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IOT-integrated home-based palliative care monitoring system for continuous nursing support and family caregiver assistance

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Abstract:

Home-based palliative care has become an increasingly important model of healthcare for individuals living with life-limiting illnesses by promoting comfort, symptom control, dignity, and quality of life within the familiar home environment. However, the growing demand for continuous care, increasing complexity of chronic diseases, limited access to healthcare professionals, and the substantial responsibilities placed on family caregivers present significant challenges to delivering timely and effective palliative services. The integration of the Internet of Things (IoT) with wearable biosensors, smart medical devices, cloud computing, mobile health applications, telehealth, and artificial intelligence (AI) has created new opportunities for continuous remote monitoring and personalised care management. IoT-integrated home-based palliative care monitoring systems enable real-time assessment of physiological parameters, symptom progression, medication adherence, physical activity, sleep quality, and patient-reported outcomes while facilitating secure communication between patients, nurses, physicians, and family caregivers. AI-driven analytical models support early identification of symptom deterioration, predict potential clinical complications, and provide evidence-based decision support to assist nursing interventions and multidisciplinary care planning. These intelligent systems also strengthen family caregiver assistance through digital education, medication reminders, emergency alerts, teleconsultation, and continuous professional guidance, thereby improving caregiver confidence and reducing care-related burden. The implementation of IoT technologies contributes to enhanced continuity of care, fewer unnecessary hospital admissions, improved symptom management, and greater patient comfort by enabling proactive rather than reactive clinical interventions. Although challenges related to data privacy, cybersecurity, interoperability, infrastructure, digital literacy, and ethical governance remain, ongoing technological advances are expected to improve the accessibility, reliability, and effectiveness of intelligent home monitoring systems. The integration of IoT-enabled monitoring with skilled nursing practice and family-centred care has the potential to transform home-based palliative care by supporting timely clinical decision-making, improving quality of life, strengthening caregiver support, and promoting safe, compassionate, and patient-centred healthcare.

Keywords:

Internet of Things; Home-based palliative care; Remote patient monitoring; Artificial intelligence; Nursing support; Family caregiver assistance; Telehealth; Wearable biosensors; Clinical decision support; Symptom monitoring; Digital health; Quality of life.

1. Introduction:

Palliative care is a holistic approach that aims to improve the quality of life of individuals living with life-limiting or progressive illnesses by preventing and relieving suffering through early identification, comprehensive assessment, and effective management of physical, psychological, social, and spiritual needs. As the global burden of chronic diseases, cancer, advanced cardiovascular disorders, chronic respiratory

illnesses, neurological conditions, and age-related frailty continues to rise, the demand for accessible and sustainable palliative care services has increased substantially. Many patients prefer to remain in their homes during the advanced stages of illness because home-based care offers greater comfort, familiarity, emotional security, and opportunities for meaningful interaction with family members. However, providing high-quality palliative care in the home environment presents several challenges, including limited access to healthcare professionals, delayed recognition of symptom deterioration, inadequate caregiver support, and difficulties in maintaining continuous clinical monitoring.

Recent advances in digital health technologies have created new opportunities to strengthen home-based palliative care through continuous remote monitoring and intelligent clinical support. Among these innovations, the Internet of Things (IoT) has emerged as a transformative technology capable of connecting medical devices, wearable biosensors, smartphones, home monitoring equipment, and healthcare information systems through secure communication networks. By enabling continuous collection and transmission of physiological and symptom-related data, IoT allows healthcare professionals to monitor patients remotely, detect early signs of clinical deterioration, and provide timely interventions without requiring frequent hospital visits.

An IoT-integrated home-based palliative care monitoring system combines wearable sensors, smart medical devices, cloud computing, mobile health applications, artificial intelligence (AI), and telecommunication technologies into a unified platform that supports patients, nurses, physicians, and family caregivers. Physiological parameters such as heart rate, respiratory rate, oxygen saturation, blood pressure, body temperature, physical activity, sleep quality, and medication adherence can be monitored continuously while patients remain in their own homes. AI-driven analytical algorithms evaluate these data alongside symptom reports, medical history, and individual risk factors to identify clinically significant changes and generate evidence-based recommendations for nursing interventions[1].

2. Principles of home-based palliative care:

Home-based palliative care is founded on the principle that individuals with life-limiting illnesses should receive comprehensive, compassionate, and person-centred care in the environment that best supports their physical comfort, emotional well-being, and personal preferences. The primary objective is not only to manage symptoms but also to preserve dignity, maintain independence where possible, and improve overall quality of life for both patients and their families.

Unlike curative treatment, palliative care focuses on relieving suffering rather than eliminating disease. Patients receiving home-based palliative care often experience complex symptoms such as persistent pain, breathlessness, fatigue, nausea, anxiety, depression, sleep disturbances, reduced mobility, and nutritional problems. Effective management requires continuous assessment, timely intervention, and close collaboration among healthcare professionals, patients, and family caregivers.

A multidisciplinary approach is fundamental to successful palliative care. Nurses, physicians, physiotherapists, occupational therapists, pharmacists, dietitians, psychologists, social workers, and spiritual care providers contribute specialised expertise while working collaboratively to address the diverse needs of patients. Nurses frequently coordinate these services, ensuring that care remains integrated, responsive, and aligned with individual preferences.

Symptom management represents one of the most important components of home-based care. Pain assessment should be continuous because symptom intensity often fluctuates during disease progression. Similarly, respiratory distress, fatigue, confusion, constipation, and psychological symptoms require ongoing evaluation to ensure prompt adjustment of treatment plans. Traditional home visits may not always detect these changes early, highlighting the importance of continuous remote monitoring.

Communication forms another essential principle of palliative care. Patients and family members require clear, compassionate, and timely information regarding disease progression, treatment options, symptom management, advance care planning, and available support services. Open communication strengthens trust, facilitates shared decision-making, and enables care that respects patient values and preferences.

Family-centred care is equally important. Serious illness affects not only patients but also those who provide daily care and emotional support. Caregivers often experience stress, fatigue, financial strain, and emotional exhaustion. Providing education, psychological support, and practical guidance enables caregivers to perform their responsibilities safely while maintaining their own well-being[2].

3. Need for IOT-integrated monitoring in home-based palliative care:

The growing demand for home-based palliative care has highlighted limitations in traditional models of service delivery. Although scheduled home visits remain essential, they provide only intermittent assessment and may

not identify rapidly changing symptoms between visits. Patients with advanced illnesses often experience unpredictable fluctuations in their clinical condition, making continuous monitoring increasingly important.

Many symptoms associated with palliative care develop gradually before becoming clinically significant. Progressive respiratory distress, worsening pain, declining mobility, reduced oxygen saturation, dehydration, infection, delirium, or cardiovascular instability may remain unnoticed until they require emergency medical attention. Continuous IoT-based monitoring allows healthcare professionals to identify these changes at an earlier stage and intervene before complications occur.

Geographical barriers also contribute to delayed care. Patients living in rural or remote areas may have limited access to specialist palliative care services, while travel requirements place additional physical and financial burdens on individuals with advanced illness. Remote monitoring technologies reduce dependence on frequent hospital attendance by enabling healthcare professionals to evaluate patient status from a distance[3].

Increasing healthcare demand has placed considerable pressure on community nursing services. Large caseloads, workforce shortages, and expanding ageing populations make it difficult to provide frequent in-person assessments for every patient. IoT-assisted monitoring enables nurses to prioritise visits according to clinical urgency, thereby improving efficiency while maintaining high standards of care.

4. Architecture of the IOT-integrated home-based palliative care monitoring system:

An IoT-integrated home-based palliative care monitoring system is designed to provide continuous, real-time monitoring of patients with life-limiting illnesses while enabling healthcare professionals and family caregivers to deliver coordinated, patient-centred care. Unlike traditional home care models that rely primarily on scheduled visits and telephone consultations, an IoT-enabled system continuously collects physiological and symptom-related information, analyses patient status using artificial intelligence (AI), and supports timely clinical decision-making through secure digital communication.

The architecture of the system consists of several interconnected components that function together to ensure continuous monitoring and efficient information exchange. The first component is the patient monitoring layer, which includes wearable biosensors and smart medical devices. These devices continuously measure physiological parameters such as heart rate, respiratory rate, oxygen saturation (SpO_2), blood pressure, body temperature, blood glucose (when indicated), sleep quality, physical activity, body position, and fall events. Patients may also use mobile applications to report symptoms including pain intensity, fatigue, nausea, anxiety, breathlessness, appetite loss, constipation, sleep disturbances, and emotional well-being.

The second component is the communication layer, which enables secure transmission of patient data. Information collected by wearable devices is transferred through Bluetooth, Wi-Fi, or cellular networks to smartphones, home monitoring hubs, or dedicated gateway devices. These platforms securely transmit encrypted information to cloud-based healthcare servers while maintaining data integrity and patient confidentiality.

The third component is the cloud computing platform, where patient information is stored, organised, and processed. Cloud infrastructure allows healthcare professionals to access updated patient information from hospitals, community healthcare centres, or remote clinical locations. Secure cloud storage also facilitates long-term analysis of symptom trends and supports multidisciplinary collaboration[4].

Table. 1: Components and Clinical Functions of the IoT-Integrated Home-Based Palliative Care Monitoring System

Component	Clinical Function
Wearable Biosensors	Monitor heart rate, respiratory rate, oxygen saturation, temperature, activity, and sleep
Smart Medical Devices	Measure blood pressure, blood glucose, body weight, and other disease-specific parameters
Mobile Health Application	Record symptoms, pain scores, medication adherence, and patient-reported outcomes
Communication Gateway	Secure transmission of patient information through wireless networks
Cloud Computing Platform	Data storage, integration, trend analysis, and remote accessibility
AI Decision Support Engine	Predict symptom deterioration and generate personalised clinical recommendations
Nursing Dashboard	Continuous patient monitoring, risk alerts, documentation, and care planning
Family Caregiver Interface	Medication reminders, educational resources, communication, and emergency notifications

5. Physiological and symptom monitoring technologies:

Continuous monitoring is fundamental to effective home-based palliative care because symptom severity may fluctuate rapidly during disease progression. IoT technologies enable the collection of objective physiological information alongside patient-reported symptoms, providing healthcare professionals with a comprehensive understanding of each individual's clinical condition.

Wearable biosensors have become increasingly sophisticated while remaining lightweight, comfortable, and suitable for long-term use. Smart wristbands, adhesive patches, chest sensors, and wearable garments continuously measure heart rate, respiratory rate, oxygen saturation, skin temperature, physical activity, and sleep quality. Continuous monitoring enables early recognition of physiological changes that may precede clinical deterioration.

Heart rate monitoring provides valuable information regarding cardiovascular function, pain, anxiety, dehydration, infection, and medication effects. Persistent tachycardia may indicate uncontrolled pain, fever, or hypovolaemia, whereas bradycardia may reflect medication toxicity or progressive physiological decline.

Respiratory monitoring is particularly important because breathlessness is one of the most distressing symptoms experienced by patients receiving palliative care. Continuous assessment of respiratory rate, breathing pattern, oxygen saturation, and respiratory effort allows healthcare professionals to identify worsening respiratory function before severe distress develops[5].

Physical activity monitoring provides indirect information regarding functional status and disease progression. Declining mobility, prolonged bed rest, or reduced daily activity often reflects worsening illness, increasing fatigue, or uncontrolled symptoms. Activity sensors also contribute to fall detection and injury prevention.

Sleep monitoring has emerged as an important component of palliative care because poor sleep quality is associated with pain, anxiety, depression, respiratory symptoms, and reduced quality of life. Continuous assessment of sleep duration and sleep interruptions assists nurses in evaluating treatment effectiveness and planning symptom management strategies.

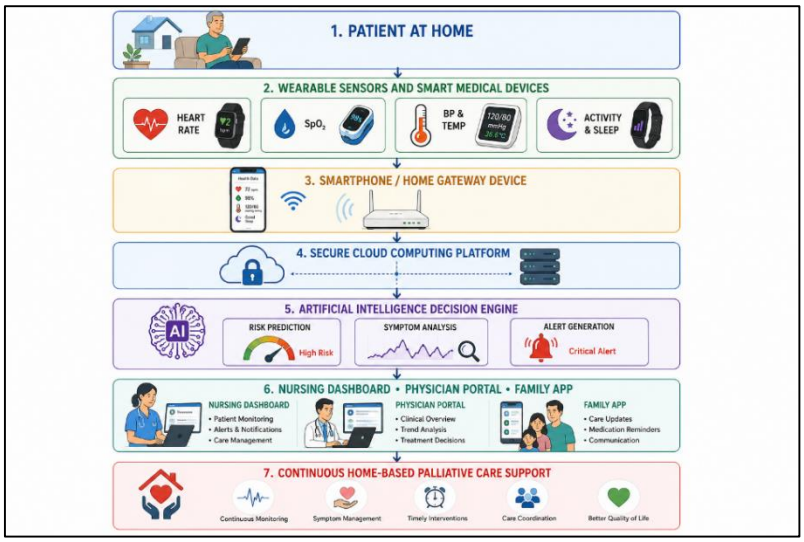

Figure. 1: Architecture of the IoT-Integrated Home-Based Palliative Care Monitoring System

6. Artificial intelligence for symptom prediction and clinical decision support:

Artificial intelligence enhances IoT-based palliative care by transforming continuous patient monitoring into meaningful clinical decision support. Rather than simply displaying physiological measurements, AI identifies patterns, predicts deterioration, and recommends timely interventions based on large volumes of patient-specific information.

Machine learning algorithms analyse physiological trends together with symptom reports, medication records, previous hospital admissions, laboratory findings, and disease characteristics. This comprehensive analysis enables AI to recognise subtle changes that may indicate worsening clinical status before symptoms become severe[6].

Pain prediction is one of the most valuable applications of AI in palliative care. Variations in heart rate, sleep quality, physical activity, facial expressions, and patient-reported pain scores can be analysed to estimate pain severity and evaluate treatment effectiveness. Early identification of uncontrolled pain allows nurses to adjust care plans promptly in collaboration with physicians.

AI also assists in recognising respiratory deterioration by analysing respiratory rate, oxygen saturation, activity levels, and patient-reported breathlessness. Predictive alerts enable timely interventions such as oxygen therapy, medication adjustment, or urgent medical review.

Nutritional decline is another important area of application. AI integrates information regarding appetite, body weight, physical activity, hydration status, and gastrointestinal symptoms to identify patients at risk of malnutrition or dehydration. Nurses can then implement nutritional support strategies before significant deterioration occurs.

7. Continuous nursing support through remote monitoring:

Continuous nursing support is a fundamental component of high-quality home-based palliative care and long-term chronic disease management. Patients with advanced illnesses often experience fluctuating symptoms that require frequent assessment, timely intervention, and ongoing emotional support. Traditional home visits provide valuable direct nursing care; however, they are usually scheduled at fixed intervals, creating periods during which symptom deterioration may remain undetected. Delayed recognition of worsening symptoms can lead to unnecessary suffering, emergency hospital admissions, and reduced quality of life.

The integration of the Internet of Things (IoT), Artificial Intelligence (AI), wearable biosensors, and telehealth technologies has transformed the delivery of home healthcare. Remote monitoring systems enable nurses to continuously observe patients' physiological status, symptom progression, medication adherence, and overall well-being without requiring the patient to travel to a healthcare facility. By providing real-time clinical information, these technologies support early detection of health deterioration, timely nursing interventions, and improved continuity of care.

Unlike conventional monitoring methods that rely on periodic assessments, AI-enabled remote monitoring provides continuous surveillance and intelligent analysis of patient data. This proactive approach allows nurses to identify subtle clinical changes before they develop into serious complications, thereby improving patient safety and enhancing the quality of palliative care[7].

8. Components of remote nursing monitoring:

A comprehensive remote monitoring system collects and integrates information from multiple sources.

Nurses can continuously review:

- Heart rate
- Blood pressure
- Respiratory rate
- Oxygen saturation (SpO_2)
- Body temperature
- Blood glucose levels (where applicable)
- Pain scores
- Medication adherence
- Sleep quality
- Physical activity and mobility
- Weight changes
- Fluid intake and output
- Patient-reported symptoms
- Caregiver observations
- Video consultation findings

All collected information is displayed through secure digital dashboards, allowing nurses to monitor patient status from hospitals, community health centres, or home healthcare services.

9. AI-assisted clinical surveillance:

Artificial Intelligence continuously analyses incoming patient data and compares it with:

- Individual baseline values
- Previous physiological trends
- Clinical practice guidelines
- Symptom progression patterns
- Predictive risk models

When clinically significant abnormalities are detected, the system generates automated alerts according to the severity of the patient's condition.

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9.1. Alert levels:

9.1.1. Routine alert:

- Mild symptom changes
- Continue observation
- Schedule routine nursing follow-up

9.1.2. Priority alert:

- Increasing pain
- Declining oxygen saturation
- Reduced mobility
- Poor medication adherence

Prompt nursing assessment is recommended.

9.1.3. Emergency alert:

- Severe respiratory distress
- Marked physiological deterioration
- Sudden loss of consciousness
- Critically abnormal vital signs

Immediate communication with physicians and emergency medical services may be required.

10. Pain management through continuous monitoring:

Pain management remains one of the primary responsibilities of palliative care nurses[8].
Continuous monitoring enables nurses to:

- Evaluate pain intensity over time.
- Detect breakthrough pain episodes.
- Assess the effectiveness of analgesic therapy.
- Monitor adverse effects of pain medications.
- Identify changes in sleep quality related to pain.
- Evaluate functional limitations caused by pain.

AI combines patient-reported pain scores with physiological indicators such as heart rate, physical activity, facial expression analysis (where available), and sleep patterns to identify uncontrolled pain earlier than conventional assessment alone.
Based on these findings, nurses collaborate with physicians to optimise analgesic therapy, adjust medication schedules, and recommend appropriate non-pharmacological pain management strategies.

10.1. Monitoring respiratory symptoms:

Respiratory symptoms are among the most common and distressing problems experienced by patients receiving palliative care.
Continuous monitoring includes:

- Respiratory rate
- Oxygen saturation (SpO_2)
- Breathing pattern
- Heart rate
- Patient-reported breathlessness
- Sleep-related breathing disturbances

Early identification of respiratory deterioration allows nurses to:

- Teach breathing exercises.
- Encourage energy conservation techniques.
- Recommend appropriate positioning (e.g., high Fowler's position).
- Monitor oxygen therapy.
- Assess medication effectiveness.
- Arrange timely medical review when necessary.

Prompt intervention can significantly reduce patient discomfort and prevent avoidable hospital admissions.

10.2. Medication adherence monitoring:

Remote monitoring systems help ensure that medications are taken safely and correctly.
AI-supported systems can:

- Send medication reminders.
- Detect missed doses.
- Monitor medication schedules.
- Alert nurses when adherence declines.
- Support caregivers in medication administration.

Improved medication adherence contributes to better symptom control and enhanced quality of life.

10.3. Emotional and psychosocial support:

Continuous nursing support extends beyond physiological monitoring.
Remote communication technologies allow nurses to:

- Provide emotional reassurance.
- Assess anxiety and depression.
- Support family caregivers.
- Deliver health education.
- Encourage self-management.
- Promote advance care planning.
- Facilitate communication with multidisciplinary healthcare teams.

Regular virtual interactions help reduce feelings of isolation and strengthen therapeutic relationships.

11. Advantages of continuous remote nursing support:

Remote monitoring offers numerous benefits for patients, caregivers, and healthcare professionals.

11.1. For patients:

- Early recognition of symptom deterioration.
- Improved symptom control.
- Greater comfort at home.
- Reduced hospital admissions.
- Enhanced quality of life.
- Increased sense of security.

11.2. For nurses:

- Continuous access to patient information.
- Improved clinical decision-making.
- Better prioritisation of patient care.
- More efficient workload management.
- Enhanced continuity of care.

11.3. For healthcare systems:

- Reduced emergency department visits.
- Lower healthcare costs.
- Better utilisation of healthcare resources.
- Improved coordination among multidisciplinary teams.

12. Limitations:

Despite its many advantages, remote monitoring has certain limitations.

- Dependence on reliable internet connectivity.
- Technical malfunction of monitoring devices.
- Inaccurate readings due to improper sensor placement.
- Data privacy and cybersecurity concerns.
- Limited digital literacy among some patients and caregivers.
- Remote monitoring cannot completely replace direct physical assessment and human interaction.

13. Role of Nurses:

Nurses remain central to the success of remote monitoring programmes. Their responsibilities include:

- Monitoring patient data continuously.
- Interpreting AI-generated alerts.
- Assessing symptom progression.
- Providing patient and caregiver education.
- Coordinating multidisciplinary care.
- Supporting medication management.
- Offering emotional and psychological support.
- Documenting assessments and interventions.
- Escalating care when deterioration is identified.
- Promoting patient safety and quality of life.

Although AI supports clinical decision-making, professional nursing judgement remains essential in interpreting patient needs and delivering compassionate, person-centred care.

- Remote monitoring enables continuous nursing support beyond scheduled home visits.
- AI analyses physiological data, symptom reports, and medication adherence to identify early signs of deterioration.
- Continuous monitoring improves pain management, respiratory care, and symptom control.
- Automated alerts help nurses prioritise patients according to clinical urgency.
- Remote monitoring enhances continuity of care, reduces unnecessary hospital admissions, and improves quality of life.
- Nurses play a vital role in interpreting data, educating patients and caregivers, and coordinating multidisciplinary care.
- AI complements—but never replaces—the clinical expertise, communication skills, and compassionate care provided by nurses.

14. Family caregiver assistance and digital communication:

Family caregivers play an indispensable role in home-based palliative care. They frequently assist with medication administration, symptom observation, nutrition, mobility, hygiene, emotional support, and communication with healthcare professionals. Although caregiving is often rewarding, it may also result in physical exhaustion, emotional distress, financial burden, and uncertainty regarding symptom management.

IoT-integrated monitoring systems strengthen caregiver support by providing continuous access to healthcare professionals and practical educational resources. Mobile applications present simplified patient information, medication schedules, symptom assessment tools, appointment reminders, and personalised care instructions. These resources improve caregiver confidence and reduce anxiety associated with managing complex clinical situations.

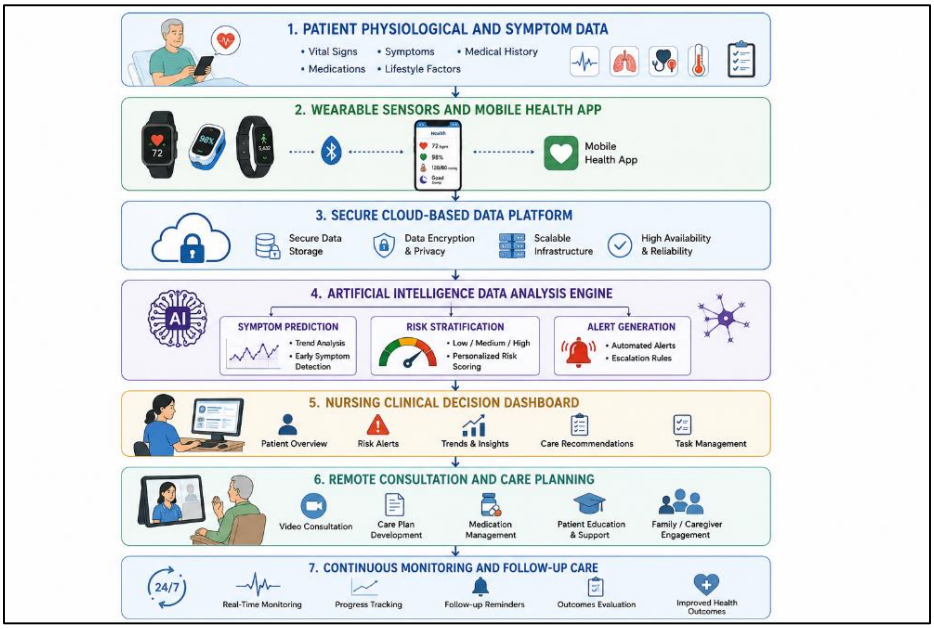

Figure. 2: AI-Enabled Remote Nursing and Clinical Decision Support Workflow

Digital communication platforms enable caregivers to contact nurses through secure messaging, telephone consultations, or video conferencing. Questions regarding symptom changes, medication administration, wound care, nutritional support, or emergency situations can be addressed promptly, reducing unnecessary hospital visits while ensuring patient safety.

Medication reminder systems are particularly valuable. Smart medication dispensers and mobile applications notify caregivers when medications are due and confirm whether doses have been administered. Missed or delayed medications generate alerts, allowing nurses to identify adherence problems and provide appropriate guidance.

15. Medication adherence and pain management:

Effective medication management is essential for symptom control in palliative care. Patients frequently receive multiple medications, including opioid and non-opioid analgesics, antiemetics, anxiolytics, corticosteroids, laxatives, antibiotics, and disease-specific therapies. Complex medication schedules increase the risk of missed doses, medication errors, and inadequate symptom control[9].

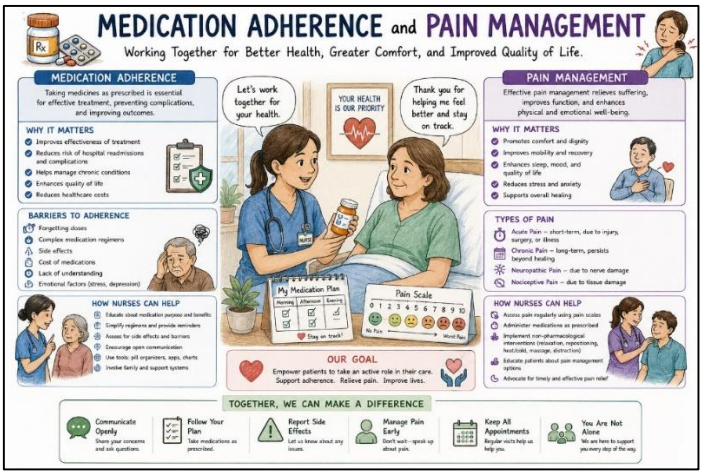

Figure. 3: Medication Adherence and Pain Management

IoT-enabled medication management systems improve adherence through automated reminders, electronic medication dispensers, and digital medication records. Patients and caregivers receive timely notifications regarding medication schedules, while healthcare professionals monitor adherence remotely. Missed doses generate alerts that prompt follow-up by nursing staff.

Pain assessment remains a continuous process rather than a single clinical event. Mobile applications allow patients to record pain intensity using validated scales while documenting pain characteristics, duration, location, and factors influencing symptom severity. AI analyses these reports together with physiological data to identify patterns suggesting inadequate pain control or emerging complications.

16. Applications in palliative care:

IoT-integrated monitoring systems have broad applications across numerous life-limiting illnesses requiring long-term palliative support.

Patients with advanced cancer often experience pain, fatigue, cachexia, breathlessness, nausea, and psychological distress. Continuous monitoring enables timely symptom management while reducing avoidable hospital admissions.

Individuals with advanced heart failure benefit from surveillance of heart rate, blood pressure, oxygen saturation, body weight, and physical activity. Early identification of fluid overload or worsening cardiac function supports prompt intervention and reduces acute exacerbations.

Patients with chronic obstructive pulmonary disease (COPD) require continuous respiratory assessment because worsening breathlessness and declining oxygen saturation frequently precede hospitalisation. Remote monitoring facilitates earlier adjustment of treatment plans.

For people living with dementia, wearable sensors assist in monitoring mobility, sleep, wandering behaviour, falls, and daily activity. Digital reminders and caregiver support enhance patient safety while reducing caregiver burden.

Individuals with progressive neurological disorders, including motor neurone disease, Parkinson's disease, and multiple sclerosis, benefit from monitoring of mobility, swallowing difficulties, respiratory function,

communication ability, and functional decline. Early detection of deterioration supports timely multidisciplinary intervention.

Home-based monitoring is also valuable for patients with end-stage kidney disease, advanced liver disease, and other chronic conditions requiring symptom-focused care.

Table. 2: Benefits, Challenges, and Nursing Implications of IoT-Integrated Home-Based Palliative Care Monitoring

Aspect	Description
Clinical Benefits	Early symptom detection, continuous monitoring, timely intervention, improved symptom control
Nursing Benefits	Remote assessment, evidence-based decision support, workload prioritisation, enhanced documentation
Patient Benefits	Improved quality of life, personalised care, reduced hospital admissions, increased comfort at home
Caregiver Benefits	Education, medication reminders, digital communication, reduced caregiver burden
Challenges	Data privacy, cybersecurity, infrastructure costs, digital literacy, device maintenance
Future Nursing Role	Digital health leadership, remote care coordination, AI-supported clinical judgement, multidisciplinary collaboration

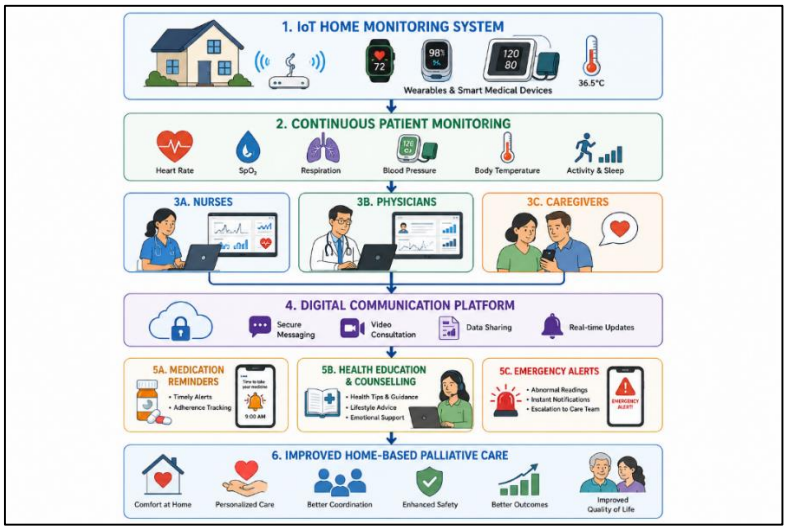

Figure. 3: Family Caregiver Assistance and Communication Framework

17. Benefits, challenges, ethical and legal considerations:

Artificial Intelligence (AI), the Internet of Things (IoT), wearable biosensors, and remote monitoring technologies are transforming healthcare by enabling continuous patient monitoring, early disease detection, clinical decision support, and personalised care. These technologies improve patient safety, support healthcare professionals in clinical decision-making, and enhance the efficiency of healthcare delivery. Despite their numerous advantages, successful implementation requires careful consideration of technical limitations, ethical principles, legal responsibilities, and regulatory requirements. Healthcare professionals must understand both the opportunities and the challenges associated with these technologies to ensure safe, effective, and patient-centred care[10].

17.1. Benefits of ai-assisted healthcare technologies:

AI-assisted monitoring systems provide numerous advantages for patients, healthcare professionals, and healthcare organisations.

17.2. Improved early detection:

Continuous monitoring enables early identification of physiological deterioration before obvious clinical symptoms develop. AI analyses real-time patient data and detects subtle changes that may indicate worsening health conditions, allowing timely intervention and reducing the risk of complications.

17.3. Enhanced clinical decision-making:
AI integrates physiological measurements, laboratory reports, imaging findings, medication history, and electronic health records to provide evidence-based clinical recommendations. This supports faster and more accurate decision-making while reducing diagnostic uncertainty.

17.4. Continuous patient monitoring:
Unlike traditional periodic assessments, AI-enabled monitoring systems provide uninterrupted surveillance of patients in hospitals, long-term care facilities, and home settings. Continuous observation improves patient safety by enabling rapid recognition of clinical deterioration.

17.5. Improved patient safety:
Automated alerts notify healthcare professionals when abnormal physiological changes occur, reducing delays in treatment and helping prevent avoidable adverse events such as respiratory failure, cardiac arrest, falls, and medication-related complications.

17.6. Personalised healthcare:
AI analyses individual patient characteristics, previous medical history, treatment response, and risk factors to support personalised care plans and optimise treatment strategies according to each patient's specific needs.
Better Resource Utilisation
Healthcare organisations can prioritise critically ill patients, optimise staff allocation, improve bed management, and reduce unnecessary hospital admissions through intelligent monitoring and predictive analytics.

17.7. Enhanced communication:
Remote monitoring platforms facilitate timely communication among nurses, physicians, patients, caregivers, and multidisciplinary healthcare teams, improving coordination and continuity of care.

17.8. Increased Accessibility:
Telehealth and remote monitoring expand healthcare access for patients living in rural, remote, or underserved areas by reducing travel requirements and enabling continuous professional support.

18. Challenges of AI-assisted healthcare:
Despite significant benefits, AI-assisted healthcare systems face several practical and technical challenges.

18.1. Data quality and accuracy:
AI systems depend on accurate, complete, and reliable patient data. Incorrect sensor placement, poor signal quality, missing information, or inaccurate documentation may reduce the reliability of AI-generated recommendations.

18.2. Technical limitations:
System failures, software errors, hardware malfunctions, internet interruptions, and power outages can temporarily disrupt patient monitoring and affect continuity of care.

18.3. Alarm fatigue:
Although AI reduces unnecessary alarms, excessive notifications may still occur, potentially leading to delayed responses or desensitisation among healthcare professionals.

18.4. High implementation costs:
Installation, maintenance, software updates, cybersecurity measures, and staff training require substantial financial investment, which may limit adoption in resource-constrained healthcare settings[12].

18.5. Integration challenges:
Integrating AI platforms with existing hospital information systems, electronic health records, laboratory systems, and medical devices may be technically complex and require ongoing maintenance.

18.6. Digital literacy:
Successful implementation depends on the ability of healthcare professionals, patients, and caregivers to use digital technologies effectively. Limited digital skills may reduce the benefits of remote monitoring systems.

18.7. Dependence on technology:
Excessive reliance on AI without appropriate clinical judgement may result in inappropriate decision-making if system recommendations are inaccurate or incomplete.

19. Ethical considerations:
The use of AI in healthcare must be guided by fundamental ethical principles that protect patients and promote high-quality care.

19.1. Patient autonomy:
Patients should be informed about the use of AI-assisted monitoring technologies and should participate in decisions regarding their care whenever possible. Informed consent should be obtained before collecting, analysing, or sharing health data.

19.2. Privacy and confidentiality:
Continuous monitoring generates large volumes of sensitive personal health information. Healthcare organisations must implement appropriate safeguards to ensure confidentiality and prevent unauthorised access to patient data[13].

19.3. Beneficence:
Healthcare professionals should use AI technologies only when they are expected to improve patient outcomes, enhance safety, and provide meaningful clinical benefit.

19.4. Non-maleficence:
AI systems should minimise the risk of patient harm by providing accurate recommendations, reducing clinical errors, and supporting safe healthcare practices. Healthcare providers must verify AI recommendations before acting upon them.

19.5. Justice and Equity:
AI technologies should be accessible to all patients regardless of age, gender, socioeconomic status, geographic location, disability, or cultural background. Efforts should be made to reduce disparities in access to digital healthcare.

19.6. Transparency:
Healthcare professionals should understand how AI-generated recommendations are produced and communicate their role clearly to patients. AI systems should support explainable and transparent decision-making whenever possible.

19.7. Accountability:
Artificial Intelligence functions as a clinical decision support tool rather than an independent decision-maker. Healthcare professionals remain accountable for diagnosis, treatment decisions, and patient outcomes.

20. Legal considerations:
The use of AI-assisted healthcare technologies also involves important legal responsibilities.

20.1. Data protection:
Patient information must be collected, stored, transmitted, and processed according to applicable data protection laws and institutional policies. Secure encryption, authentication, and access controls are essential to safeguard confidential health information.

20.2. Informed consent:
Patients should receive clear information regarding the purpose of remote monitoring,

the type of data collected, potential benefits, possible risks, and how their information will be used before providing consent.

20.3. Professional responsibility:

Healthcare professionals remain legally responsible for patient assessment, diagnosis, treatment planning, and clinical decision-making. AI recommendations should always be interpreted alongside professional clinical judgement.

20.4. Documentation:

Clinical assessments, AI-generated alerts, nursing interventions, physician decisions, and patient responses should be documented accurately and promptly as part of the patient's permanent health record.

20.5. Regulatory compliance:

Healthcare organisations should ensure that AI-assisted medical devices and software comply with national regulatory standards, quality assurance requirements, and professional practice guidelines before clinical implementation.

20.6. Cybersecurity:

Hospitals and healthcare institutions should implement robust cybersecurity measures to protect healthcare systems against hacking, ransomware, unauthorised access, and data breaches[14].

21. Future perspectives:

Future developments are expected to integrate artificial intelligence, wearable biosensors, cloud computing, edge computing, and the Internet of Medical Things (IoMT) into increasingly intelligent home-based palliative care systems. Predictive AI models will provide earlier recognition of symptom deterioration, personalised treatment recommendations, and adaptive monitoring based on each patient's changing clinical condition.

Miniaturised wearable devices, non-contact monitoring technologies, voice-assisted digital platforms, and smart home environments are likely to improve patient comfort while enhancing continuous surveillance. Integration with electronic health records, telemedicine services, and multidisciplinary care platforms will strengthen continuity of care across healthcare settings.

Future systems may also incorporate environmental monitoring, nutritional assessment, behavioural analytics, and advanced patient-reported outcome measures to provide a more comprehensive understanding of patient well-being. As these technologies continue to evolve, nurses will play an increasingly important role in digital health leadership, remote clinical management, patient education, and quality improvement[15].

22. Conclusion:

IoT-integrated home-based palliative care monitoring systems represent a significant advancement in the delivery of compassionate, patient-centred care for individuals with life-limiting illnesses. By combining wearable biosensors, smart medical devices, artificial intelligence, cloud computing, and secure digital communication, these systems enable continuous monitoring of physiological parameters, symptom progression, medication adherence, and functional status while patients remain in the comfort of their homes.

For nurses, IoT technologies enhance remote assessment, support evidence-based clinical decision-making, improve care coordination, and facilitate timely intervention when patient conditions change. Family caregivers benefit from continuous professional guidance, medication reminders, educational resources, and digital communication tools that improve confidence and reduce caregiver burden.

23. Refrence:

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