed with the 100% smartphone ownership among the study's participants. This highlights a critical and consistent gap observed in developing countries: the widespread availability of digital devices does not automatically translate to an equivalent level of knowledge and adoption of mHealth technologies. This finding is further supported by Walle A et al.'s research, which found that despite a high number of participants, only 43.4% of respondents had a favorable attitude toward mHealth technology, reinforcing the idea that device access and positive attitudes do not always lead to high awareness and usage [7].

In comparison, studies such as the one by Wubante et al. [8], which reported that 65.7% of participants had good knowledge and 55.5% had favorable attitudes toward e-PHR systems, provide a clear benchmark from a different context. The high knowledge and attitude scores in that study underscore a stark difference from the current study's findings and emphasize the need for targeted interventions to bridge the knowledge gap.

The finding that 100% of healthcare providers in this study own smartphones is a significant result, surpassing most reported rates in global healthcare literature. This rate aligns with the high ownership levels found in developed countries but exceeds the 85-95% typically reported in developing nations [10,11]. This high adoption rate highlights the rapid digital transformation occurring in urban healthcare facilities in India and is consistent with the country's broader digital health initiatives under the Ayushman Bharat Digital Mission [12,13].

The study revealed significant disparities in mHealth awareness across professional branches, with medical and dental professionals showing 2.89- and 3.66-times higher awareness respectively compared to pharmacy professionals. This finding is consistent with global literature demonstrating that medical professionals typically have higher digital health literacy compared to allied health professionals [10,14].

Similar patterns have been reported in studies by Shekoni et al. [15], and Walle et al.[7] where physicians consistently showed higher mHealth adoption rates compared to nurses and pharmacists. The educational differences between professional programs may explain these disparities, as medical curricula increasingly incorporate digital health components [16,17].

The study identified computer/laptop ownership as a significant predictor of mHealth awareness (OR: 4.02),

supporting findings from Addotey-Delove et al. [18] showed that healthcare providers with computer access were more likely to have adequate digital literacy, while studies had reported similar associations between computer ownership and digital health acceptance. This finding reinforces the importance of digital infrastructure in healthcare settings, as highlighted by systematic reviews identifying technological access as a primary determinant of mHealth adoption [4,17].

The study found that 69.2% of mHealth-aware providers obtained information from colleagues, which aligns with established patterns in healthcare technology adoption literature. Peer influence has been consistently identified as a crucial factor in technology acceptance among healthcare professionals [19]. This finding supports the diffusion of innovation theory, where interpersonal networks play critical roles in technology adoption [20].

This also indicated the absence of systematic training programs

Despite 82% of providers expressing willingness to use mHealth for patient management, only 16.1% had actually used mHealth in clinical practice within the past year. This substantial intention-behavior gap is well-documented in mHealth literature globally.

Similar gaps have been reported in systematic reviews, with studies consistently showing that positive attitudes toward mHealth don't necessarily translate to actual usage. Research from rural US healthcare systems reported comparable patterns, with high acceptance rates but limited implementation. Barriers contributing to this gap include time constraints, integration challenges, and lack of institutional support.

The Puducherry study reveals a striking disparity in India's healthcare digital transformation: while 82% of healthcare providers expressed willingness to use mHealth for patient management, only 16.1% had actually implemented it in clinical practice. This substantial intention-behavior gap of approximately 66 percentage points represents one of the most significant implementation challenges facing India's digital health initiatives.

This finding reflects a broader pattern observed across India's healthcare system, where the Ayushman Bharat Digital Mission (ABDM) has registered over 190,000 healthcare professionals but continues to face significant engagement gaps. Similar intention-practice disparities have been documented in other Indian healthcare digitization efforts, where positive attitudes toward digital health technologies don't translate into sustained usage patterns.

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technologies don't translate into sustained usage patterns [21,22].

A systematic review by Sharma et al had documented low digital literacy among healthcare providers as the most common human resource-related barrier, affecting implementation across multiple states. The Government of India's Digital India campaign has initiated training workshops, but coverage remains insufficient for the vast healthcare workforce [21]. The "Kerala model" for implementing the ABDM offers a promising approach through its localized strategy by developing user manuals in local language and establishing coordinated training committees at both the state and district levels [23].

The evidence from the current study suggests a multifaceted approach to enhance digital health adoption, which includes integrating competency-based digital health training into medical and nursing curricula and establishing peer-to-peer learning networks. Further, the low current usage rates, a quality assurance and monitoring framework to track adoption rates, analyze patient outcomes, and gather provider feedback to ensure the program's long-term effectiveness.

The study's primary strengths include a large and representative sample size, which enhances the statistical power and generalizability of the findings within a tertiary care setting. The use of a pre-tested, face-validated questionnaire and the inclusion of diverse professional branches further strengthen the data quality and allow for comprehensive subgroup analyses. However, this exploratory cross-sectional survey was designed to establish baseline mHealth KAP metrics across multiple care levels in Puducherry and did not prespecify multivariable modelling or full psychometric validation. Future studies should incorporate comprehensive predictor variables and formal instrument validation to enable adjusted analyses and improve measurement precision

Conclusion

Despite universal smartphone ownership and high willingness to integrate mHealth into patient management, actual clinical use among Puducherry healthcare providers remains remarkably low. Key predictors of awareness include device ownership, internet access, and professional designation. Bridging the gap between provider willingness and effective mHealth practice in resource-limited Indian settings requires addressing training, infrastructure, and organizational deficits. This necessitates a comprehensive strategy, including the integration of competency-based mHealth and digital literacy modules into both undergraduate and in-service training. Furthermore, institutional adoption must be aligned with national standards, such as the ABDM framework and registries. Key supportive measures include conducting periodic digital literacy audits and maturity assessments, prioritizing access to workstations/laptops, and establishing peer-led learning networks to maximize colleague influence and sustain practice change

Statements and Declarations

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Conflict of interest

The authors declare no competing interests.

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ORIGINAL ARTICLE

Clinical Evaluation of LMA Gastro™ in Upper Gastrointestinal Procedural Endoscopy: A Prospective Observational Study

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Abstract

Introduction: Upper gastrointestinal endoscopy requires effective airway management to ensure patient safety, procedural ease, and hemodynamic stability. The LMA Gastro™, is a second-generation device with a dual channel for simultaneous ventilation and gastric access. This study aimed to evaluate its clinical performance, hemodynamic response, recovery profile, and complication rates in participants undergoing upper GI endoscopy under general anesthesia. **Materials and Methods:** A prospective observational study was conducted at a tertiary care hospital after obtaining ethical clearance (Ref. No: GEMREC01012022). One hundred adult participants (ASA I–III) scheduled for elective upper GI endoscopy under general anesthesia using LMA Gastro™ were included. Standard monitoring was applied, and hemodynamic parameters (pulse rate, systolic and diastolic pressures, SpO_2) were recorded at predefined intervals. Procedure duration, recovery time, postoperative complications, and endoscopist satisfaction were noted. Data were analyzed using SPSS v27, applying Friedman, Chi-square, and non-parametric tests, with $p < 0.05$ considered significant. **Results:** The mean age of participants was 56.15 ± 16.16 years. Successful LMA insertion was achieved on the first attempt in 90% of participants. Significant but clinically acceptable reductions were noted in pulse rate, SBP, and DBP intraoperatively ($p < 0.001$), while SpO_2 remained stable (>99%). The mean procedure duration was 32.25 ± 17.66 min, and recovery time averaged 9.78 ± 2.41 min. Complications were minimal (12.9%), with sore throat being most common. Endoscopist satisfaction was high (median 4, IQR 4–5). **Conclusion:** LMA Gastro™ provides a secure airway with stable hemodynamics, rapid recovery, and minimal complications, making it a safe and efficient option for upper GI endoscopy.

Keywords: LMA Gastro, Endoscopy, Airway Management, Hemodynamic Stability, Supraglottic Device

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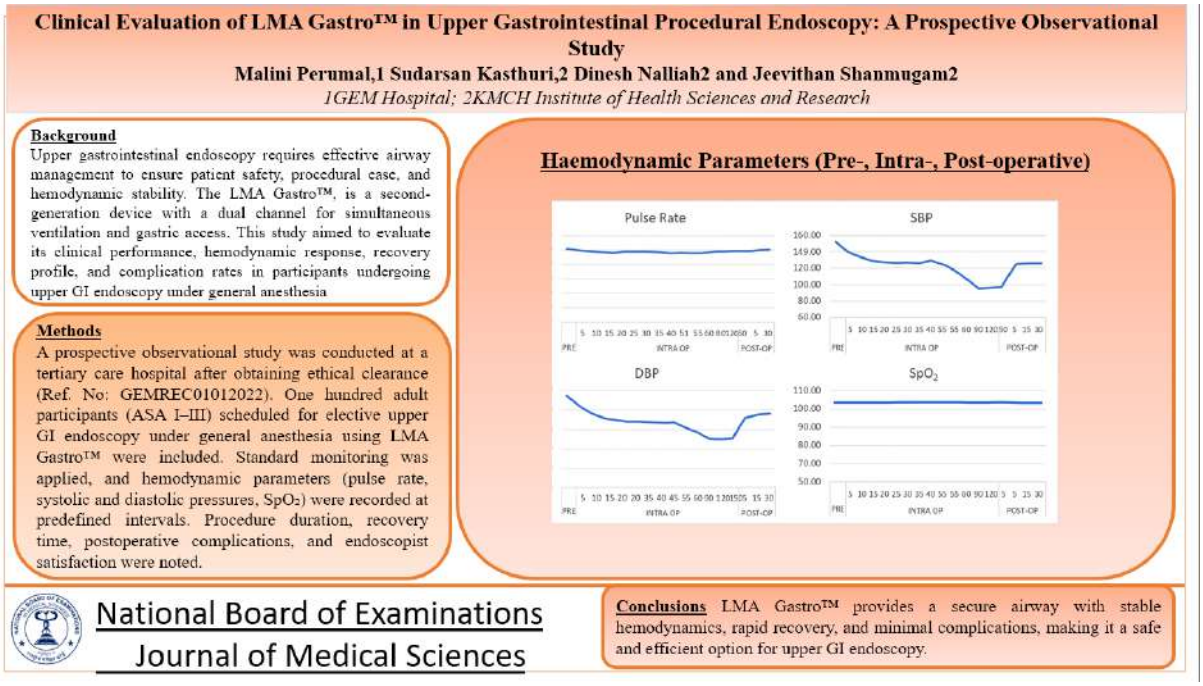
Graphical Abstract



Introduction

Upper gastrointestinal (GI) endoscopic procedures are commonly performed for both diagnostic and therapeutic purposes. Sedation and airway management are critical components of these procedures, as they influence patient safety, procedural efficiency, and operator satisfaction. Conventional airway control during upper GI endoscopy often relies on conscious sedation with supplemental oxygen. However, sedation-induced respiratory depression, hypoxia, and loss of airway tone can lead to serious complications, especially in participants with comorbidities or prolonged procedures [1,2].

The advent of supraglottic airway devices (SADs) has revolutionized anesthesia practice by providing a safe and effective alternative to endotracheal intubation. Among these, the Laryngeal Mask Airway (LMA) has become a cornerstone device for elective procedures, owing to its ease of insertion, reduced hemodynamic response, and minimal postoperative discomfort compared to endotracheal tubes [3,4]. The LMA Gastro™, is a second-generation device with a dual channel for simultaneous ventilation and gastric access. It features an integrated endoscope channel, allowing continuous airway maintenance and unimpeded endoscopic access simultaneously [5].

Several studies have demonstrated that LMA Gastro enables secure ventilation while permitting endoscopist maneuverability during upper GI procedures [5,6]. It minimizes hypoxemic events, improves operator visibility, and provides better control of airway patency than traditional nasal cannula or oropharyngeal airways [7]. In addition, the use of LMA Gastro reduces sympathetic stimulation during insertion compared with laryngoscopy and intubation, leading to greater hemodynamic stability — a key consideration in high-risk populations [8].

Despite these advantages, real-world evidence regarding its clinical performance in terms of ease of insertion, hemodynamic changes, complications, and procedural satisfaction remains limited, particularly in routine diagnostic and therapeutic endoscopy. Most available literature has focused on small sample sizes or simulation-based trials, highlighting the need for larger observational datasets [9,10].

In this context, the present prospective observational study was conducted to evaluate the clinical performance of LMA Gastro during upper GI endoscopy in adult participants. The study aimed to analyze insertion characteristics, hemodynamic trends, recovery parameters, and complication rates. It also explored operator satisfaction and associations between ASA classification, number of airway attempts, and complication incidence.

Materials and Methods

This prospective observational study was conducted in the Department of Anaesthesiology in collaboration with the Department of Gastroenterology at a tertiary care hospital. The study was carried out over a period of six months after obtaining approval from the Institutional Human Ethics Committee (Ref. No: GEMREC01012022). The study adhered to the ethical principles outlined in the Declaration of Helsinki and the Indian Council of Medical Research (ICMR) National Ethical Guidelines (2017).

Before enrolment, each participant received a clear explanation of the purpose and procedure of the study in their own language, and written informed consent was obtained. Confidentiality of patient details was ensured throughout data collection and analysis. Participation was voluntary, and no additional intervention or risk was introduced beyond routine anesthetic management.

Participants aged between 18 and 80 years belonging to ASA physical status I–III and undergoing diagnostic or therapeutic upper gastrointestinal endoscopy under general anesthesia with LMA Gastro™ were included. Those with anticipated difficult airway, restricted mouth opening (<2.5 cm), upper airway pathology, increased risk of aspiration, emergency cases, ASA IV and V categories, or pregnant and lactating women were excluded from the study.

All participants underwent avthorough pre-anesthetic assessment including detailed history, airway examination, and routine investigations. Standard fasting guidelines were followed. After securing intravenous access, baseline parameters such as pulse rate, systolic and diastolic blood pressure, and oxygen saturation (SpO_2) were recorded. Continuous monitoring with electrocardiography, non-invasive blood pressure, and pulse oximetry was used throughout the procedure.

Anesthesia was induced with propofol (2–2.5 mg/kg) and fentanyl (1–2 µg/kg) intravenously. Once adequate depth of anesthesia and jaw relaxation were achieved, an appropriately sized LMA Gastro™ (size 3 or 4) was inserted and its position confirmed by chest rise and capnographic waveform. The cuff was inflated and secured, allowing the endoscope to be passed through the integrated channel without airway compromise. Maintenance of anesthesia was achieved with a mixture of oxygen and air along with sevoflurane (1–2%). Muscle relaxants were not used. Hemodynamic

parameters including PR, SBP, DBP, and SpO_2 were recorded at baseline, 5 minutes after insertion, 15 minutes intraoperatively, and 5 minutes post-procedure.

At the end of the procedure, sevoflurane was discontinued, and participants were allowed to breathe spontaneously. The device was removed after the return of protective airway reflexes and adequate spontaneous ventilation. The recovery time was noted from the removal of the airway device to the time the patient obeyed verbal commands. Post-procedural monitoring was continued in the recovery room, and participants were observed for complications such as sore throat, laryngospasm, bleeding, and airway events. The endoscopist's satisfaction regarding ease of procedure and visualization was rated using a 5-point Likert scale (1–5).

All study-related parameters including demographic data, ASA grade, airway characteristics, hemodynamic readings, duration of procedure, recovery time, and postoperative outcomes were entered in a structured proforma designed for the study. Data accuracy was verified by the principal investigator. Statistical analysis was performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Quantitative data were expressed as mean ± standard deviation (SD), and categorical data as frequency and percentage. Changes in hemodynamic parameters at different time intervals were compared using the Friedman test. The association between ASA grade or number of LMA attempts and postoperative complications was analyzed using the Chi-square test. Spearman's correlation was applied to examine the relationship between procedure duration and recovery time. Comparison of satisfaction scores between participants with and without complications was made using the Mann–Whitney U test. A p-value < 0.05 was considered statistically significant

Results

The study population had a mean age of approximately 56 years, indicating inclusion of both middle-aged and elderly participants. Males constituted nearly two-thirds of the participants, reflecting a slight male predominance. The majority of participants were classified under ASA II, suggesting that most belonged to the moderate-risk category, while only a small proportion were ASA III, denoting higher anesthetic risk. The average body mass index fell within the normal to overweight range, signifying a representative clinical distribution without extremes of obesity or undernutrition (Table 1).

Table 1. Demographics & Baseline Characteristics

Variable	**Value**
Mean Age (years)	56.15 ± 16.16
Sex	
Male	64 (63.4%)
Female	36 (35.6%)
ASA Classification	
ASA I	31 (30.7%)
ASA II	52 (51.5%)
ASA III	17 (16.8%)
Mean BMI (kg/m^2)	24.75 ± 4.55

Insertion of the LMA was successful on the first attempt in 90% of cases, with only a minimal proportion requiring multiple attempts or conversion, demonstrating excellent ease of placement and airway control. Endoscopy completion rates were high, with the majority accomplished in a single attempt, and only a few procedures requiring repetition or being cancelled. The commonly used LMA size was 3, followed by size 4, aligning with expected adult airway dimensions. The mean procedure duration was around 32 minutes, while recovery averaged under 10 minutes, reflecting short anesthetic exposure and quick emergence. The endoscopist's median satisfaction score of 4 (IQR 4–5) indicated overall favorable procedural conditions and airway stability (Table 2).

Table 2. Airway Management & Procedural Outcomes

Variable	**Value**
LMA Attempts	
1	90 (90%)
2	7 (7%)
3	1 (1.0%)
Failed	2(2.0%)
Endoscopy attempts:	
1	86 (86%)
2	7 (7%)
3	3(3%)
Cancelled	3(3%)
LMA size	
3	59 (59.0%)
4	41 (41.0%)
Procedure duration (min)	32.25 ± 17.66
Recovery time (min)	9.78 ± 2.41
Endoscopist satisfaction (Likert, median [IQR])	4.0 [IQR 4.0–5.0]

Haemodynamic trends revealed a significant yet clinically acceptable decline in pulse rate, systolic, and diastolic blood pressures following induction and during the intraoperative phase, with gradual return toward baseline in the postoperative period. These reductions were statistically significant but remained within physiologic limits, indicating stable cardiovascular dynamics under anesthesia. Oxygen saturation was consistently maintained above 99% throughout all stages, demonstrating effective oxygenation and ventilation without hypoxic episodes. Overall, the monitored parameters confirmed adequate anesthetic depth and safety during the procedure (Figure 1).

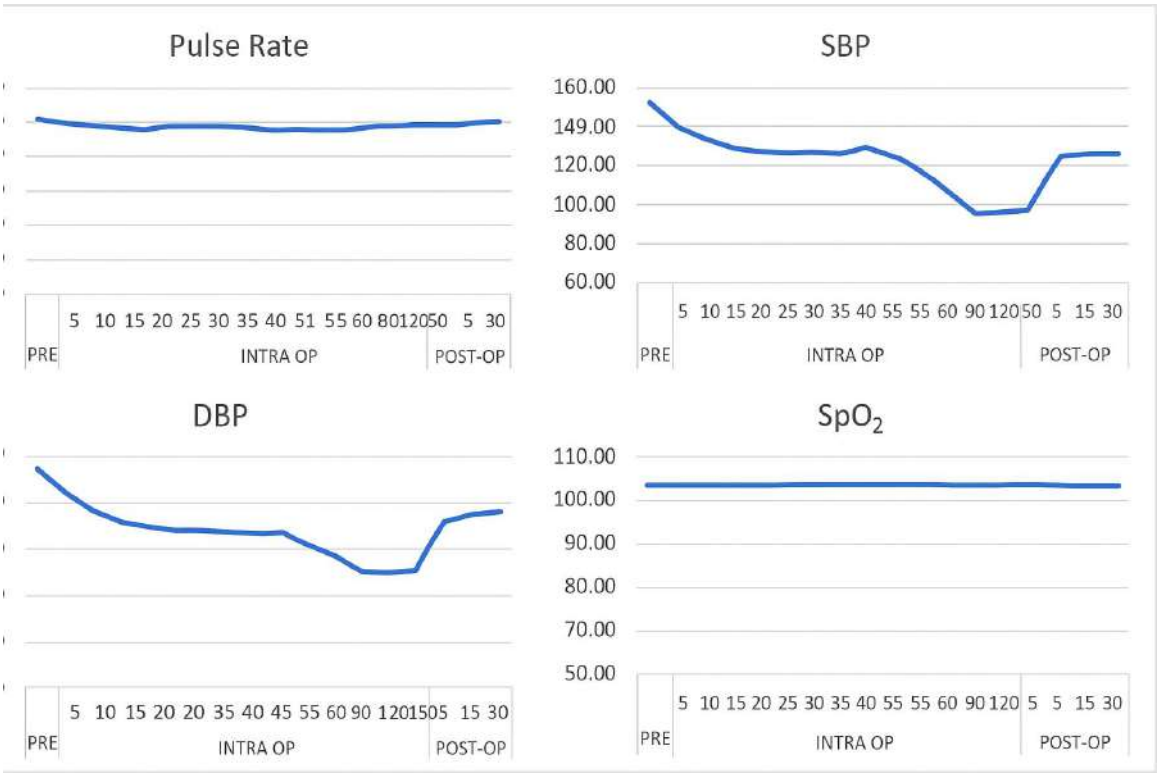


Figure 1. Haemodynamic Parameters (Pre-, Intra-, Post-operative)

The postoperative complication rate was low, with sore throat being the most common minor event (61.6%), followed by rare instances of laryngospasm and bleeding, and no airway-related emergencies. The overall complication incidence was limited to 13%, emphasizing the safety of LMA use in endoscopic procedures. Participants were mobilized within approximately two hours and resumed oral intake by four hours on average, confirming early recovery. Most participants were discharged on postoperative day 1, with very few requiring prolonged observation, indicating excellent recovery kinetics (Table 3).

Table 3. Recovery & Complications

Outcome	**Value**
Complications	
Sore throat	8 (61.6%)
Laryngospasm	2 (15.3%)
Bleed	3 (23.1%)
Any complication	13 (13%)
Discharge	
Discharge POD 1	80
POD 2	5
POD 3	6
POD 4	1
Mean time for Mobilization (hr)	2.36 ± 0.51
Mean duration for Oral intake (hr)	4.39 ± 0.70

Analysis of repeated measures demonstrated statistically significant reductions in pulse rate, systolic, and diastolic pressures during the intraoperative phase compared with preoperative values ($p < 0.001$), reflecting expected anesthetic effects. However, these changes remained clinically stable and returned toward baseline by the postoperative period. Oxygen saturation did not vary significantly across time points ($p > 0.05$), confirming maintenance of adequate oxygenation. Overall, these findings highlight hemodynamic stability under LMA anesthesia.

No statistically significant associations were observed between ASA grade and complication rate, although a trend toward higher events in ASA III participants was noted. Similarly, complications tended to be more frequent when LMA insertion required multiple attempts (≥2), yet the difference did not reach statistical significance.

Discussion

The present study evaluated the clinical performance, hemodynamic profile, recovery parameters, and complication rates associated with the use of LMA Gastro™ during upper gastrointestinal endoscopy. The findings indicate that this device provided a secure airway with minimal complications, stable hemodynamics, and high endoscopist satisfaction, demonstrating its suitability as a safe alternative to conventional methods of airway management for diagnostic and therapeutic endoscopic procedures.

In the present study, the mean age of the study population was 56.15 years, with a slight male predominance. This demographic trend is comparable to earlier endoscopy-based studies, where middle-aged adults formed the predominant group [1,2]. Most participants were classified as ASA II, reflecting moderate anesthetic risk, similar to previous observational trials using LMA devices.[4]

The LMA Gastro™ was inserted successfully on the first attempt in 90% of cases, which is consistent with the results other studies [5,6]. The device's design, including an integrated endoscope channel and separate airway lumen, facilitates easy insertion and simultaneous endoscope access. The few cases requiring more than one attempt or resulting in conversion highlight the importance of operator experience and proper size selection. In the present study, the most used sizes were 3 and 4, aligning with manufacturer guidelines for adult airway management.

Hemodynamic parameters showed a statistically significant but clinically acceptable reduction in pulse rate, systolic, and diastolic blood pressure during the intraoperative phase compared to baseline. This reduction reflects the attenuation of sympathetic stimulation due to smooth insertion without laryngoscopy or tracheal intubation. Previous studies have similarly demonstrated that LMA insertion causes minimal cardiovascular perturbation compared to endotracheal intubation [3,8]. The stability observed in this study supports the notion that supraglottic airway devices provide better hemodynamic tolerance, especially in ASA II–III participants. Notably, oxygen saturation remained consistently above 99%, confirming adequate ventilation and oxygenation throughout the procedure, like the findings of Terblanche et al. [5].

The mean procedure duration of approximately 32 minutes and recovery time under 10 minutes indicate short anesthetic exposure and rapid emergence.

Comparable studies have reported quick recovery profiles with LMA-based anesthesia due to the absence of neuromuscular blockade and lower anesthetic requirements [7]. In our cohort, the majority of participants were mobilized within 2.5 hours and resumed oral intake within 4 hours, suggesting excellent early recovery and minimal postoperative discomfort.

Complications were infrequent and minor, with sore throat (8.2%) being the most common. This rate is comparable to that reported with other second- and third-generation LMAs, such as the ProSeal and Supreme variants, where mild sore throat occurred in 5–10% of participants.[4] No airway-related adverse events or desaturation episodes were observed, underscoring the safety of LMA Gastro™ in maintaining airway patency even during shared airway procedures. The overall incidence of complication rate (12.9%) was lower than that reported with endotracheal intubation in similar settings, which is known to produce higher incidences of cough and laryngeal discomfort [10].

In the current study, ASA grade and number of LMA attempts did not show a statistically significant association with complication rates, although a trend toward higher events was noted in ASA III and multiple-attempt cases. This observation aligns with the work of Terblance et al. (2020), who found that operator experience and patient comorbidity may influence minor complication frequency without affecting major outcomes [5].

The endoscopist satisfaction scores were high, with a median rating of 4 (IQR 4–5), indicating excellent procedural conditions. Similar satisfaction levels were reported in prior studies evaluating LMA Gastro™ for upper GI procedures, where operators noted improved scope handling and visibility compared to conventional airway adjuncts [11]. The integrated design of the LMA Gastro™ minimizes airway obstruction and allows unimpeded endoscopic manipulation, thereby enhancing procedural efficiency.

Conclusion

The present prospective observational study demonstrated that the **LMA Gastro™** is a safe and effective airway device for upper gastrointestinal endoscopic procedures, offering stable hemodynamics, high first-attempt success, and excellent endoscopist satisfaction. It provided adequate oxygenation and ventilation throughout the procedure with minimal complications, most of which were minor and self-limiting. The short recovery time and early postoperative mobilization further highlight its suitability for ambulatory and day-care endoscopy. These findings support the use of LMA Gastro™ as a reliable alternative to endotracheal intubation or conventional airway adjuncts, particularly in **ASA I–III** participants undergoing short-duration procedures, ensuring both patient comfort and procedural efficiency.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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ORIGINAL ARTICLE

Health Care Seeking Behaviour and Utilization of Ayush Services in Urban Puducherry

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Abstract

Background: Traditional, Complementary, and Alternative Medicine (TCAM) has gained global traction for managing chronic conditions, yet urban utilization patterns in India remain underexplored. This study evaluates healthcare-seeking behaviour and service utilization of AYUSH systems—Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy—in urban Puducherry. **Methods:** A cross-sectional descriptive study conducted over a period of 1 year, enrolled 150 adult patients (>18 years) attending the AYUSH clinic at General Hospital, Puducherry, for ≥6 months. Stratified sampling was applied and data were collected with a pre-structured questionnaire based on the Consumer Choice and Health Belief Models. Likert scales assessed attitudes toward efficacy and safety. **Results:** Participants had sought AYUSH for management of diabetes (27%), hypertension (16%), followed by osteoarthritis (12%). The primary reasons for choosing AYUSH included symptom relief (60.4%), followed by the absence of side effects (29.9%), and holistic care. Patients reported benefits such as symptom subsidence (32.5%) and improved well-being (31.1%). High mean Likert scores (>5.8/6) indicated strong agreement that AYUSH treatments were safer than allopathy. **Conclusions:** Urban Puducherry residents had demonstrated strong preference and satisfaction with AYUSH services for chronic disease management, and findings underscores the need for the integrative healthcare. Policy initiatives should reinforce AYUSH-allopathy collaboration, community engagement.

Keywords: Traditional, Complementary, and Alternative Medicine (TCAM), Health-care seeking behaviour, Non-communicable diseases, Puducherry

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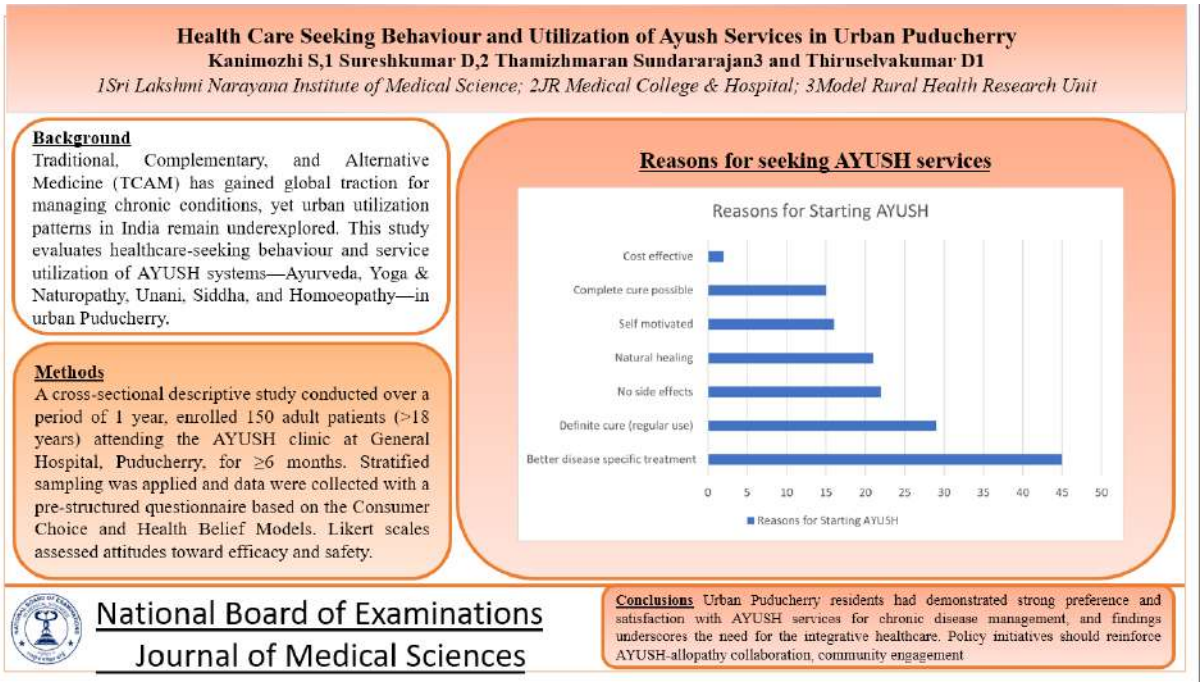
Graphical Abstract



Introduction

Traditional, Complementary, and Alternative Medicine (TCAM) includes a wide range of indigenous health practices that are widely practised worldwide [1,2]. Nearly 80% of the world's population has used any form of TCAM, often in conjunction with conventional medicine, during their lifetime. Further, its adoption is influenced by alignment with the traditions and easy accessibility, and integration of physical, mental, and spiritual well-being [3,4]. The World Health Organisation (WHO) acknowledged the role of TCAM's in attaining universal health coverage and suggested its evidence-based integration into national level health programs. Hence, countries were developing the regulatory frameworks and policies to ensure the safety and quality of TCAM practices in chronic disease management, prevention, and public health initiatives [1,2,5]. The AYUSH system, represents the Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy, in India, an officially recognised traditional and complementary medical disciplines, with their distinct historical and theoretical foundations, have long been practiced in the nation's health traditions. To formalize into the mainstream healthcare infrastructure, the Indian government established the Ministry of AYUSH in 2014 [6,7].

The National AYUSH Mission (NAM), aim to integrate AYUSH services into exiting Healthcare system, thereby enhancing public access and affordability. This pluralistic approach ensures adherence between the allopathic and AYUSH systems thereby promoting the comprehensive and diverse healthcare service for the Indian population [8,9].

Puducherry faces a notable public health challenge mainly due to the Non-Communicable Diseases (NCDs) exhibiting a range of NCD risk factors [10,11]. This high prevalence is further intensified by detrimental lifestyle factors, including improper food practices and low physical activity [12].

Healthcare-seeking behavior for AYUSH is influenced by various factors.

AYUSH is being utilized as primary care for routine ailments and also as a complementary treatment alongside allopathy for chronic conditions. This dual characteristics of AYUSH, underscores its integration into the modern healthcare, thereby ensuring synergistic benefits and a patient-centered approach to well-being. However, a notable gap exists in the understanding of AYUSH service utilization among the urban population. Hence, the current study aims to address this knowledge gap by assessing the healthcare-seeking behaviors, the factors influencing the choice of AYUSH systems, and their integration with conventional allopathic care.

Materials and Methods

This facility-based analytical cross-sectional study was conducted over one year at the AYUSH clinics under the General Government Hospital, Puducherry, among the adult patients (≥18 years), seeking treatment for various chronic and degenerative conditions, including diabetes, hypertension, osteoarthritis, and bronchial asthma for more than six months. The minimum sample size of 150 was calculated using the single proportion formula for cross-sectional studies by assuming an expected AYUSH utilization prevalence of 50%, a margin of error 8%, and 95% confidence level ($Z_{\alpha/2}$=1.96), and to ensure generalizability a stratified random sampling technique was employed. The sampling frame encompassed all eligible patients meeting the above said criteria, which was then stratified by the three primary AYUSH disciplines offered at the facility, that were Ayurveda, Siddha, and Homeopathy. From each stratum, 50 eligible patients were selected by simple random sampling to achieve an estimated sample size of 150 participants.

The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from participants before enrollment. Data were collected using a pre-tested, structured questionnaire developed from the “Consumer Choice Model" and the "Health Belief Model”. The questionnaire included two sections: 1) an interview-based component on the reasons for initiating, continuing, or discontinuing treatment, and 2) a self-administered Likert scale to quantify patients' agreement with AYUSH services and safety. The clarity and relevance of te questionnaire were validated through a pilot study involving 15 individuals at a Siddha clinic in a Primary Health Centre in Koodapakkam, and the study was conducted with administrative approval from the Directorate of Indian Systems of Medicine and Homeopathy, Puducherry.

Operational definitions

‘Long-term use’ was defined as continuous AYUSH treatment for ≥6 months. ‘Symptom subsidence’ was considered when participants reported a Likert score ≥4 for symptom improvement.

Statistical Analysis

Data captured via Epicollect-5 software were analyzed using the R statistical environment. Descriptive statistics summarized the cohort, using means and standard deviations for continuous variables and frequencies with percentages for categorical data. The normality of continuous variables was assessed using the Shapiro-Wilk test to select appropriate inferential tests. Missing data (<5% per variable) were addressed

with the multiple imputation under the missing at random assumption.

Results

The study included 152 adult patients and predominantly females in Siddha and Homeopathy, whereas Ayurveda had approximately equal representation. Also, most of the patients were homemakers, pensioners/dependents (Table 1).

Table 1. Demographic characteristics of the study population

Characteristics	Ayurveda (N=51)	Siddha (N=50)	Homeopathy (N=51)
Gender			
Male	25	18	34
Female	26	32	17
Occupation			
Professionals	2	1	0
Associate professionals	6	4	1
Clerks	4	0	3
Service/sales workers	2	2	3
Elementary (e.g. housemaids, peons)	0	7	5
Daily household chores/homemaker	18	16	25
Pensioners/dependents	12	18	5

Disease profile and Health conditions treated

The most documented illness were diabetes mellitus (n=41) followed by hypertension (n=24), and osteoarthritis (n=18). Other notable conditions included bronchial asthma (n=17), sinusitis, cervical spondylosis, and low back ache, each accounting for 12 cases. The services also addressed a wide range of other chronic ailments, such as psoriasis, renal calculi, rheumatoid arthritis, and menstrual irregularities.

Reasons for Initiating and Preferring AYUSH Care

Most of the participants (94%) had treatment history allopathic medications for their chronic illness, but only 13.8% had continued it along with AYUSH. The primary reasons for this shift was dissatisfaction with conventional medicine and other leading reasons were the ineffectiveness of allopathic treatments (36.7%) and the occurrence of unwanted side effects (33.2%). A notable portion of patients were motivated by a desire to explore alternative systems (6.3%), a preference for natural remedies (5.9%), or specific concerns like fear of surgery (5.1%) and drug allergies (5.1%) (Figure 1).

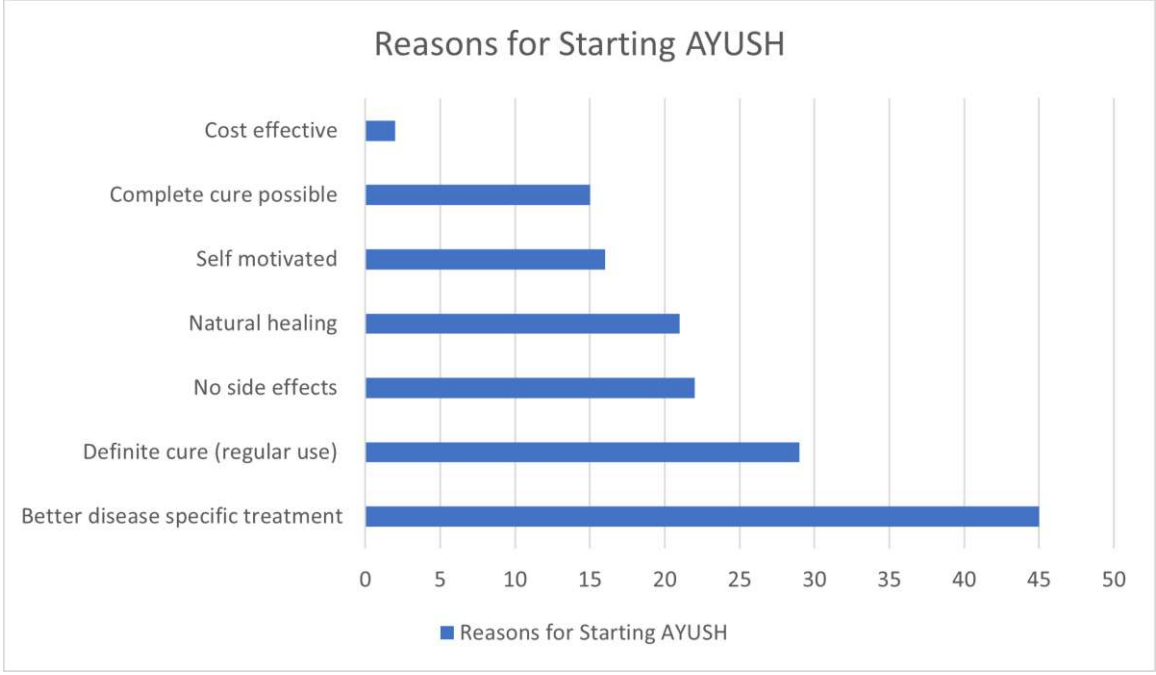


Figure 1. Reasons for seeking AYUSH services

Factors Influencing Continuing Utilization of AYUSH

Subsiding of symptoms (60.4%), and absence of side effects (25.9%) continues to be a major motivators for continuing AYUSH treatment, other prominent factors were listed in the Table 2.

Table 2. Reasons for adherence to AYUSH treatment modalities

Reasons	n (%)
Early period	
Symptoms started subsiding	125 (60.4)
No side effects compared to allopathy	62 (29.9)
Medicine easier to use	13 (6.3)
Cost effective	7 (3.4)
Long-term follow-up (>6 months)	
Gradual relief from all symptoms	135 (35.7)
No side effects	98 (25.9)
Disease under control	75 (19.8)
Appreciation of holistic approach	26 (6.9)
Pleasant treatment experience	25 (6.6)
Cost effective	8 (2.1)

Perceived Benefits of AYUSH Therapy

Further, the study population had reported significant improvements, primarily citing that their symptoms had subsided (32.5%) and they felt healthier than before (31.1%) (Figure 2).

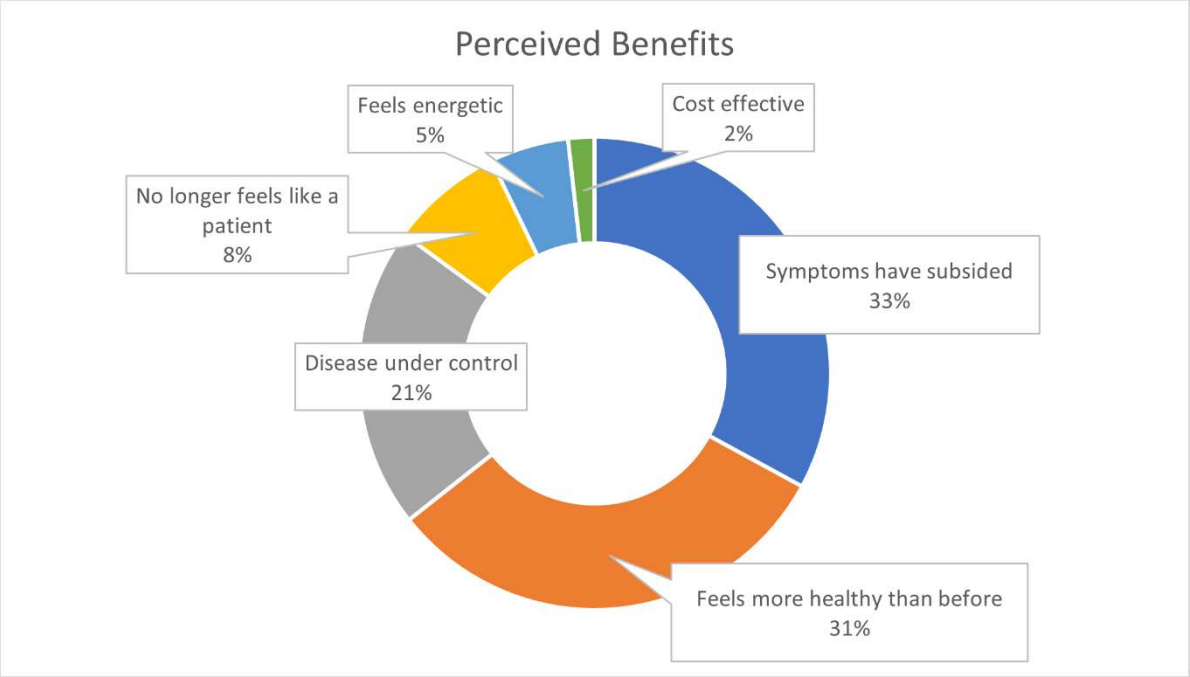


Figure 2. Perceived Benefits of AYUSH Therapy

Discussion

The current study reveals a significant insight into the integration of traditional and complementary medicine in contemporary healthcare systems. Our findings demonstrate that most patients had history of allopathic treatment, however only 13.8% continued concurrent allopathic therapy, which denotes a significant change towards AYUSH-based care.

The service utilization of AYUSH for chronic conditions, especially for diabetes mellitus (27%), hypertension (16%), and osteoarthritis (12%), aligns with existing literatures demonstrating the global patterns of TCAM use. Exiting international studies had reported higher TCAM utilization among patients with chronic diseases, for instance Hasan et al. [13] reported 63.9% CAM utilization among chronic disease patients, and some studies from lower Mekong countries documented TCAM prevalence rates of 47.8% among diabetic patients and up to 60% among cancer patients [14]. Our findings contribute to this evidences, by demonstrating that urban Indian populations exhibit similar patterns of seeking traditional medicine for chronic disease management [15].

The primary motivators for AYUSH preference identified in our study were perceived absence of side effects and symptomatic improvement, which is similar to the findings from published studies. A systematic review of TCAM use in Sub-Saharan Africa reported that patients sought traditional medicine due to dissatisfaction with conventional healthcare, perceived effectiveness, and

cultural alignment [16]. Similarly, a multicentric study in Bangladesh found that 55.5% of CAM users reported less adverse effects as their primary reason, and also Nigerian study had identified the absence of side effects as the reason of CAM preference [17,18].

Our findings align with the reported patterns of AYUSH utilization found through the in national surveys. Findings from the Longitudinal Aging Study in India (LASI) data reported that one in 14 older adults had utilized AYUSH services, where majority were seeking treatment for chronic conditions, including hypertension and diabetes. Our study's demographic profile, showing predominant utilization among homemakers (39.3%) and pensioners/dependents (23%), supported by national patterns [15,19].

The Likert scale responses in our study, with mean scores above 5.8 for statements regarding AYUSH causing fewer adverse effects and providing more empathetic care compared to allopathy, reflect strong patient satisfaction levels. These findings were supported by the reports of Pengpid et al, where they documented 88.7% satisfaction rates with AYUSH consultations and 85.6% of patients rating treatment outcomes as positive. The high satisfaction levels observed in our study indicate integration of patient-centred care principles within AYUSH practice [15].

Regional variations in AYUSH utilization across India have been documented, with states like Uttar Pradesh (18.7%), Maharashtra (13.8%), and Kerala (7.7%) showing different adoption patterns. Our study from Puducherry, a region with strong Siddha and Ayurveda traditions, provides valuable insights into utilization patterns in South India [20].

The predominant use of AYUSH for non-communicable diseases in our study reflects broader epidemiological transitions occurring in urban India. Puducherry's high burden of NCD risk factor, combined with lifestyle factors such as inadequate physical activity and poor dietary patterns, creates a condition where holistic, lifestyle-focused interventions offered by AYUSH systems become more relevant and suitable for welfare of the community [11].

Our finding that only 13.8% of participants used concurrent allopathic treatment, differs from some international studies reporting higher rates of concurrent use. For instance, Seelamantula et al., has documented complementary use rates of 38.6%, indicating potential variations in integration patterns across different healthcare systems and cultural contexts [20].

The strong preference for natural healing approaches and the perception of AYUSH reflects existing beliefs on traditional medicine. The current findings demonstrated the need for health system planning, and including the AYUSH services as both primary care options and alternative pathways for patients dissatisfied with conventional treatment outcomes.

The facility-based design and use of a stratified sampling strategy across the three major AYUSH systems enhanced the representativeness of the study population within the formal sector. Furthermore, the development and employment of the assessment tool based on theoretical frameworks (the Consumer Choice Model and Health Belief Model), ensures the robustness. Recall bias was minimized by restricting the questions to last six-month period. However, the absence of

longitudinal follow-up prevents causal inference on treatment outcomes.

Conclusion

The study highlights a significant shift toward AYUSH services among urban Puducherry residents with chronic non-communicable diseases, influenced by perceived effectiveness, safety, and holistic care. High patient satisfaction and symptom relief suggest AYUSH's potential as both primary and complementary therapy. Integration of AYUSH into mainstream health systems needs strengthening, with emphasis on collaborative care models. Future longitudinal and cost-effectiveness studies are to be carried out to provide evidence-based policy and optimize integrative healthcare delivery.

Author's Contribution

KS: Involved in conceptualization, data curation, formal analysis, methodology, project administration, resources, software, supervision, validation, visualization, and edited the manuscript; SD: Involved in conceptualization, data curation, methodology, project administration, resources, software, supervision, validation, and edited the manuscript; TS: Involved in data curation, formal analysis, methodology, validation, visualization, wrote the original draft and review, and edited the manuscript; TD: Involved in project administration, supervision, validation, visualization, wrote the original draft and review and edited the manuscript.

Ethical Approval

Before initiating the study, the Institute Human Ethical Committee approval was obtained

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

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ORIGINAL ARTICLE

A Comparative Evaluation of Hyperbaric Levobupivacaine Versus Hyperbaric Bupivacaine for Elective Infraumbilical Surgeries Under Spinal Anaesthesia

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Abstract

Levobupivacaine, the S (-) enantiomer of bupivacaine, is known for its reduced cardiotoxicity and central nervous system side effects. The present study was conducted to compare the anesthetic efficacy and safety profiles of two local anesthetic agents—hyperbaric levobupivacaine and hyperbaric bupivacaine—in patients undergoing elective infra-umbilical surgeries. A total of 100 patients classified as ASA Physical Status I–II were randomly assigned to receive subarachnoid block with either hyperbaric levobupivacaine or hyperbaric bupivacaine. Group L (n = 50) received 3 ml of 0.5% hyperbaric levobupivacaine (15 mg), while Group B (n = 50) received 3 ml of 0.5% hyperbaric bupivacaine (15 mg). The onset and duration of sensory and motor blockade, recovery characteristics, hemodynamic changes, and adverse effects were compared between the two groups. The onset of sensory block was faster in Group B compared to Group L. The time for two-segment regression and duration of motor blockade were significantly longer in Group B. However, Group L demonstrated greater hemodynamic stability than Group B. Overall, 0.5% hyperbaric levobupivacaine (15 mg) produced satisfactory sensory and motor blockade with stable hemodynamic parameters and fewer adverse effects than an equivalent dose of hyperbaric bupivacaine. Therefore, hyperbaric levobupivacaine may be considered a safer and effective alternative for subarachnoid block in infra-umbilical surgeries.

Keywords: Levobupivacaine, bupivacaine, infra-umbilical surgeries, hemodynamic stability

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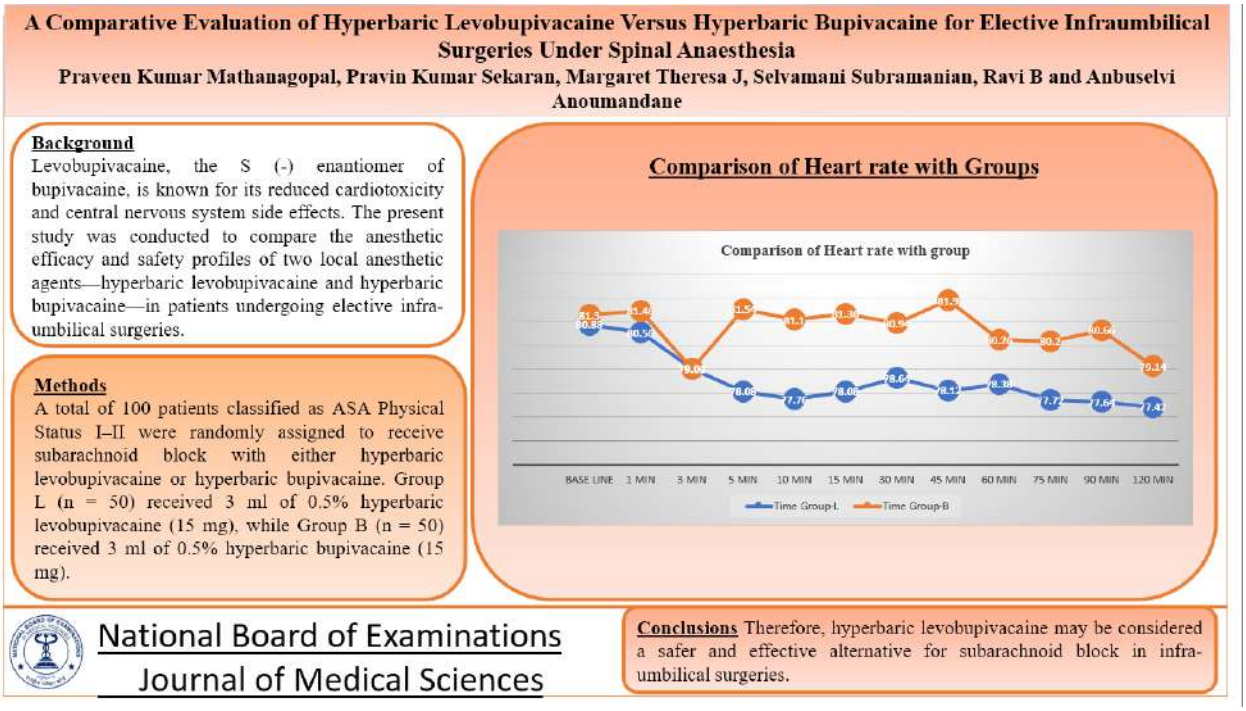
Graphical Abstract



Introduction

Spinal anaesthesia is a fundamental anaesthetic technique extensively utilized in infra-umbilical surgeries, which include lower limb orthopaedic procedures, urological operations and various gynaecological interventions. The primary advantages of spinal anaesthesia include a rapid onset of action, predictable and dense sensory and motor block, reduced postoperative pain, and lower incidence of systemic side effects compared to general anaesthesia [1]. Among the various local anaesthetics used in spinal anaesthesia, bupivacaine has long been regarded as the gold standard due to its favourable pharmacokinetic profile, which includes a prolonged duration of action suitable for lengthy surgical procedures [2]. However, It is associated with a significant risk of cardiotoxicity and neurotoxicity, particularly in higher doses or accidental intravascular administration. To mitigate these risks, levobupivacaine, the S-enantiomer of bupivacaine, has been developed and introduced into clinical practice. Levobupivacaine exhibits a similar pharmacokinetic and pharmacodynamic profile to racemic bupivacaine but with a significantly lower incidence of cardiotoxicity and central nervous system toxicity. This improved safety profile is due to the stereo-selectivity of levobupivacaine, which binds less avidly to cardiac sodium channels compared to the R-enantiomer found in racemic bupivacaine [3,4]. Comparative study between hyperbaric levobupivacaine and hyperbaric bupivacaine shall demonstrate levobupivacaine can provide comparable sensory and motor block characteristics with an improved safety profile.

Materials and Methods

This prospective randomized controlled study was conducted in one hundred patients undergoing elective infra-umbilical surgeries under subarachnoid block in a tertiary care hospital. The study

period was from July 2022 to February 2024. The hundred patients were randomly allocated to either one of the two group using sealed envelope technique.

Sample size calculation

All the data collected from the selected cases were systematically entered into a master chart. Statistical analysis was performed using Microsoft Excel and SPSS version 28.0. The software was utilized to calculate frequencies, percentages, ranges, means, and standard deviations. Statistical tests such as the Chi-square test, Friedman test, and t-test were applied, and corresponding p-values were obtained. A p-value of less than 0.05 was considered statistically significant.

Inclusion criteria

- Patients aged between 25 and 50 years
- Body weight ranging from 40 to 80 kg
- Classified as ASA Physical Status I or II
- Scheduled for elective infra-umbilical surgeries

Exclusion criteria

- ASA I II patients
- BMI > 35
- Severe renal, hepatic, respiratory and cardiovascular diseases
- Known hypersensitivity to amide local anaesthetic drugs and study drugs
- Coagulopathy and bleeding diathesis
- Infect ion at the site of injection.

Results

The study compared several parameters including hemodynamic stability, onset and duration of sensory and motor blockade, two-segment regression time, incidence adverse events, and the requirement of ephedrine between the two groups. The onset of sensory block occurred more rapidly in Group B compared to Group L. The time to achieve two-segment regression was significantly longer in Group B than in Group L. Similarly, the duration of motor block was extended in Group B. Overall, Group L demonstrated greater hemodynamic stability than Group B (Figure 1).

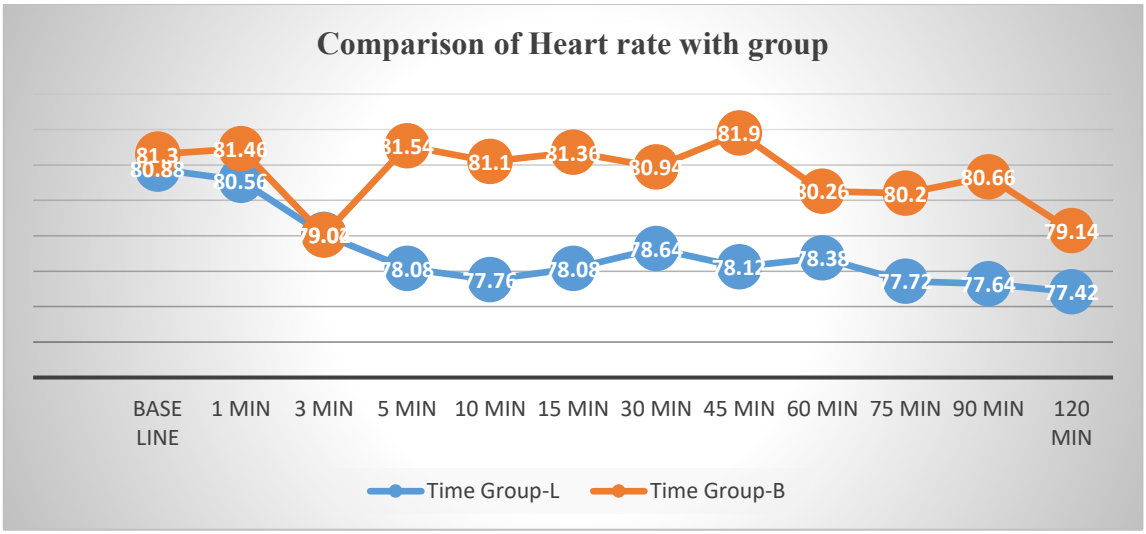


Figure 1. Comparison of Heart rate with Groups

The figure above illustrates the comparison of heart rate between the groups using an unpaired t - test. Despite the relatively lower heart rates observed in Group-L, the obtained p-value of greater than 0.05 indicates that there is no statistically significant difference between the groups. Therefore, they are considered comparable in terms of heart rate (Figure 2).

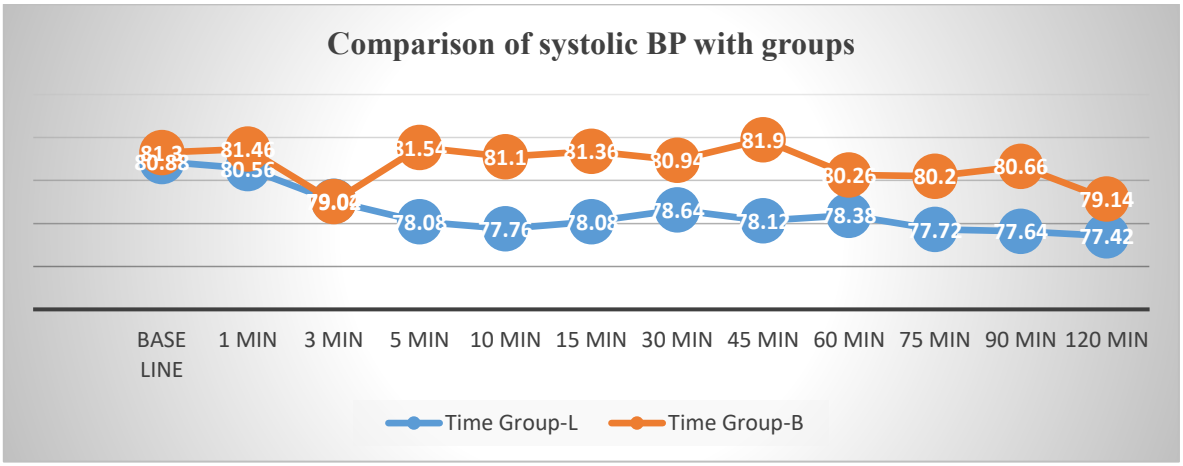
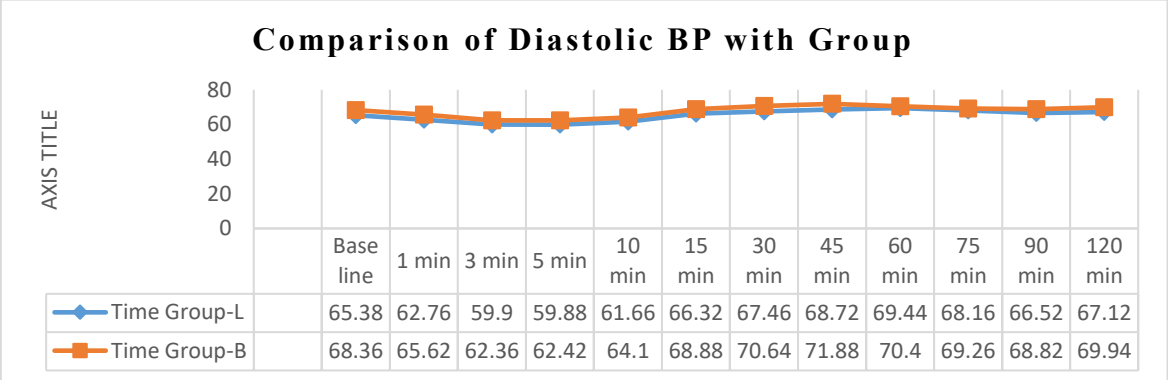


Figure 2. Comparison of Systolic BP with Groups

The table above presents the comparison of systolic blood pressure (SBP) between the groups using an unpaired t -test. Despite the relatively lower SBP observed in Group -L, the obtained p-value of greater than 0.05 indicates that there is no statistically significant difference between the groups. Therefore, they are considered comparable in terms of SBP.



	Base line	1 min	3 min	5 min	10 min	15 min	30 min	45 min	60 min	75 min	90 min	120 min
Time Group-L	65.38	62.76	59.9	59.88	61.66	66.32	67.46	68.72	69.44	68.16	66.52	67.12
Time Group-B	68.36	65.62	62.36	62.42	64.1	68.88	70.64	71.88	70.4	69.26	68.82	69.94

Figure 3. Comparison of Diastolic BP with Groups

The table above illustrates the comparison of diastolic blood pressure (DBP) between the groups using an unpaired t -test. Despite the DBP being relatively lower in Group -L, the obtained p-value of greater than 0.05 indicates that there is no statistically significant difference between the groups. Therefore, they are considered comparable in terms of DBP (Figure 3).

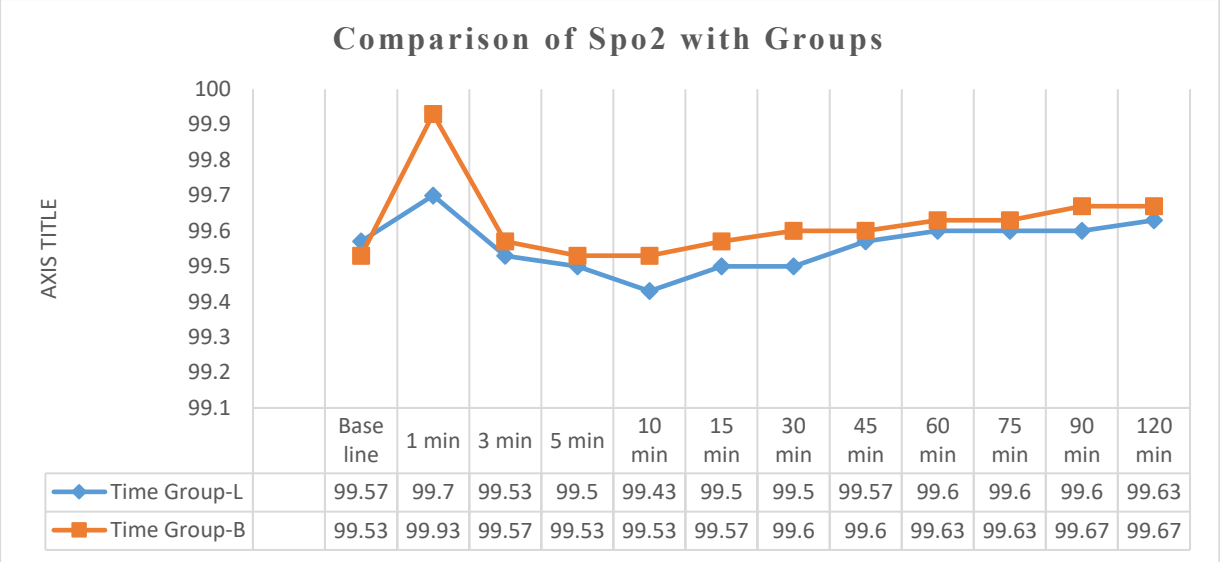


Figure 4. Comparison of spO2 with Groups

The above table shows comparison of spO2 with Groups by Unpaired t -test: a p-value>0.05, which is not a statistically significant difference and therefore, they are not comparable (Table 5).

Table 5. Comparison of Onset of Sensory blockade (minutes)

Onset (Sensory)	**Group**	
	Group -L	**Group- B**
Mean	2.45	1.88
SD	0.47	0.47
P Value	< 0.0001	
P<0.05, Hence highly significant		

The above table shows comparison of Onset of Sensory Blockade with Groups by Unpaired t - test with p<0.0001 which shows high statistically significant difference between the onset of Sensory Blockade with Groups. Group-B had significant early onset of act ion compared to Group L (Table 6).

Table 6: Comparison of Time for peak Sensory blockade

Duration (Sensory)	**Group**	
	Group -L	**Group- B**
Mean	11.77	13.27
SD	2.24	3.20
P Value	< 0.0078* HS	
P<0.05, Hence highly significant		

The above table shows comparison of Time for peak Sensory Blockade (minutes) with Groups by Unpaired t -test with p=0.0078 which shows high statistically significant difference between the mean time for maximal Sensory Blockade with the Groups. Group-L had significant early onset of maximal sensory blockade (Table 7).

Table 7: Comparison of Two Segment Regression Time for sensory block

Time for 2SR	**Group**	
	Group -L	**Group- B**
Mean	73.20	77.50
SD	6.29	5.27
P Value	0.0003* HS	
P<0.05, Hence highly significant		

The above table shows comparison of time for Two Segment Regression time with Groups by Unpaired t -test shows a p=0.0003, which shows high statistically significant difference between the mean duration for Two Segment Regression Time with the Groups. Group-L had significantly earlier two segment regressions than Group B (Table 8).

Table 8. Comparison of Onset of Complete Motor blockade

Onset (Motor)	**Group**	
	Group -L	**Group- B**
Mean	4.18	2.83
SD	0.7	0.59
P Value	< 0.0001* HS	
P<0.0001, Hence highly significant		

The table above illustrates the comparison of the onset of motor blockade between the groups using an unpaired t -test. The obtained p-value of 0.0001, which is less than 0.05, indicates a highly statistically significant difference in the onset of motor blockade between the groups. Specifically, Group -B exhibited a significantly earlier onset of complete motor blockade compare d to Group-L (Table 9).

Table 9. Comparison of Duration for maximum Motor Blockade

Duration of maximum motor blockade	**Group**	
	Group -L	**Group- B**
Mean	11.70	6.78
SD	1.97	1.42
P Value	<0.0001	
P<0.0001, Hence highly significant		

The above table shows comparison of duration for maximum motor blockade in minutes with Groups by Unpaired t- test with a p<0.0001 which shows high statistically significant difference between the mean duration of motor blockade with the Groups. Group-L had significant longer time for achieving maximum motor block (Table 10).

Table 10. Comparison of Regression Time for motor block

Duration of maximum motor blockade	**Group**	
	Group -L	**Group- B**
Mean	101.82	138.99
SD	17.17	29.13
P Value	<0.0001* HS	
P<0.05, Hence highly significant		

The table above displays the comparison of the regression time for motor blockade between the groups using an unpaired t - test. The obtained p-value of less than 0.0001 indicates a highly statistically significant difference in the mean duration for the regression time of motor blockade between the groups. Specifically, Group-B demonstrated a significantly longer time for regression of the motor blockade compared to Group-L (Table 11).

Table 11. Comparison of dose of ephedrine used

Duration of maximum motor blockade	**Group**	
	Group -L	**Group- B**
Mean	10.20	23.40
SD	3.77	3.38
P Value	<0.0001* HS	
P<0.0001, Hence highly significant		

The above table shows comparison dosage of ephedrine used for correcting hypotension within Groups by Unpaired t -test shows a $p<0.0001$, which shows high statistically significant difference. There is higher consumption of Ephedrine in Group -B (Table 12).

Table 12. Complications

Complications	Group-L	Group-B	Chi square	P-Value
Hypotension	**4**	**11**	**3.8**	**0.049**
Bradycardia	**2**	**6**	**2.17**	**0.14**
Headache	**1**	**1**		**-**
Nausea	**2**	**8**	**4**	**0.04**
Vomiting	**1**	**2**	**0.34**	**0.55**
High spinal block	**0**	**0**		
Total spinal block	**0**	**0**		

For the complication of hypotension, Group B exhibits a higher frequency compared to Group L (11 vs4), resulting in a Chi -square value of 3.8 and a p-value of 0.049. This indicates a statistically significant association between the group and the occurrence of hypotension. In the case of bradycardia, although Group B again demonstrates a higher frequency, the difference is not statistically significant, with a Chi -square value of 2.17 and a p-value of 0.14.Regarding nausea, vomiting, and itching, Group B shows higher frequencies compared to Group L. Notably, nausea and itching exhibit statistically significant associations with the group, as indicated by Chi -square values of 4 and 0.34, respectively, and corresponding p-values of 0.04 and 0.55.

Discussion

This randomized prospective control study done in 100 patients of age 25-50 years scheduled for elective infra-umbilical surgeries. The key parameters evaluated included intraoperative hemodynamics, onset and duration of sensory and motor blockade, time for two-segment regression sensory blockade and motor blockade, as well as the incidence of adverse effects and the required dose of ephedrine for managing hypotension.

In the present study, the onset of sensory blockade was observed to be 2.45±0.47 minutes with Levobupivacaine and 1.88±0.47 minutes with Bupivacaine. Notably, the onset of sensory blockade was significantly prolonged with Levobupivacaine compared to Bupivacaine at the equivalent dosage (15 mg). However, there was no statistically significant distinction in the duration taken for the sensory blockade to extend to the T10 dermatome level between the two drugs (4.73±0.9 minutes with Levobupivacaine and 4.74±1.14 minutes with Bupivacaine). Lee et al. [5] conducted a dose-effect study comparing racemic bupivacaine and levobupivacaine in patients undergoing

urological surgery. They found nearly equivalent clinical profiles and hemodynamic effects with 2.6 ml of 0.5% of both drugs. The time for peak sensory blockade was 11.77±2.24 minutes with Levobupivacaine and 13.27±3.20 minutes with Bupivacaine. This difference in early onset of sensory blockade with Levobupivacaine was statistically significant. In the present study, two-segment regression time was 73.20±6.26 minutes with Levobupivacaine and 77.50±5.27 minutes with Bupivacaine. The two-segment regression time was significantly longer with Bupivacaine with p value of <0.05 which is comparable with study conducted by Gautier et al [6] showed early two segment regression times with Bupivacaine.

Present study showed the onset of complete motor blockade was 4.18±0.7 minutes with Levobupivacaine and 2.83±0.59 minutes with Bupivacaine. The onset of motor blockade was significantly longer with Levobupivacaine. Similar rapid onset of motor blockade was seen in the study by Vanna et al [7] (3.9 min vs 3 min). In the present study the time for peak motor blockade was 11.7±1.97 minutes with Levobupivacaine and 6.78±1.42 minutes with Bupivacaine. This difference in early onset of motor blockade with Bupivacaine was statistically significant. The motor blockade regression time was 101.82±17.17 minutes with Levobupivacaine and 138.99±29.13 minutes with Bupivacaine. The motor blockade regression time was significantly longer with 0.5% Bupivacaine, which signified longer duration of motor blockade with Bupivacaine than Levobupivacaine. Similar prolonged motor blockade with Bupivacaine was seen in the study by C. Glaser et al [8] (280 min vs 284 min) Whereas Fattorini et al [9] reported prolonged motor duration with Levobupivacaine (256 min vs 245 min) The effects of baricity on block characteristics have been inconsistent in the literature. Therefore, we cannot solely at tribute the differences in sensory and motor block between the two groups in our study to the difference in baricity.

The present study showed no statistically significant changes in the hemodynamic parameters (heart rate, blood pressure and oxygen saturation) between both the groups. However, it was seen that the mean heart rates and blood pressures were found to be lower in the Group-L. Both the parameters were within the 20% range of the baseline parameters, except for some patients having hypotension (systolic blood pressure <90 mm Hg) in 8% with Levobupivacaine and 22% with Bupivacaine especially after 3 minutes and 5 minutes of administering the subarachnoid blockade.

The fall in the heart rates (Bradycardia defined as a heart rate <60 beats/minute) was seen in 2(4%) patients in Levobupivacaine group; while it was seen in 6 (12%) patients in Bupivacaine group. Though there were instances of bradycardia, none of the patients required Atropine supplement for bradycardia. A similar trend was seen in the blood pressure as well (systolic, diastolic and mean arterial pressure). The blood pressure in Group-L was lower than that of group-B, however these differences were not statistically significant between the groups. Ephedrine was supplemented for hypotension, besides giving boluses of crystalloid solution. Both the groups were comparable in the oxygen saturations.

In the preset study the incidence of Bradycardia was 4% in Group-L and 12%

in Group-B; nausea was 4% in Group-L and 16% in Group-B and vomiting, itching was seen in 2% in Group-L and 4% in Group-B). The incidence of bradycardia and vomiting was however not statistically significant. In regional anaesthesia for caesarean sections, nausea and vomiting can arise from various factors. A primary reason is the reduction in cerebral blood flow resulting from hypotension induced by the anaesthesia. Additionally, the level reached by the nerve block can contribute to nausea and vomiting, either through an increase in block level or inadequate cover age of structures affected by peritoneal stretching during surgery. The lower incidence of nausea observed in the levobupivacaine group in our study may be attributed to the fact that the doses administered achieved adequate blocks while causing less hypotension, thereby minimizing the risk of nausea and vomiting.

The incidence of hypotension was 8% in Group -L and 22% in Group-B. The incidence of hypotension was however highly statistically significant. Hypotension is a common complication associated with spinal anaesthesia. Various strategies have been employed to mitigate hypotension, including preoperative hydration with crystalloid or colloid solutions. Fattorini et al [9] observed better cardiovascular stability with levobupivacaine compared to bupivacaine, despite similar sensory and motor block characteristics. Similarly, Parpaglioni et al [10] reported a significant decrease in hypotension incidence with levobupivacaine in caesarean sections. The variations in reported hypotension rates a cross studies may be attributed to differences in the definition of hypotension, with some studies considering a 25% decline in systolic blood pressure from baseline values, while others, including ours, used a 20% decline from the baseline pressure as the threshold. In the current study, ephedrine was given in increments of 3 - 6mg to correct hypotension. The mean dose of ephedrine used was 10.2±3.77 mg with Levobupivacaine and 23.4±3.38 mg with Bupivacaine. There was significantly higher requirement of Ephedrine for correcting hypotension following subarachnoid block with Bupivacaine.

Conclusion

To conclude duration of sensory block and motor block in patients receiving 0.5% Hyperbaric Levobupivacaine was less when compared to patients receiving 0.5% Hyperbaric Bupivacaine. Onset of sensory and motor block was slow compared to the Bupivacaine group. Incidence of complications like Hypotension and Bradycardia were less in Hyperbaric Levobupivacaine group when compared to Hyperbaric Bupivacaine group. So Levobupivacaine being a safer local anaesthetic agent can be considered as a suitable alternative to bupivacaine for spinal anaesthesia in infra-umbilical surgeries

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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POINT OF VIEW

h-index: A Metric of Merit or a Mirage in Academia?

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Abstract

The *h-index*, introduced in 2005, has become a dominant metric in evaluating medical researchers and journals. Celebrated for balancing productivity and citation impact, it remains widely used in tenure, funding, and publication decisions. However, its limitations including disciplinary bias, disadvantages for early-career scholars, gender inequities, and insensitivity to societal impact which raise concerns about fairness and innovation. While offering utility, the *h-index* risks oversimplifying scholarly value into a numbers game. Alternatives such as *g-index, m-quotient, field normalization, and altmetrics*, along with holistic frameworks like DORA, provide more nuanced assessments. Redefining impact beyond citations is essential for advancing equitable medical academia.

Keywords: h-index, citations, research, publications, authors, journals

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Introduction

In the high-stakes world of medical academia, where careers often hinge on 'impact,' the *h-index* serves as a key determinant of academic recognition. The *h-index* stands as a formidable gatekeeper. It was introduced in 2005 by physicist Jorge Hirsch, this metric, where an author has h papers each cited at least h times [1], offers a tantalizingly simple gauge of scholarly worth. Yet, is it a fair arbiter of merit or a deceptive trap that entrenches inequality, stifles innovation, and distorts the soul of medical research?

The Allure of the *h-index*

Hirsch's brainchild was a response to flawed metrics like total citations, skewed by a few blockbuster papers, or publication counts, which reward quantity over quality [1]. The *h-index* elegantly balances both: a researcher with an *h-index* of 30 has 30 papers, each cited at least 30 times, signalling consistent impact. For medical academics, this is a godsend. Hiring committees, grant panels, and tenure boards lean on it to compare researchers across subspecialties, from cardiology to epidemiology [2].

For many young researchers, the *h-Index* offers the promise of recognition that transcends borders and local hierarchies. It levels, at least in appearance, the playing field between an academic at a major Ivy League institution and one working in a regional hospital in India. A number is universally interpretable, and in globalized science, it provides a common language. Similarly, for senior scientists, a high *h-index* acts as a kind of professional currency, as it may signal prestige, authority, and legitimacy.

Journals, too, wield the *h-index* to quantify their clout. Defined as the largest *h* where *h* articles have at least *h citations*. It outperforms the Impact Factor (IF), which is tethered to a narrow two-year window and vulnerable to gaming via self-citations [3,4]. Titans like *The New England Journal of Medicine* (NEJM) boast *h-indices* above 200, cementing their role in shaping clinical practice [3]. For authors, a journal's *h-index* guides submission choices, promising visibility and career leverage.

A Dominance of Numbers?

It remains debated whether the *h-index* functions as a useful benchmark or an oversimplified metric. Beneath its polished surface lies a metric that amplifies bias and rewards conformity. Early-career researchers often recently completing residencies, balancing clinical loads with grant applications face a steep climb. Their *h-indices* lag not for lack of quality but because citations accrue slowly [5]. This also disproportionately harms women and underrepresented minorities, who battle systemic barriers like unequal funding and mentorship, and widening gap [6].

In medicine's collaborative mega-trials, the metric equates a principal investigator's toil with a co-author's cursory nod, inflating scores for the well-connected [7]. A researcher listed as the 25th author on a multicentre trial may receive the same citation credit as the first author who carried the intellectual burden. Thus, the *h-index* rewards networking and institutional affiliation as much as true scientific creativity. Over time, this can distort career trajectories, with some thriving on collecting it.

Disciplinary disparities deepen the critique. Biomedical fields, driven by rapid citation cycles, produce lofty *h-indices*, while areas like medical ethics or public health, where impact unfolds over decades, languish [2]. A cardiologist might hit *h*=50 by mid-career, while an orthopaedist stalls at *h*=15, despite comparable rigor. This entrenches prestige hierarchies, sidelining interdisciplinary work that bridges lab to bedside or daring research that defies convention.

The human consequences of this numbers game are sobering. Researchers report feeling pressured to prioritize citation-friendly topics over patient-relevant questions. Instead of exploring novel hypotheses that might reshape practice, many retreat to the safety of publishing in well-trodden areas. The *h-index*, in this light, becomes less a neutral tool and more a cultural force shaping the very direction of science [8]. Figure 1 summarizes the strengths and weaknesses of the *h-index*.

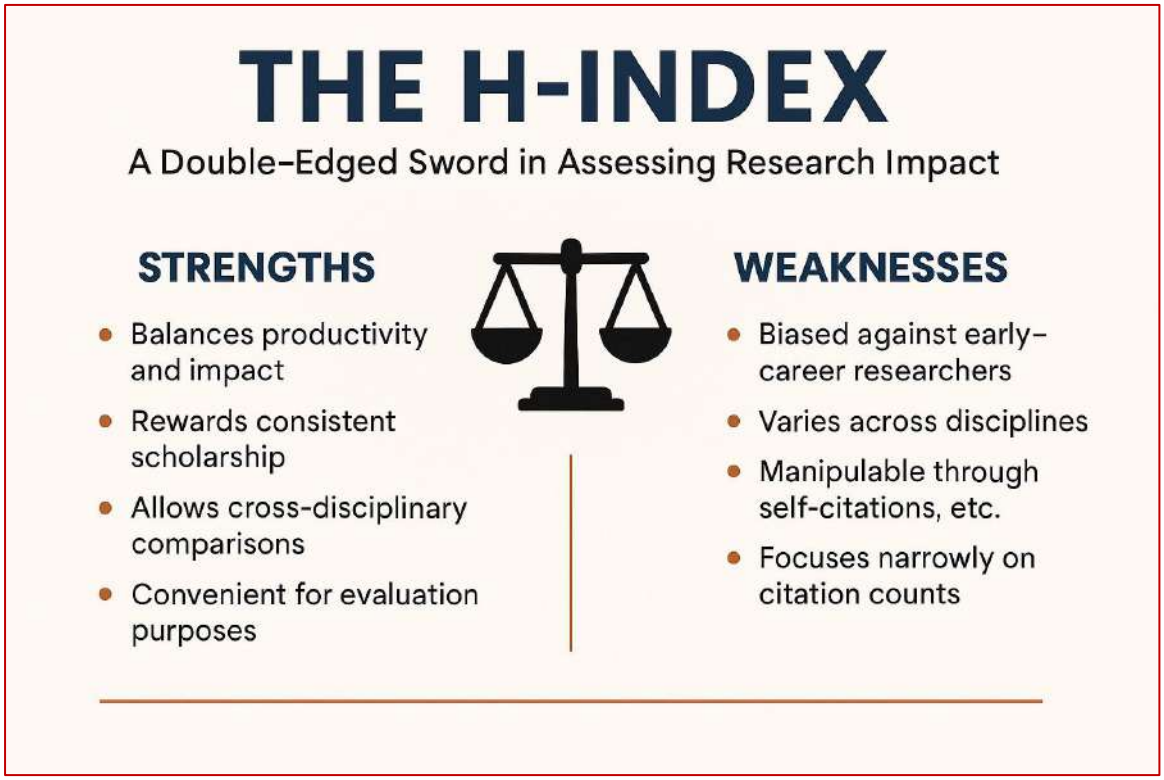

Figure 1. The strengths and weaknesses of *h-index*

Journals Under Scrutiny

Journals also face similar distortions. Older journals with vast archives naturally a mass higher *h-indices*, dwarfing newer venues in fields like precision medicine or AI diagnostics [4]. Citation cartels and predatory publishing further muddy the waters; while less manipulable than IF, the *h-index* is not immune to self-citation schemes [7,9]. Moreover, it ignores non-traditional outputs critical to medicine: datasets, software, or policy briefs that save lives but do not rack up citations [5].

Consider, for instance, the case of COVID-19 research. A preprint on a novel treatment strategy might influence global health policy within weeks, yet traditional citation metrics would take years to reflect that significance. The *h-index* cannot account for the immediacy of such societal impact. In a world where digital communication accelerates knowledge transfer, relying solely on a lagging indicator risk misjudging both people and publications [10].

Reimagining Evaluation

What if we reconsidered its dominance? Variants like the *g-index*, which emphasizes highly cited papers, or the *m-quotient*, adjusting for career length, address some flaws [2]. *Field-normalized indices* and the *ha-index*, averaging citations in a journal's *h-core*, offer fairer benchmarks [3]. *Altmetrics*, which track social media mentions, policy citations, and downloads, bring an additional dimension. While imperfect, these newer tools attempt to capture the multifaceted ways in which science matters [10,11].

The San Francisco Declaration on Research Assessment (DORA) and Leiden Manifesto principles champions holistic evaluations, blending metrics with peer review, teaching, and societal impact [6]. Imagine valuing a researcher's mentorship or policy influence as much as their citation tally. A professor who spends hours nurturing young investigators or developing local healthcare solutions may have an *h-index* of 15 but a transformative effect on their community. By broadening our lens, we acknowledge contributions that lie beyond the narratives.

For practical guidance, Table 1 offers informal benchmarks tailored to medicine. Authors with *h-index* <10 are emerging; 20–40 signals mid-career strength; >60 marks global pioneers. Journals below 40 are niche; above 200, elite flagships like The Lancet. Yet, these are guides, not gospel; contextualize within subspecialties and databases, as Google Scholar inflates scores versus Scopus and Web of Science [9].

Table 1. Informal *h-index* Benchmarks for Medical Authors and Journals

Category	Authors (h-index)	Journals (h-index/h5-index)	Interpretation
Very Low	<10	<20	Emerging talents; new journals
Low	10-20	20-40	Junior faculty; regional outlets
Medium	20-40	40-100	Mid-career leaders; respected journals
High	40-100	100-200	Senior experts; top-tier publications
Elite	>100	>200	Global pioneers; flagship journals

A Call for Reform

The *h-index's* dominance in medical academia warrants critical reflection. It seduces with simplicity but blinds us to research's multifaceted brilliance. Are we measuring what matters: lives saved, knowledge advanced, barriers broken, or merely what counts? By embracing inclusive, nuanced assessments, we can liberate scholarship from this metric's grip, fostering a medical ecosystem where ideas, not numbers, define impact.

At the same time, dismantling the domination of the *h-index* does not mean discarding metrics altogether. Numbers will always play some role in evaluation. The challenge lies in rebalancing our priorities: moving from a singular fixation on citations to a richer tapestry of recognition [8]. As medicine grapples with global crises; from pandemics to climate change, the research that changes the world may not always be the most cited. Often, it will be the work done quietly, locally, and collaboratively.

Table 2 summarizes the benefits and drawbacks of the *h-index* and highlights alternative or complementary metrics that provide a more balanced evaluation of research performance. While the *h-index* offers a simple and widely recognized measure combining productivity and impact, it has notable drawbacks such as field dependency, insensitivity to recent or highly cited papers HCPs [12,13], and disadvantages for early-career researchers. Therefore, other indices—like the *g-index, m-index*, and *contemporary h-index*—along with *field-normalized and alternative metrics*, are recommended to provide a more comprehensive and fair assessment of a researcher's scholarly influence.

Table 2. Benefits, Drawbacks and Alternatives of *h-index*

Features	Benefits	Drawbacks	Alternatives
Simplicity	Simple and intuitive single-number measure of productivity and impact	-Oversimplifies research impact -Ignores citation context or author contribution	-i10-index -Total Citations -Average Citations per Paper (CPP)
Balance (Quantity vs. Quality)	Balances publication count and citation impact	Penalizes researchers with few but highly influential papers, or many low-cited ones	-g-index -h_a-index
Comparative Use	Useful for comparing researchers within the same field or seniority	Misleading across disciplines due to differing citation practices	-Field-Weighted Citation Impact (FWCI) -Normalized Citation Impact (NCI)
Stability	-Not overly affected by one highly cited paper (HCP) -Reflects consistent output	-Hard to improve after a point -Insensitive to recent influential work	Contemporary h-index (hc-index)
Data Availability	Easily obtained from Scopus, Web of Science, and Google Scholar	Different databases report inconsistent h-index values	Cross-check using ORCID or multiple sources for reliability
Career Assessment	Widely recognized and used in academic evaluations	Encourages quantity over quality; ignores teamwork and mentoring contributions.	Combine with Altmetrics, Peer review, or Grant success rates for a holistic view
Time Sensitivity	Reflects long-term performance trends	Disadvantageous for early-career researchers with fewer publications	m-index (h-index ÷ years since first publication)

A legacy of transformation, not a tally of citations. Instead of relying solely on the *h-index*, a combined evaluation approach integrating the h-index, m-quotient (to adjust for career length), altmetrics (to capture societal and online impact), and qualitative peer review (to assess mentorship and non-traditional outputs) offers a more holistic measure of a medical researcher's impact [11]. Additionally, the *g-index,* which emphasizes HCPs [12,13], can complement this framework to reward exceptional influence. The measure of a scholar's life should be in the questions asked, the barriers dismantled, and the patients whose lives are bettered because of their work. We believe that the quantitative measures should inform, but not define, the broader narrative of scientific progress.

Moving forward, academic institutions and funding bodies should adopt multi-dimensional assessment frameworks that integrate bibliometric indicators with qualitative evaluations. Policies aligned with the San Francisco Declaration on Research Assessment (DORA) and Leiden Manifesto principles can guide this shift. Implementing field-normalized metrics, mentorship credits, and societal impact indicators would promote fairness and inclusivity. A balanced policy approach can ensure that research assessment captures innovation, collaboration, and real-world influence—beyond citation counts alone.

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Conflict of Interest

None to disclose by the authors

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Not required for such a bibliometric study based on published data and not involving human data or intervention.

Patient consent

Since no patients were involved in this study, it is not applicable.

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AI Tools Utilization: The manuscript's English and readability were enhanced with the assistance of Perplexity. Nonetheless, all content is original and has not been derived from external sources. The authors have diligently reviewed the manuscript in its entirety and assume full responsibility for its contents.

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CASE REPORT

Multisystem Involvement in a Newly Diagnosed Adult with Homozygous Sickle Cell Disease

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Abstract

Background: Sickle cell disease is a haemolytic disorder usually diagnosed in paediatric age group. In regions where proper screening lacks it goes undiagnosed in childhood and presents itself in adulthood with multisystem complications, diagnosis and treatment of these patients in adulthood becomes challenging. The incidence of sickle cell disease Indian adults is ~1.1% and prevalence of sickle cell trait is ~5.9% making it very hard to diagnose and needs a vigilant approach. **Case Presentation:** A 31-yr old female conscious oriented came walking by herself with chief complaints of pain in her b/l upper and lower limbs since 1 week with fatigue and headache since 15 days. No seizure, vomiting or other signs of increased ICP. CT Brain-normal. Lab investigations showed microcytic anaemia, indirect hyperbilirubinemia, positive sickling test and leucocytosis. Haemoglobin electrophoresis confirmed homozygous sickle cell disease. She was treated with hydration, oxygen, analgesic and hydroxyurea. On day 4 she developed acute hypoxemic respiratory failure for which invasive ventilation was needed. 2D Echocardiography revealed moderate pulmonary hypertension with severe tricuspid regurgitation, right atrial and ventricular dysfunction with mild pericardial effusion. Bone marrow aspiration revealed hypercellular marrow with erythroid hyperplasia. Also, on day 7 she developed status epilepticus for which MRI Brain showed acute infarct in rt splenium of corpus callosum in the pericallosal branch of posterior cerebral artery, suggesting embolic stroke also CSF study was normal. With adequate blood transfusions, antibiotic, antiepileptics supportive management patient improved and was discharged in stable condition. **Conclusion:** This case is an example of considering SCD even in adults with Vaso-occlusive symptoms with unexplained anaemia, as it as a much grave and multisystemic complications where diagnosis and treatment becomes challenging and can lead to life threatening events.

Keywords: Sickle cell disease, Pulmonary hypertension, Embolic stroke, Vaso-occlusive crisis, Haemolytic crisis, Thromboembolic crisis

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Introduction

Sickle cell disease (SCD) is an inherited disorder of haemoglobin structure, where there is point mutation in the beta globin gene (chr 11) by which valine replaces glutamic acid at 6th position leading to formation of Hb S [4]. HbS under low oxygen tension and dehydration has tendency to polymerize into long rigid fibers which distort the shape of RBC leading to sickle shape RBC, which are fragile and are lysed in extravascular and intravascular systems [1]. Also they obstruct the small capillaries causing microvascular occlusion. This disease is usually diagnosed in childhood, delayed detection in adulthood is seen in regions lacking screening leading to severe complications like pulmonary hypertension, cerebrovascular accidents haemolytic crisis due combination of sickling, endothelial injury, hypercoagulable state, Vaso-occlusion, thromboembolism. This report highlights this unusual presentation of homozygous SCD in a young adult who developed acute thromboembolic events affecting the lungs, heart, brain within course of single admission.

Case presentation

A 31-yr old female, Komal More, presented with generalized pain in all her limbs since 1 week insidious in onset gradually progressive associated with headache and fatigue since 15 days. No power loss, seizure, syncope, vomiting or signs of increase ICP. On presentation (day1) her vitals were stable. Laboratory findings showed haemoglobin 8.3 g/dl, mean corpuscular volume (MCV) 68fl, white blood cell count 17810/microL, platelet count 375000/microL, total bilirubin 2.6 mg/dl (direct 1.1, indirect 1.5), SGOT 38IU/L, SGPT 34IU/L, creatinine 1.2 mg/dl. Thyroid function tests revealed TSH 16.24 microIU/mL, with normal T3/T4, suggestive of sick euthyroid syndrome. Peripheral smear showed anisopoikilocystosis with microcytosis.

Suspecting sickle cell anaemia, a sickling test was done which turned out to be positive. Haemoglobin electrophoresis showed a peak in HbS window and elevated HbF, consistent with homozygous sickle cell disease. She was then treated with hydroxyurea, analgesics, hydration, oxygen therapy and was improving well for next 2 days.

On day 4 she developed acute onset breathlessness with persistent SpO2~60%, even non-invasive ventilation failed to improve oxygenation, she was then intubated providing invasive intubation. In an attempt to find the cause of respiratory distress 2D Echocardiography was done which revealed moderate pulmonary hypertension, severe tricuspid regurgitation, right atrial and right ventricular dysfunction and mild pericardial effusion. Post-intubation her hypoxemia decreased as revealed by ABG.

On the same day, (day 4) labs showed haemoglobin 4.8g/dl, WBC 40,210/microL, platelets 50,000/microL, MCV 64fl, total bilirubin 4.1 mg/dl(direct 0.9, indirect 3.2), SGOT 98IU/L, SGPT74 IU/L, D-dimer 3880ng/ml. Bone marrow aspiration was done to rule out bone marrow dysfunction which revealed hypercellular marrow with erythroid hyperplasia. Also, iron studies did not reveal iron deficiency. Also, no hepatomegaly or splenomegaly or haematuria. Accordingly, blood transfusions and antibiotic treatment was given.

By the evening of day 5, the patient regained consciousness, was extubated and maintained stable oxygenation.

On day 6 haemoglobin improved to 9.8g/dl, WBC 33,850/microL, platelets 68,000/microL, total bilirubin 2.8mg/dl(direct 1.0, indirect 1.8), SGOT 78IU/L, SGPT62IU/L.

On day 7, she developed multiple seizures progressing to status epilepticus for which CSF study was done, which was normal also MRI Brain was done which showed acute infarct in right splenium of corpus callosum in pericallosal branch of the posterior cerebral artery, suggestive of embolic stroke. With intensive supportive care, appropriate management with anticoagulant and antiplatelets, the patient was stabilized over the period of next 6 days and discharged on 14th day with clinically and vitally improved state.

Discussion

SCD complications arise due to multiple factors including haemolytic crisis, abnormal red cell structure, microvascular obstruction and thromboembolic episodes. Pulmonary hypertension being one of the serious cardiopulmonary complications, is thought to be because of repeated microvascular obstruction, nitric oxide depletion, and progressive vascular remodelling. The presence of severe tricuspid regurgitation and right sided failure in our patient suggest chronic pulmonary vascular disease likely precipitated by acute Vaso-occlusive crisis.

Cerebral infarction is another complication of SCD, with ischemic stroke affecting both children and adults [2]. In our case, the acute non haemorrhagic infarct in the splenium of the corpus callosum supplied by posterior cerebral artery points towards an embolic event, possibly due to patients hypercoagulable [6] and severe endothelial injury. Elevated D- dimer levels supports the active thrombus formation during hospitalization.

Bone marrow examination showed erythroid hyperplasia indication well-functioning marrow with ongoing compensatory haematopoiesis rather than marrow suppression, which then helped guide transfusion strategy. The absence of hepatosplenomegaly may reflect functional asplenia, a common long-term outcome in homozygous SCD.

This case highlights the clinical importance of considering SCD in adults presenting with unexplained fatigue, pain and anaemia. Early detection, monitoring the possible neurological and cardiovascular complications and timely institution of disease modifying therapy such as hydroxyurea [7] can be life saving and significantly improve prognosis [3].

Conclusion

Undiagnosed homozygous SCD presenting in adulthood can be life threatening due to its multisystem thromboembolic complications. A high index of suspicion and multidisciplinary approach involving prompt diagnosis, supportive therapy and targeted interventions proves to be life saving with good prognosis in such patients

Abbrevation

SCD	Sickle cell disease
b/l	bilateral
MRI	Magnetic resonance imaging
RBC	Red blood cell
SGOT	Serum glutamic oxaloacetic transaminase
SGPT	Serum glutamic pyruvic transaminase
CSF	Cerebro spinal fluid

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

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CASE REPORT

Fatal Phosgene Inhalation: A Case Report

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Abstract

Phosgene ($COCl_2$) is widely used in the chemical industry for the manufacture of isocyanates, carbamates, insecticides, herbicides, chloroformates, and pharmaceutical compounds such as barbiturates. Historically, phosgene was also employed as a chemical warfare agent during World War I due to its potent respiratory asphyxiation effects. Nowadays, fatalities associated with phosgene inhalation typically result from accidental occupational exposure in industrial settings. We report two cases of fatal accidental phosgene inhalation at a pharmaceutical industry in Visakhapatnam city. A total of 33 individuals were exposed following a phosgene leak during the manufacture of the anti-retroviral drug lamivudine. Although all affected individuals received initial treatment and were discharged, two developed short term to delayed symptoms and subsequently succumbed to poisoning. Autopsy findings in both cases revealed laryngeal oedema; congested and heavy bluish discoloured lungs; congestion and petechial hemorrhages in the tracheal walls; mucosal erosions in the stomach; along with bluish discoloration and congestion of other viscera. Histopathological examination of the lungs showed congested blood vessels, alveolar spaces filled with inflammatory cells and eosinophilic material, disrupted alveolar septa, and pulmonary oedema. The chemical analysis of viscera detected phosgene and hence the cause of death was determined as phosgene poisoning. Phosgene is a potent respiratory irritant that triggers lipoxygenase-derived leukotriene synthesis, causing systemic inflammation and pulmonary edema. Industrial physicians must be vigilant, and strict safety protocols are essential to prevent accidental exposures. Timely hospitalization and appropriate treatment are critical, as delayed onset of symptoms may occur even after initial recovery.

Keywords: Phosgene, Occupational exposure, Industrial accident, Respiratory asphyxiant

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Introduction

Phosgene (Carbonyl dichloride, $COCl_2$, CAS No: 75-44-5, Molecular weight: 98.92 gm/mol) is a highly toxic, colourless gas with an odour resembling freshly cut hay. It was historically used as a chemical warfare agent in World War I, accounting for 80% of the 100,000 gas-related deaths [1,2]. It is used in the manufacture of pharmaceuticals, polycarbonates, dyes, isocyanates, pesticides, and polyurethane precursors [3]. Phosgene, typically a gas at ambient conditions, can be stored as a liquid under pressure or at low temperatures, and has also been utilized in certain ore separation processes. The manufacture of isocyanates consumes about 85% of the world's phosgene production. Phosgene can also be produced as a by-product of welding or combustion of chlorinated hydrocarbons like polyvinyl chloride (PVC) [3]. In the present scenario, phosgene remains an industrially significant chemical, with global production exceeding 5 billion pounds annually [3].

Phosgene is three times heavier than air, forming dense plumes that settle in low-lying areas. It has poor water solubility but hydrolyses in moisture to form hydrochloric acid and carbon dioxide, leading to severe tissue damage. Inhalation is the primary route of exposure in occupational settings. Phosgene exposure can occur in fires involving certain chlorinated organic compounds found in many household solvents, paint removers, and dry-cleaning fluids or wool, Polyvinyl chloride, and other plastics [1,4]. The estimated lethal dose of phosgene in humans is approximately 500 ppm/min. Equivalent fatal exposures include 3 ppm for 170 minutes or 30 ppm for 17 minutes [1,4]. OSHA PEL (TWA): 0.1 ppm (0.4 mg/m^3); OSHA STEL: none set; NIOSH REL (TWA): 0.1 ppm (0.4 mg/m^3); NIOSH ceiling (15-min): 0.2 ppm (0.8 mg/m^3); ACGIH TLV-C: 0.02 ppm (no TLV-TWA/STEL).

The severity of phosgene toxicity is dependent on several factors, including the dose, duration, and route of exposure, as well as the individual's age, health status, and preexisting medical conditions [4,5]. Phosgene exerts its toxic effects through protein acylation, disrupting enzyme function and the blood-air barrier. There is no biological marker that predicts the onset of phosgene induced pulmonary injury with certainty. In general, the exposure occurs in industrial settings, fires involving chlorinated compounds, and atmospheric emissions. Due to its delayed onset of symptoms, increased awareness is needed not only among safety personnel and industrial workers but also among healthcare professionals for prompt recognition, effective management, and timely emergency response.

Case report

The present incident of phosgene gas exposure occurred following a chemical spillage at a pharmaceutical unit involved in the manufacturing of the anti-retroviral drug lamivudine. Among the 33 individuals exposed inhalationally (over a period of approximately two hours), a 23-year-old male succumbed at home approximately 21 hours after exposure (patient A), while another individual, a 35-year-old male (patient B), was referred to the emergency department of a tertiary care centre; approximately 22 hours post-exposure. On admission, the patient was in severe respiratory distress and unconscious, with a Glasgow Coma Scale (GCS) score of 6T (E1, VT, M5). On Examination vitals are as

follows: PR:98 bpm, RR-24 rpm, BP- 90/60 mm of Hg on inotropes, Spo2- 80% on ventilator. Laboratory investigations revealed the following parameters: RBS: 106 mg/dl, PT: 15.1 Sec, Hb: 21.9 g/dl, WBC count: 30,200 cells/cu.mm, RBC Count: 7.8 cells/cu.mm, arterial pH of 7.1, partial pressure of oxygen (PaO_2) at 54 mmHg, partial pressure of carbon dioxide ($PaCO_2$) at 50 mmHg, bicarbonate (HCO_3^-) level of 12.7 mmol/L, and troponin I level of 91 meq/mL.

Arterial blood gas (ABG) analyses performed at two subsequent time intervals revealed progressively worsening values. At the first interval, the pH was 6.98, with a pCO_2 of 108 mmHg, pO_2 of 9 mmHg, and HCO_3^- of 16.1 mmol/L. At the second interval approximately three hours later, the pH further declined to 6.95, with a pCO_2 of 100 mmHg, pO_2 of 31 mmHg, and HCO_3^- of 14.1 mmol/L. Despite medical management, he succumbed to the toxic effects of phosgene gas 34 hours after exposure.

Subsequent police investigation revealed serious lapses in safety and reporting protocols. It was discovered that the management directed the workers to clean the chemical spillage without providing any personal protective equipment (PPE) (the ideal PPE in such situation is Fully encapsulating Level A chemical-protective suit with positive-pressure SCBA, chemical-resistant gloves, and boots). Furthermore, it is learnt that the incident was deliberately concealed and not reported to the appropriate authorities. Following initial first aid at the facility, the exposed workers were sent home without referral to higher medical centres for definitive care. Approximately nine hours after exposure, the two highly affected individuals began experiencing severe symptoms, prompting them to seek hospital care. Hence, a negligence case was registered by the police under 106(1), 125(a), 125(b), 239, 286 BNS and both the cases were sent for autopsy. It is noteworthy that both the deceased were young males without any comorbidities as per available history.

At autopsy, in both cases, laryngeal edema was noted. The trachea and bronchi showed congestion, purpura, and petechial hemorrhages in the walls. The lungs were bluish discoloured, heavy, congested, and oedematous, indicative of pulmonary edema (Figures 2-3). Mucosal erosions were noted in the stomach. The liver, kidneys, and spleen were congested. Along with the routine viscera samples involving the liver, kidneys, stomach, small intestine contents, blood; the entire left lung tied at hilum was placed in a plastic bag and sent to the Regional Forensic Science Laboratory (RFSL) immediately for assessment of inhalational poisoning. The right lung and the whole heart (Figure 1) were sent for histopathological examination.

Chemical analysis of viscera was qualitatively positive for phosgene. Histopathology of the heart was unremarkable, while the histopathological examination of the lungs revealed congested blood vessels, alveolar spaces filled with inflammatory cells and pink eosinophilic material, disrupted alveolar septa, and pulmonary edema (Figures 4-6). Based on the autopsy and histopathological findings, along with the chemical analysis of viscera, and taking into account the inquest and accident analysis conducted by the Chief Inspector of Factories, Visakhapatnam, the cause of death was opined as death due to phosgene poisoning in both the cases.

Figure 1. Bluish tinge on the outer surface of left auricle of the heart (patient A)

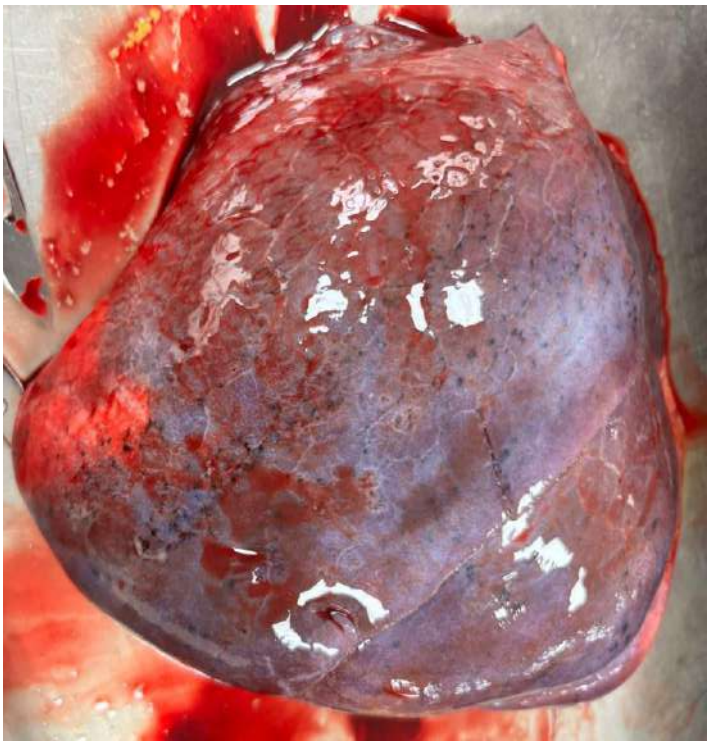

Figure 2. Heavy and voluminous right lung (patient B)

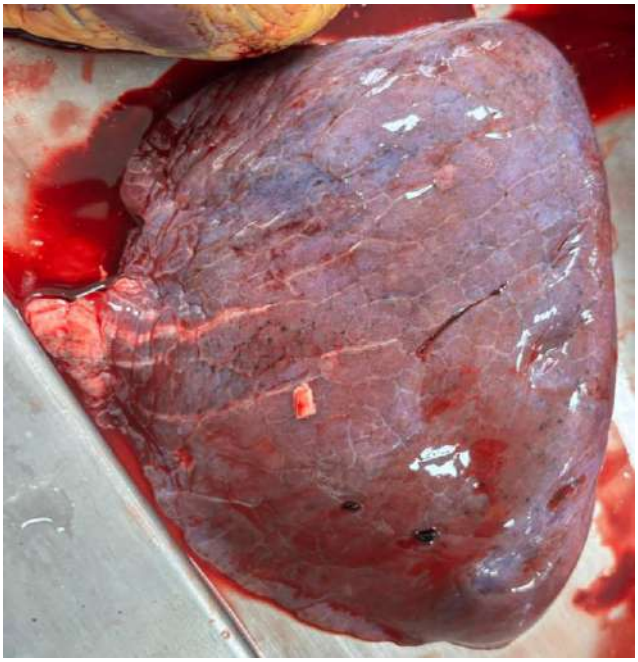

Figure 3. Heavy and voluminous left lung (patient B)

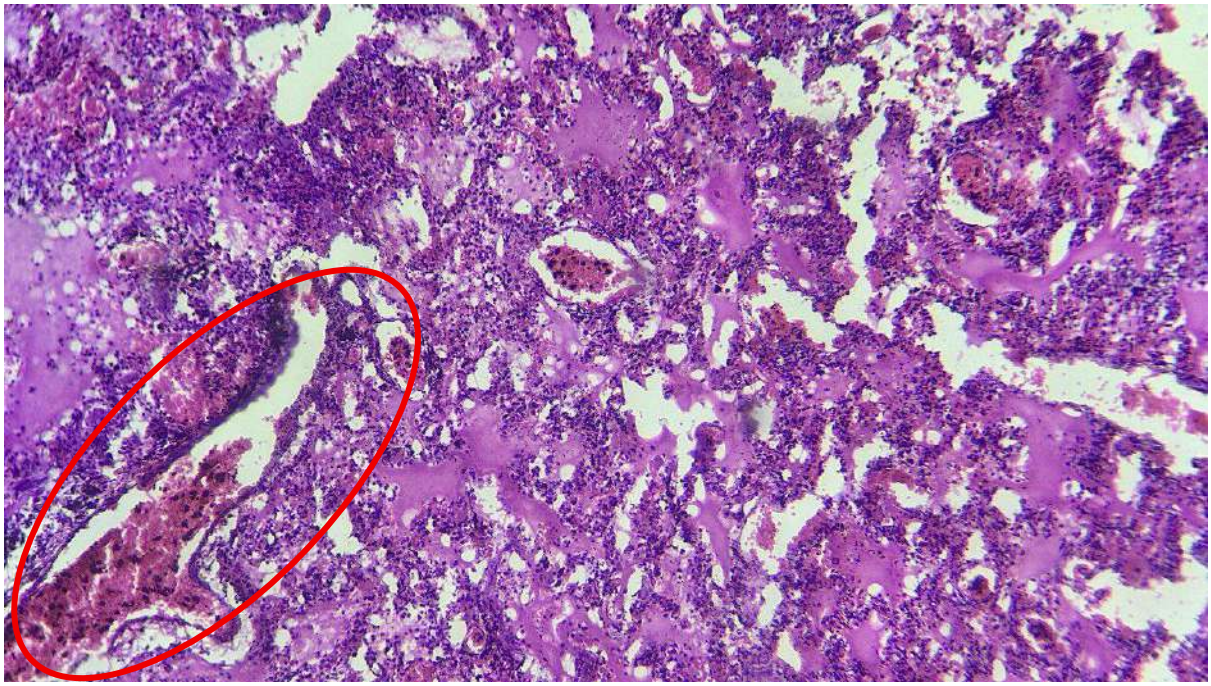

Figure 4. HPE Lung, H & E 100X, Congested blood vessels (patient A).

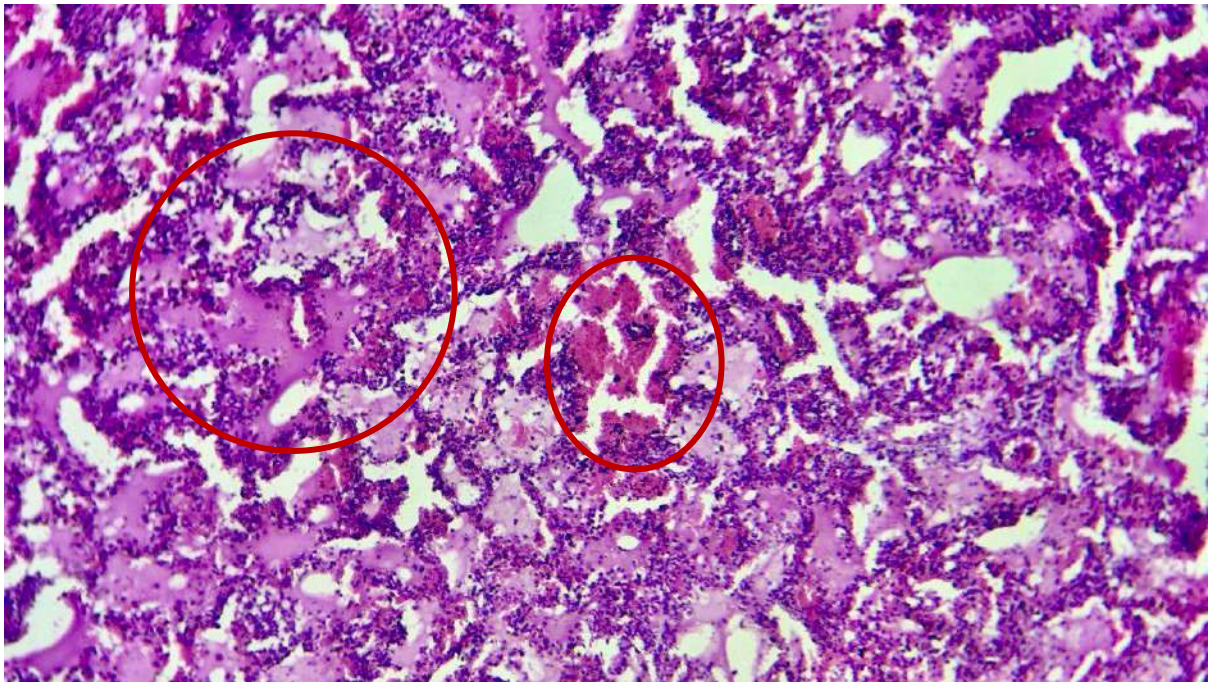

Figure 5. HPE Lung H & E 100X, Alveolar spaces filled with inflammatory cells, pink eosinophilic material in alveolar spaces (patient B).

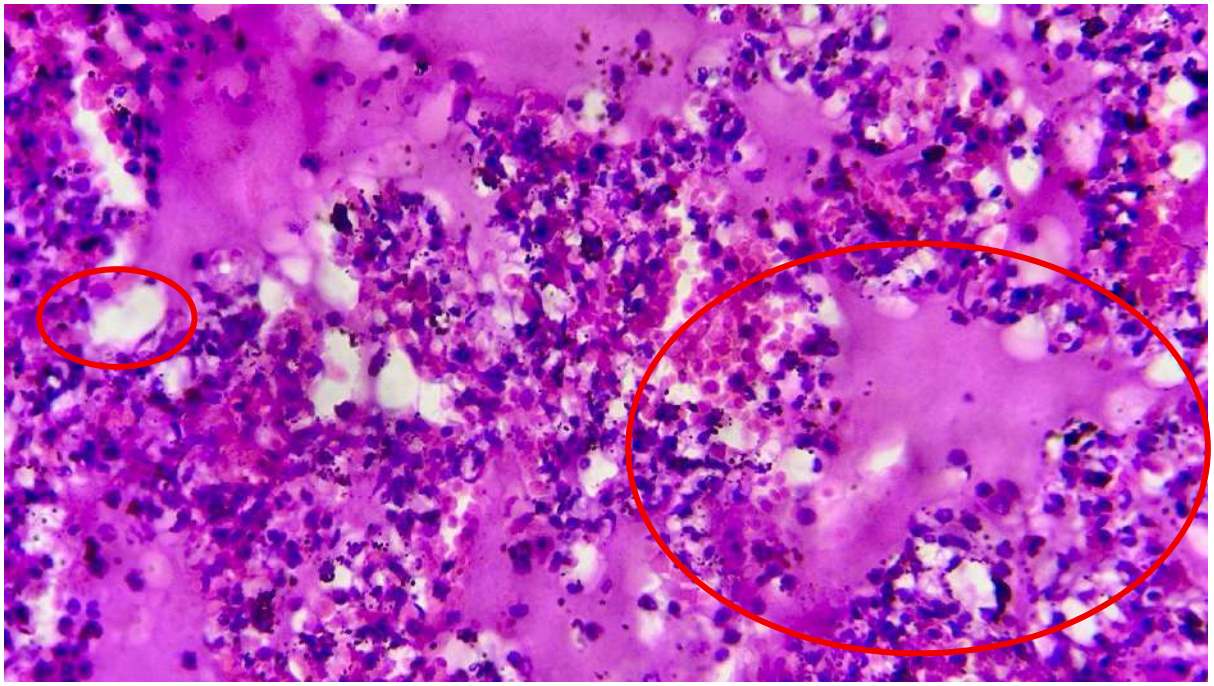

Figure 6. HPE Lung H & E 400X, Disrupted alveolar septa and pulmonary oedema (patient A)

Discussion

Phosgene ($COCl_2$) is a highly toxic respiratory asphyxiant. Upon inhalation, it reacts with moisture in the lungs to form hydrochloric acid (HCl) and carbon dioxide (CO_2). HCl damages the alveolar-capillary membrane, increasing permeability and leading to pulmonary edema. Toxicity arises via two primary mechanisms: hydrolysis and acylation. Hydrolysis results

in HCl and CO_2, but this accounts for only a portion of the damage under physiological conditions. The more harmful mechanism is acylation, wherein phosgene reacts with hydroxyl, thiol, amine, and sulfhydryl groups in proteins, lipids, and carbohydrates. This leads to oxidative injury, rapid glutathione depletion, and enhanced free radical damage. Furthermore, phosgene disrupts surfactant production, impairs gas exchange, and induces hypoxia [3]. The injury triggers an inflammatory response, exacerbating fluid accumulation and oxygenation impairment. Unlike immediate irritants such as chlorine, phosgene has a delayed onset of symptoms often up to 24 hours making early exposure deceptively mild.

At high concentrations, phosgene can cause severe pulmonary edema, acute respiratory distress syndrome (ARDS), and respiratory failure [1]. There is no specific antidote for phosgene poisoning. The treatment is primarily supportive, including oxygen therapy, mechanical ventilation, N-acetyl cysteine and corticosteroids to reduce inflammation [5].

In this industrial accident involving phosgene exposure, two out of the thirty-three exposed individuals succumbed to the delayed manifestation of toxic effects. The clinical presentation observed in the treated case (Patient B) included Type 1 respiratory failure, elevated haematocrit, leucocytosis, and pulmonary edema; findings consistent with those reported by Vaish et al. [2] in their case series. However, in contrast to the same case series, Troponin I levels were grossly elevated in Patient B, suggesting potential direct cardiac toxicity. Despite this, histopathological examination of the heart was unremarkable, which may be attributed to a shorter survival period in this case.

The ABG analysis in the present case showed severe respiratory acidosis with profound hypoxemia and partial metabolic compensation which is very typical of phosgene poisoning and is consistent with previous case reports [2-4]. The delayed onset non cardiogenic pulmonary oedema was evident in both the cases.

Bluish discoloration of the heart and lungs was a distinct finding in both cases of phosgene poisoning. In general, such discoloration is classically observed in methemoglobinemia, particularly due to nitrate, nitrite, or aniline poisoning [1]. In these poisonings, methylene blue is often administered as an antidote. It acts as an artificial electron carrier, reducing methaemoglobin back to functional haemoglobin via the NADPH-methaemoglobin reductase pathway. However, in the present cases, there was no history of methylene blue administration during management [6], suggesting that the observed discoloration was not related to methemoglobinemia or its treatment (methylene blue when administered at high doses can cause bluish discoloration of viscera).

While several clinical reports of phosgene poisoning document both survival and fatal outcomes, autopsy-based case studies are notably absent from the existing literature. This is one of the first reported autopsy case of phosgene poisoning in our region.

Phosgene-induced acute lung injury (P-ALI) is a condition in which inhalation of phosgene gas causes progressive pulmonary edema, respiratory distress, and hypoxemia that may lead to acute respiratory distress syndrome or death commonly associated with short-term phosgene inhalation. P-ALI is characterized

by pulmonary edema after 6–24 h of exposure, and its severity is dependent on the concentration × exposure duration. Fatalities associated with phosgene exposure predominantly occur in the early stage of severe P-ALI [7].

Phosgene exposure in industrial environments can be effectively minimized by establishing a comprehensive Safety Management System (SMS) that includes systematic hazard identification, risk assessment (HIRA), and periodic safety audits. Engineering measures such as fully enclosed equipment, gas detectors, and adequate ventilation are necessary along with administrative controls like clear standard operating procedures (SOPs), regular employee induction and refresher trainings, and clearly laid out emergency protocols. Plant equipment must incorporate both primary and secondary containment systems and be constructed with materials suitable for phosgene handling. Routine inspections, gas leak detection mechanisms, and pressure relief systems play a vital role in mitigating accidental releases. Likewise, appropriate personal protective equipment and dedicated breathing air systems are essential during maintenance and emergency interventions [8,9].

Conclusion

Phosgene is widely used in the manufacturing industry but is a highly hazardous chemical capable of causing severe lung injury, with both immediate and short term toxic effects following accidental exposure. Safety engineers and industrial physicians should be aware of the short term and delayed toxicity of phosgene inhalation to prevent morbidity and mortality associated with the industrial accidents.

In spite of its industrial relevance, phosgene toxicity remains insufficiently studied, and its underlying mechanisms are not fully understood. Further research is needed to explore new therapeutic strategies and repurpose existing drugs for the treatment of phosgene-associated lung injury (P-ALI). The potential for direct cardiac toxicity due to phosgene exposure warrants further investigation. In addition, the bluish discoloration of viscera observed in phosgene poisoning cases is an area of academic interest that may provide insights into its systemic effects.

Limitations

Radiological investigations were not performed in the admitted case as the patient was on mechanical ventilation and succumbed within a few hours of admission. Chemical analysis of the viscera qualitatively detected the presence of phosgene; however, quantitative analysis was not conducted. There is no verifiable data available pertaining to exact duration (assumed as about two hours as per police version) and dose of exposure, and the exact pre-existing health status of the deceased (we inferred as without any comorbidities).

The data pertaining to survivors of the industrial accident including their management, clinical outcomes and long term follow-up were not available. Phosgene as the causative factor of morbidity and mortality has been established independently by both the inquiry commission and the autopsy data. However, the authors have no access to the inquiry report.

Conflicts of interest

The authors declare that they do not have conflict of interest.

Funding

No funding was received for conducting this study.

Ethical considerations

All concerns were addressed by the authors. Consent for forensic autopsy in both the cases was obtained from law enforcement authorities.

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CASE REPORT

High-Grade Pulmonary Neuroendocrine Carcinoma (NEC) presenting as a Mediastinal Mass: A Morphological and Immunohistochemical Diagnostic Challenge

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Abstract

Background: Pulmonary neuroendocrine tumors (NETs) encompass a wide spectrum, ranging from well-differentiated neuroendocrine tumors (NETs: typical and atypical carcinoids) to poorly differentiated, high-grade neuroendocrine carcinomas (NECs: small cell lung carcinoma [SCLC] and large cell neuroendocrine carcinoma [LCNEC]). Accurate classification is critical for appropriate management. **Case Presentation:** A 75-year-old male with COPD and recurrent cerebrovascular accidents presented with progressive dyspnea, cough with mucoid expectoration, and low-grade fever. Imaging revealed a large mediastinal mass encasing the right pulmonary vessels with metastatic lung changes. CT-guided biopsy showed a malignant neoplasm with necrosis, high mitotic activity, and a Ki-67 index of 62%. Tumor cells expressed TTF-1, synaptophysin, and chromogranin, consistent with high-grade pulmonary NEC. NETs were excluded; morphology favored a differential diagnosis of SCLC versus LCNEC. **Conclusion:** This case highlights the diagnostic challenge of differentiating pulmonary NEC subtypes. Integration of morphology and immunohistochemistry is essential, as therapeutic strategies diverge markedly from those used for NETs.

Keywords: Pulmonary neuroendocrine carcinoma, Small cell lung carcinoma, Large cell neuroendocrine carcinoma, Mediastinal mass, Immunohistochemistry

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Introduction

Pulmonary neuroendocrine neoplasms (NENs) represent approximately 20% of primary lung cancers and are classified into two broad categories:

1. Well-differentiated neuroendocrine tumors (NETs): typical carcinoid and atypical carcinoid.
2. Poorly differentiated neuroendocrine carcinomas (NECs): small cell lung carcinoma (SCLC) and large cell neuroendocrine carcinoma (LCNEC) [1,2].

Distinguishing between NETs and NECs is crucial, as prognosis and management differ substantially [3]. While NETs exhibit relatively indolent behavior with low to moderate mitotic activity, NECs are aggressive, high-grade malignancies with rapid progression [4]. Morphology, supported by immunohistochemistry (IHC) and proliferation index (Ki-67), plays a central role in diagnosis, particularly when tissue is limited to small biopsy samples [5].

Case Report

A 75-year-old male, smoker, with COPD and recurrent strokes, presented with two months of cough, expectoration, low-grade fever, and progressive dyspnea (MMRC grade 2 → 4). Examination revealed digital clubbing, SpO_2 92% on room air, and reduced breath sounds on the right side.

Chest X-ray showed a right upper-zone mediastinal opacity with extension into mid and lower zones. Contrast-enhanced CT demonstrated a lobulated, homogeneously enhancing mediastinal mass (6.3 × 13.5 × 15.6 cm) extending into the right lung, encasing the right pulmonary artery and veins, and involving hilar and paratracheal regions. Patchy nodular infiltrates in both lungs suggested metastases. A thin right pleural effusion was present (Figure 1).

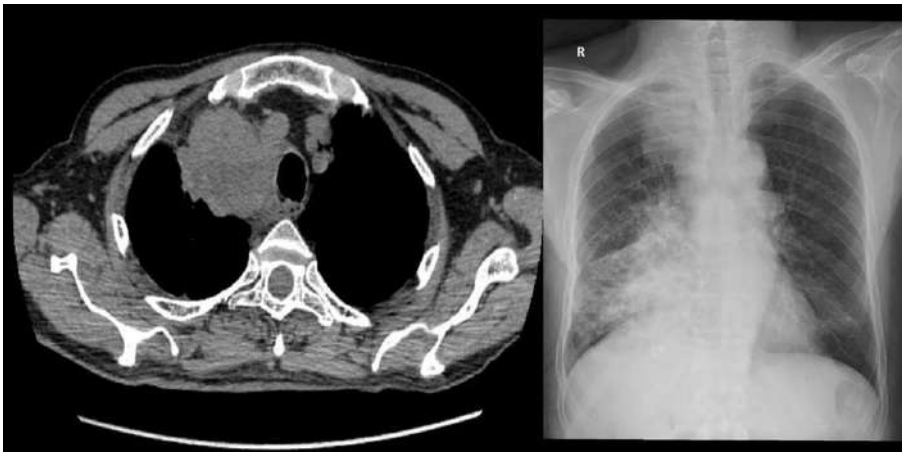

Figure 1. Chest X-ray (PA view) shows homogeneous opacity in the right upper zone extending into the paratracheal region, and a non-homogeneous opacity in the right mid and lower zones with loss of the right cardiac border. CT thorax reveals a lobulated, homogeneously enhancing mediastinal soft-tissue lesion (6.3 × 13.5 × 15.6 cm).

CT-guided biopsy revealed pleomorphic malignant cells in diffuse sheets with scant cytoplasm, hyperchromatic nuclei, frequent mitoses, and necrosis (Figure 2). IHC showed TTF-1 nuclear positivity, synaptophysin and chromogranin cytoplasmic positivity, scattered CK7 positivity, and high Ki-67 (~62%). CK20, LCA, and vimentin were negative; CD56 was non-contributory (Figure 3). Findings were consistent with high-grade pulmonary NEC [4,5]. In this case, the mediastinal involvement represents secondary extension from a centrally located pulmonary neuroendocrine carcinoma rather than a primary mediastinal tumor. This inference is supported by the radiologic pattern of contiguous spread from the right lung, the expression of TTF-1 on IHC—favoring pulmonary origin and the absence of features suggestive of thymic or primary mediastinal neuroendocrine carcinoma.

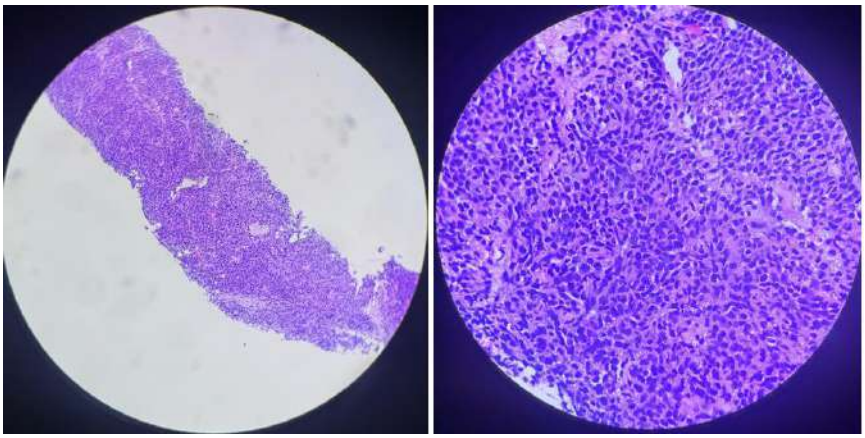

Figure 2. HPE shows diffuse sheets of pleomorphic malignant cells with scant cytoplasm, hyperchromatic nuclei, frequent mitoses, and necrosis.

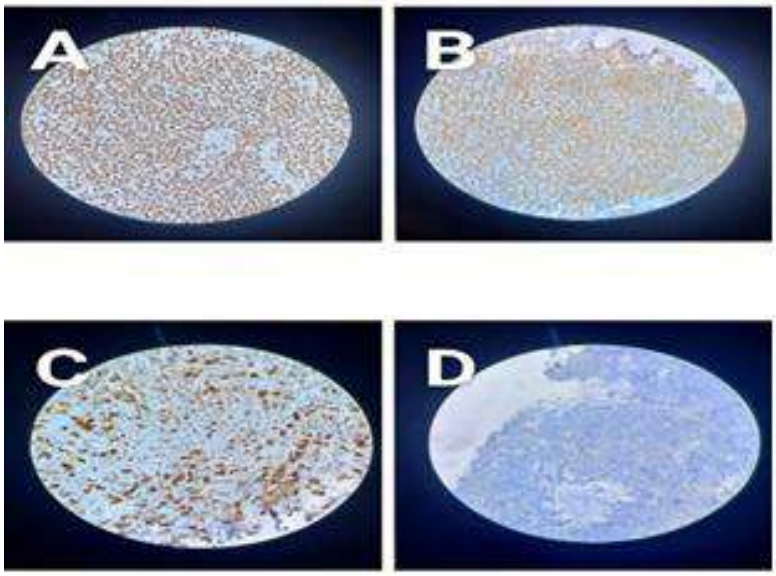

Figure 3. IHC demonstrates TTF-1 nuclear positivity, synaptophysin and chromogranin cytoplasmic positivity, and high Ki-67 (~62%), consistent with high-grade pulmonary neuroendocrine carcinoma.

The patient was diagnosed with stage IV disease and referred for further management to a dedicated Oncology centre and is currently under treatment.

Discussion

Pulmonary NENs are classified into four major histologic categories: typical carcinoid, atypical carcinoid (both NETs), large cell neuroendocrine carcinoma (LCNEC), and small cell lung carcinoma (SCLC) (both NECs) [1].

High-grade tumors (NECs: LCNEC and SCLC) are distinguished from NETs by marked mitotic activity, extensive necrosis, and a high proliferative index [2,5]. In the present case, the high Ki-67 index and positivity for neuroendocrine markers excluded a diagnosis of NET.

Differentiating between the two NEC subtypes—SCLC and LCNEC—remains challenging [3]. SCLC typically consists of small cells with nuclear molding, crush artifact, and scant cytoplasm, whereas LCNEC demonstrates larger polygonal cells, more abundant cytoplasm, and prominent nucleoli [4]. Both entities express neuroendocrine markers and TTF-1 and carry a poor prognosis [2]. However, management diverges: SCLC is generally treated with systemic chemotherapy and immunotherapy, whereas LCNEC, when localized, may be managed along non-small cell lung cancer (NSCLC) protocols [4].

The differential diagnosis in this setting also included thymic carcinoma and lymphoma, both of which can present as large anterior mediastinal masses. Thymic carcinoma typically arises from thymic epithelium, shows positivity for cytokeratin, CD5, and CD117, and lacks TTF-1 expression. In contrast, lymphomas are of lymphoid origin, express CD45 and lineage markers (CD3 or CD20), and are negative for epithelial and neuroendocrine markers. In the present case, the tumor's strong TTF-1 positivity excluded thymic and lymphoid malignancies, confirming pulmonary origin of the tumor.

The unusual presentation as a dominant mediastinal mass further expanded the differential diagnosis to include lymphoma and thymic carcinoma, emphasizing the central role of histopathology and immunohistochemistry in narrowing the diagnosis [1].

Conclusion

Pulmonary neuroendocrine carcinomas (NECs) present significant diagnostic challenges, particularly when they manifest as mediastinal masses. Careful integration of morphology, immunohistochemistry, and proliferative indices is essential to distinguish NECs (SCLC and LCNEC) from well-differentiated neuroendocrine tumors (NETs). Such differentiation is critical, as therapeutic approaches for NECs diverge substantially from those for NETs, and even between SCLC and LCNEC themselves [2,4,5].

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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CASE REPORT

Unmasking Sheehan's Syndrome: A Delayed Diagnosis of Postpartum Hypopituitarism

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Abstract

This case presents how a patient with multiple endocrine deficiencies having multiple hormonal and metabolic deficiencies eventually led to the diagnosis of Sheehan's syndrome (a rare condition occurring after postpartum haemorrhage during child birth leading to pituitary apoplexy causing Sheehan's syndrome). A 40year old female patient brought to emergency in an unconscious state with GCS score of 5 having severe hypoglycaemia (BSL 26 mg/dl) on presentation with vitals pulse 58 bpm, BP 80/50 mmHg, and SpO_2 95%. Patient was immediately shifted to ICU and corrected hypoglycaemia. Despite correction of hypoglycaemia the patient remained unconscious following which further evaluation was done suggested severe hypothyroidism with severe adrenal insufficiencies with hyponatremia with meningitis (CSF studies done). After taking detailed history including obstetric history patient relatives gave history of abortion 6 months ago with massive blood loss (PPH). Patient gradually responded to hormonal therapy. To identify the underlying cause, an MRI with contrast performed which revealed Empty Sella Turcica confirming Sheehan's syndrome.

Keywords: Sheehan's Syndrome, Multiple Endocrine Syndrome, Hypopituitarism, Postpartum Haemorrhage, Hormone Replacement Therapy

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Introduction

Sheehan's syndrome is a rare but serious postpartum complication that results from ischemic necrosis of the pituitary gland following severe postpartum haemorrhage (PPH). This condition leads to varying degrees of hypopituitarism, manifesting in multiple endocrine deficiencies. The clinical presentation of Sheehan's syndrome can often be delayed or subtle, making its diagnosis challenging. The affected pituitary gland fails to produce sufficient levels of essential hormones, leading to dysfunctions in the thyroid, adrenal, and gonadal axes. Although a small percentage of patients with Sheehan's syndrome may cause an abrupt onset of severe hypopituitarism immediately after delivery, most patients have a mild disease and go undiagnosed and untreated for a long time. It may result in partial or panhypopituitarism and GH is one of the hormones lost earliest. Hypotension or shock due to massive bleeding during or soon after delivery results in ischemic necrosis of the enlarged pituitary gland during pregnancy, followed by variable degrees of anterior and sometimes posterior pituitary gland dysfunction. The improved obstetrical care decreased the incidence of SS significantly; however, SS should always be kept in mind in the aetiologies of hypopituitarism in women [**Error! R eference source not found.**. The great majority of the patients has empty Sella on CT or MRI [**Error! Reference source not f ound.** In many cases, patients present with symptoms resembling other endocrine disorders, such as Multiple Endocrine Syndrome (MES), where two or more hormonal systems are disrupted [**Error! R eference source not found.**. The clinical manifestations of SS vary depending on the extent of pituitary damage and may include fatigue, amenorrhea, hypoglycaemia, hypotension, and features mimicking other endocrine disorders such as Multiple Endocrine Syndrome (MES) [5]. This overlapping symptomatology makes the accurate diagnosis of Sheehan's syndrome complex, often resulting in misdiagnosis. Common symptoms include fatigue, amenorrhea, failure of lactation, and signs of adrenal insufficiency. Without timely diagnosis and treatment, patients may face life-threatening complications due to the progressive nature of pituitary failure.

This case report explores a patient who initially presented with features suggestive of Multiple Endocrine Syndrome, involving dysfunctions of the thyroid, adrenal, and gonadal systems. However, detailed diagnostic evaluation revealed Sheehan’s syndrome as the underlying cause. This case highlights the importance of considering postpartum endocrine disorders in the differential diagnosis when dealing with multisystem hormonal abnormalities in middle age female patients.

By presenting this case, we aim to raise awareness about the diagnostic challenges posed by Sheehan’s syndrome especially in middle age group following miscarriage/abortion as its differentiation from other endocrine disorders, and the need for prompt recognition and management to prevent further morbidity and mortality.

Case Discussion

We report the case of a 40-year-old Female brought by relatives in a unconscious state with chief complaints of sudden onset irrelevant talk with irrational behaviour followed by sudden loss of consciousness 1-2 hrs ago. Patient was immediately shifted to ICU and blood sugar

level was checked (BSL-26 mg/dl). Dextrose 25% was administered. Patient still remained unconscious following which further evaluation was done. Patient MRI plain suggested cerebral edema. and CSF Analysis indicative of Meningitis. She was treated for the same with osmotic diuretics and Antibiotics and other supportive measures. The patient exhibited persistent bradycardia, recurrent hypoglycemic episodes, and hypotension which prompted us to perform free TFT and serum cortisol levels which were found to be deranged where Free T3 levels came <0.00 pg/ml and Free T4 – 0.26 pg/ml TSH – 3.31 µIU/mL. and serum cortisol – 5.77 µg/dL following which we came to the diagnosis of myxoedema coma for which she was treated with levothyroxine and glucocorticoid to which she gradually started responding. As sudden onset of this condition is rare and concrete cause for the same is still remain uncertain therefore, we repeatedly ask relative for any particular history they are hiding following which they gave history of abortion 6 months ago where she suffered massive blood loss which gave us a clue regarding pituitary cause for same. After which MRI contrast revealed Empty Sella Turcica which gave us a diagnosis of Sheehan's syndrome.

Laboratory investigations

Haemoglobin (Hb) – 10.0mg/dl
Total WBC – 3110 cells/ cumm
PCV – 30.0 %
Platelet count – 185000 / cumm
Serum Sodium – 123 mmol/L
Serum Potassium – 4.2 mmol/L
Serum Chloride – 94 mmol/L

Free TTF

Free T3 - <0.00 pg/ml
FreeT4 – 0.26 pg/ml
TSH – 3.31 µIU/mL
Serum cortisol (8am) – 5. µg/dL

CSF analysis

Macroscopy

Quantity – 1.5 ML
Colour – Clear and Colourless
Appearance – Clear
Cobweb – Absent
Deposit – Absent
Protein – 34 Mg/Dl
Sugar – 104 Mg/Dl

Microscopy

Total nucleated cells – 76 / cumm
(Neutrophils: 34%, Lymphocytes: 65%)
RBCs – 25/hpf
ADA report: 4.21 U/L

Impression: Meningitis

MRI BRAIN (plain + contrast) – EMPTY SELLA TURCICA (Figures 1 and 2).

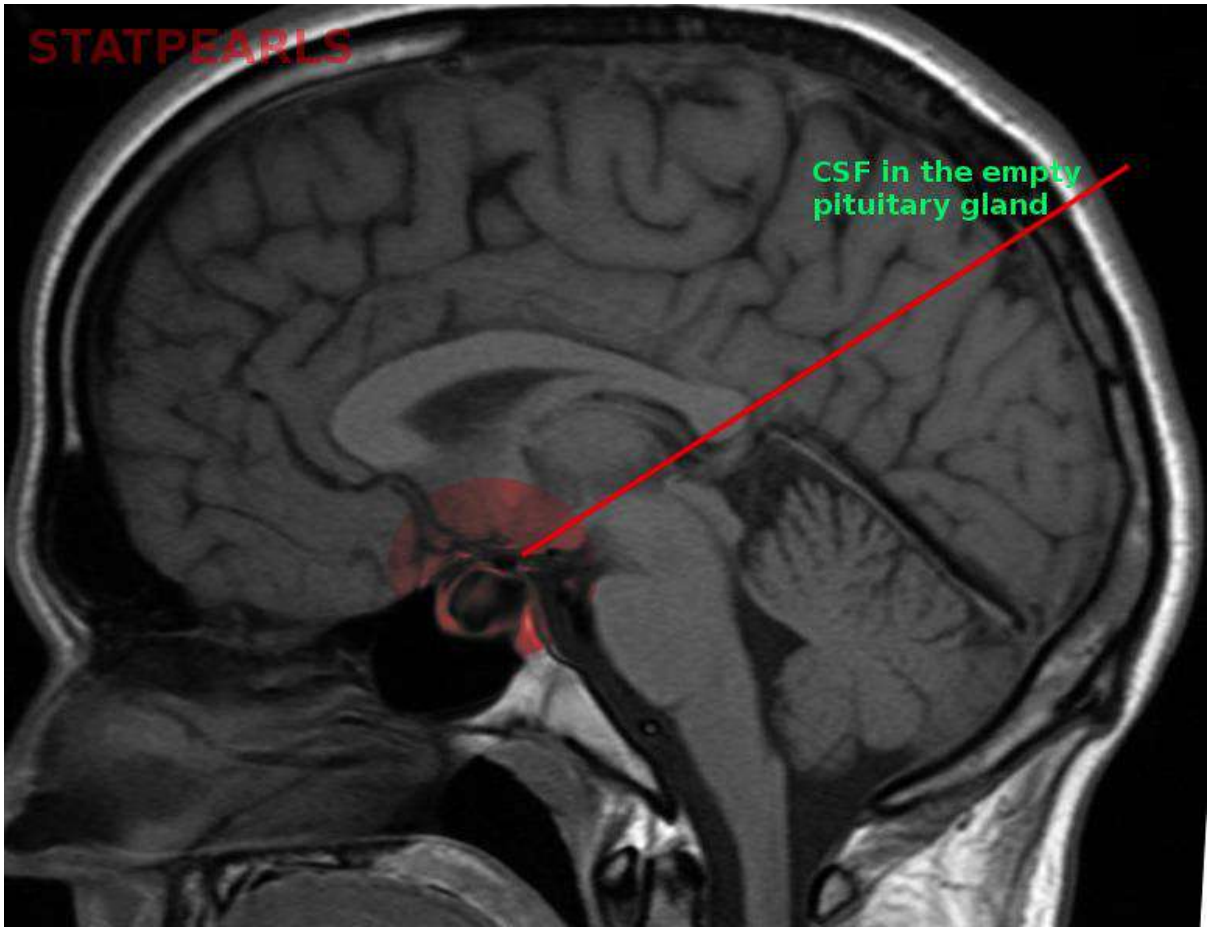

Figure 1. Empty Sella on MRI. Cerebral spinal fluid fills the sella turcica and empty pituitary gland. Image courtesy S Bhimji, MD [9]

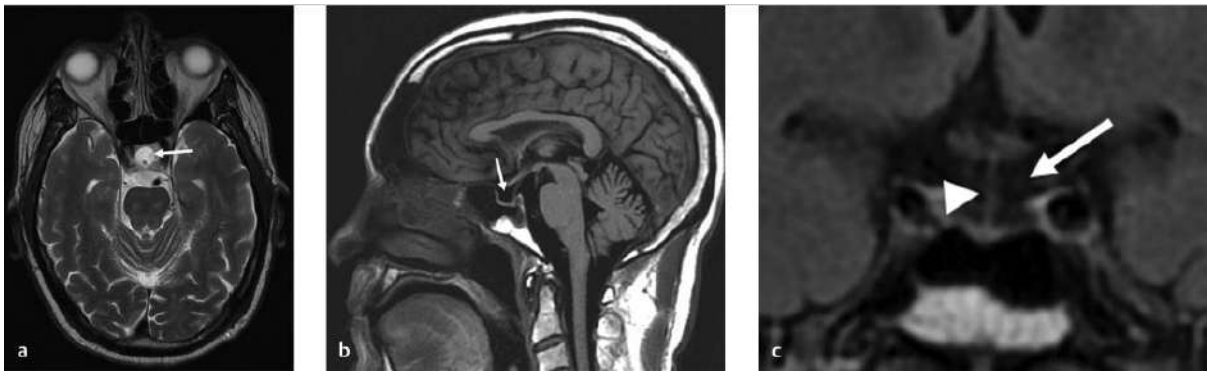

Figure 2 (a-c). Brain MR images without contrast including axial T2-weighted (fig.2-a), sagittal T1-weighted (fig2-b), and coronal fluid-attenuated inversion recovery (FLAIR)(fig2-c) sequences demonstrate an empty sella (white arrows) filled with CSF with nonvisualization of the pituitary gland. However, the pituitary stalk can be visualized (arrow head)

Treatment and Outcome

Patient was treated with levothyroxine and glucocorticoids with other supportive treatment consist of Antibiotics; Antacids; osmotic diuretics; Antiepileptics; Multivitamins; Hormone replacement; IV Fluids; RT feeding etc.

The diagnosis of Multiple Endocrine Syndrome was considered due to the involvement of various hormonal systems and on further investigation, a

detailed obstetric history and pituitary hormone profiling, Sheehan's syndrome was identified as the underlying cause. Magnetic resonance imaging (MRI) revealed an Empty Sella Turcica, confirming the diagnosis. The patient was immediately treated with hormone replacement therapy with glucocorticoids and levothyroxine, leading to significant clinical improvement. patient was discharged with stable vital signs and oriented to time, place, and person.

Discussion

Sheehan's syndrome, also known as postpartum hypopituitarism, occurs due to ischemic necrosis of the pituitary gland following severe postpartum haemorrhage although typically observed in younger women following childbirth, this case highlights its incidence even in middle age female especially following abortion / miscarriage which are usually missed on presentation.

In middle age and elderly women as age progresses the complexity of diagnosing Sheehan's become more difficult due to symptoms such as fatigue, weight loss, reduced mental function, and weakness can be seen in normal aging or other comorbid conditions which are common in older age, like depression or hypothyroidism.

Diagnosing Sheehan's syndrome in the middle age and elderly requires a high index of suspicion, especially in women with a history of severe postpartum haemorrhage or peripartum bleeding and the absence of lactation postpartum, cognitive decline or mental sluggishness which may worsen if left untreated.

The patient's overall quality of life improves significantly when treated with proper hormone replacement therapy and glucocorticoids.

Gonadal hormone replacement is recommended in premenopausal women with Sheehan syndrome, unless there is a contraindication (such as deep vein thrombosis, pulmonary embolism, severe cirrhosis, active viral hepatitis and uncontrolled severe hypertension) [7]. Treatment can be continued until the average age of menopause relevant to that population. Oral oestrogen preparations can lower IGF-1 levels which will be important in patients on GH treatment [8].

Conclusion

This case highlights that the diagnosis of Sheehan's syndrome in middle-aged and elderly women pose diagnostic challenges that can lead to delayed or missed diagnoses especially in those patients who are coming to emergency with severe cases of multiple endocrine disorders and difficulty in getting detailed history including obstetric history. Therefore, even in middle-aged and elderly women presenting with multiple endocrines disorders require thorough evaluation and detailed obstetric history should be taken into consideration to diagnosed Sheehan's syndrome as it is completely manageable and expected good clinical outcome as we can see in this patient with hormone replacement therapy and other supplemental medications. MRI is the diagnostic modality of choice and typically shows partial or complete empty Sella [4]. Early diagnosis and timely hormone replacement therapy are essential to prevent life-threatening endocrine crises and improve outcomes [3].

ABBREVATION:
Glasglow Coma Scale – GCS
Multiple Endocrine Syndrome – MES
Postpartum Haemorrhage – PPH
Intensive Care Unit – ICU
Lumbar Puncture – LP
Thyroid Function Test – TFT
Magnetic Resonance Imaging – MRI

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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