



RESEARCH BRIEF

TEXTILE INNOVATIONS
IN HEALTHCARE

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Executive Summary

This Brief investigates the latest technical innovations in textiles for the healthcare industry. It covers both emerging technologies (i.e., academic literature), and recently commercialized innovations, with a global scope and an emphasis on developments within the last 5-10 years. This research explores the various applications of textiles and segments them accordingly within the Brief so that the Brief encompasses the latest innovations and technology for various sectors.

For all identified emerging technologies, an analysis of how the identified technology improves upon the current state of the art, what challenges it seeks to solve, and any notable points of where further research may be needed prior to developing a commercialized product has been provided. For commercialized innovations, a high-level overview of top players and their applicable patents has been included, with a deep dive on the specific products/technologies, and why it's considered an innovation in its respective textile segment.

Analyst Opinion

Textile innovations in healthcare represent a dynamic intersection of technology, material science, and sustainability. This Brief identifies significant advancements across antimicrobial textiles, smart textiles, and sustainable practices, revealing both opportunities and challenges. One standout insight is the role of antimicrobial textiles in directly addressing pathogen transmission risks in healthcare environments. While these innovations have demonstrated efficacy in reducing microbial contamination, their adoption faces hurdles, including cost barriers and the need for clinical validation. The Brief highlights a gap in real-world application studies, emphasizing a need for long-term durability assessments and scalable production methodologies that address both performance and ecological concerns.

Smart textiles emerge as a transformative solution, bridging healthcare with wearable technology. Their ability to integrate sensors and therapeutic functionalities within fabrics offers applications ranging from patient monitoring to drug delivery. However, the scalability of these innovations remains limited by issues such as wearability, washability, and cost. The mention of triboelectric nanogenerators and piezoelectric platforms indicates promising avenues for self-sustaining systems, yet their commercial viability will depend on addressing environmental and regulatory constraints. The potential of integrating smart textiles with IoT and data analytics systems underscores a broader trend toward personalized healthcare but requires cohesive strategies for data management and privacy compliance.

The analysis also points to a broader opportunity for interdisciplinary collaboration. The synergy between academia, healthcare providers, and industry players is critical for advancing textile innovations. For instance, the incorporation of natural antimicrobial agents like chitosan and the exploration of advanced fabrication techniques such as plasma processing suggest that breakthroughs are as much about the processes as the materials themselves. This underscores the importance of aligning research and commercial objectives to accelerate innovation while maintaining cost-effectiveness and environmental sustainability.

Research Methodology

In our research, we utilized the Cypris platform, third-party datasets, and broader internet searches to identify relevant data. Throughout this process, we refined our approach by adapting our keywords to synonyms and related terms to ensure comprehensive data collection within this sector. For our foundational query, we used Cypris' Boolean searching functionality with the following search term:

- [\(\(healthcare\) and \(garment or upholstery or flooring or medical bedding\) and \(textile or textiles or fabric or fabrics\)\)](#)

Introduction to Textiles in Healthcare and Their Applications

Healthcare textiles are a critical component of modern healthcare environments, designed to enhance hygiene, comfort, and functionality across various applications. Healthcare-grade textiles must meet stringent standards for durability, hygiene, and safety, including resistance to frequent laundering at high temperatures, antimicrobial properties to prevent infection, and compliance with ISO regulations or FDA guidelines for medical devices. These textiles should also provide comfort, fluid resistance, and fire retardancy where applicable, with ongoing innovations driving improvements in performance and sustainability.

Garment Textiles

Garment textiles in healthcare, such as scrubs, lab coats, and isolation gowns, play a dual role in protecting healthcare workers (HCWs) and patients while also posing risks of pathogen transmission. A significant issue in this area is the contamination of healthcare apparel with multi-drug-resistant organisms (MDROs) like MRSA and *Acinetobacter baumannii*. These pathogens can persist on garments for extended periods, with contamination levels increasing significantly throughout a single work shift. Factors such as inadequate laundering protocols, improper handling of clean garments, and the movement of HCWs between healthcare facilities and public spaces exacerbate the problem. Despite efforts to maintain hygiene, traditional fabrics fail to offer adequate protection against microbial retention and cross-contamination.

To address these challenges, innovations in healthcare textiles include the development of engineered fabrics with antimicrobial properties and fluid-repellent barriers. Studies have shown these textiles can significantly reduce pathogen levels on apparel, enhancing infection control. For example, fabrics treated with advanced antimicrobial and hydrophobic chemistries demonstrated reduced contamination by MDROs in clinical settings. However, adoption remains limited, partly due to cost and a lack of clinical testing data. Further research is needed to optimize the efficacy of antimicrobial textiles, particularly in real-world healthcare environments. Specific areas requiring focus include integrating antimicrobial mechanisms with improved fluid repellency, testing against diverse microbial strains, and evaluating the long-term durability of these treatments under repeated laundering and use.¹

¹ [Role of healthcare apparel and other healthcare textiles in the transmission of pathogens: a review of the literature \(Mitchell et al., 2015\)](#)

Upholstery Textiles

Upholstered furniture in healthcare settings, such as waiting room chairs, recliners, and examination tables, requires textiles that are durable, stain-resistant, and easy to sanitize. The latest trends emphasize antimicrobial and fluid-repellent coatings to minimize infection risks. Manufacturers are also exploring the use of PVC-free and phthalate-free materials for safer and more sustainable options. Innovations include textiles with self-cleaning properties and customizable designs to enhance patient comfort and the aesthetic appeal of healthcare spaces.

Flooring Textiles

While hard flooring materials (like vinyl or linoleum) dominate healthcare settings due to their durability and cleanability, textile flooring is finding niche applications where its benefits align with specific needs, such as noise reduction and comfort. Textiles used in healthcare flooring, such as carpets and mats, play an essential role in creating safe and hygienic environments. Current trends focus on antimicrobial treatments, slip-resistant surfaces, and acoustic properties to reduce noise in busy facilities. Innovations in this sector include modular flooring systems made from recyclable materials, offering easy installation and replacement. Some textiles also feature integrated air filtration technologies, contributing to cleaner indoor air quality. Future advancements in antimicrobial and easily cleanable textile technologies may expand its use in more healthcare environments.

Medical Bedding Textiles

Medical bedding textiles, encompassing mattress covers, reusable linens, and pillowcases, are designed for patient comfort and infection control. Trends in this sector highlight fluid-repellent and antimicrobial properties, ensuring longevity and cleanliness in high-use settings. Advanced textiles now incorporate breathable membranes that balance waterproofing with temperature regulation, improving patient comfort. The use of sustainable, durable materials such as recycled polyester is also gaining traction, aligning with broader efforts to reduce waste in healthcare operations. Smart bedding textiles, which monitor patient movement and pressure to prevent bedsores, represent a significant innovation in this space.

Emerging Antimicrobial Textile Technologies

The research and technology landscape for antimicrobial textiles is highly dynamic, driven by their critical role in reducing microbial contamination in healthcare and other industries. Current technologies utilize synthetic compounds, natural agents, and advanced nanotechnology to enhance the antimicrobial properties of textiles. Synthetic agents like N-halamines and quaternary ammonium compounds (QACs) are widely used for their efficacy against bacteria, fungi, and some viruses. Metal nanoparticles such as silver, copper, and zinc oxide are also incorporated due to their potent antimicrobial action through mechanisms like membrane disruption and oxidative stress induction. Natural compounds, including chitosan, lignin, and essential oils, are gaining traction as eco-friendly alternatives, offering antimicrobial properties while being biodegradable and less toxic.

Challenges in antimicrobial textiles include environmental concerns, durability, and potential health risks. The release of nanoparticles or synthetic chemicals into the environment during use and washing can pose ecological hazards and lead to bioaccumulation in organisms. Additionally,

antimicrobial treatments often degrade after repeated laundering, reducing their long-term effectiveness. To address these issues, researchers are exploring advanced methods such as plasma treatments, microencapsulation, and sol-gel techniques to enhance the durability and environmental compatibility of antimicrobial finishes. For example, plasma processing allows for the deposition of antimicrobial agents without altering the bulk properties of textiles, while microencapsulation stabilizes natural agents like essential oils, preventing degradation and leaching.

Further research is needed to optimize the safety, cost, and performance of antimicrobial textiles. This includes studying the long-term health effects of nanoparticle exposure, developing standardized methods to evaluate antimicrobial efficacy, and creating biodegradable textiles with effective antimicrobial properties. There is also significant potential for integrating smart technologies, such as textiles embedded with sensors, to monitor microbial activity or release antimicrobial agents on demand. Advancements in these areas could lead to more sustainable and effective solutions for antimicrobial textiles in healthcare and beyond.²

Research Papers

Title: [Advancements in enhancing antibacterial properties of cotton fabric through chitosan and nanoparticles](#)

Publication Date: November 23, 2023

Authors: Aakash Verma, Simran Ahuja, Sanjiv Arora

Institution: Kurukshetra University (India)

Abstract: Over recent years, the garment industry has been actively seeking innovative solutions to address critical challenges in clothing production. One significant issue has been the susceptibility of hydrophilic cotton fabrics, commonly used in healthcare and sportswear, to bacterial growth, posing hygiene concerns. To deal with this, it becomes crucial for us to make durable cotton fabrics that can fight bacteria. This study explores the development of durable antibacterial cotton textiles by utilizing a range of antibacterial agents and mechanisms. Chitosan's properties, such as its ability to inhibit fungal growth, compatibility, non-toxicity, bioactivity, and antimicrobial potential make it a promising candidate for the textile industry. Additionally, the incorporation of metal nanoparticles along with chitosan offers interesting potential, such as UV absorption, self-cleaning capabilities, and antimicrobial activity. Therefore, research aimed at enhancing cotton fabric by harnessing the potential of chitosan and metal nanoparticles continues to attract significant attention in today's textile world. Cotton fabric modified by combining chitosan and nanoparticles exhibits high antimicrobial activity compared to fabric modified with either nanoparticles or chitosan alone. The implications of this study are far-reaching with improvement in hygiene, comfort, and durability in a wide range of clothing applications, thus making a substantial contribution to the evolution of the textile industry.

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Patents

Title: [Antibacterial healthcare multi-component fiber integrated blended yarn, production method and application](#)

Publication Number: CN104342804A

Publication Date: February 10, 2015

² [Highly specialized textiles with antimicrobial functionality – Advances and challenges \(Tanasa et al., 2023\)](#)

Assignee: University Zhongyuan Technology

Summary: This patent describes a novel antibacterial health care multi-component fiber yarn made by blending aloe viscose fiber, Viloft fiber, and cashmere fiber. The invention aims to address limitations in current textile fibers, such as the poor wet strength of aloe viscose, low cohesion of Viloft, and lack of health benefits in cashmere. By combining these fibers in specific ratios (aloe viscose 30-65%, Viloft 25-50%, and cashmere 10-25%), the yarn integrates the antibacterial, anti-inflammatory, and skin-care properties of aloe vera with the softness and warmth of cashmere and the eco-friendly, breathable qualities of Viloft. The preparation method minimizes fiber damage during processing, optimizes fiber straightness and blending, and ensures high yarn quality with superior breaking strength and uniformity. The resulting yarn and textiles exhibit enhanced comfort, durability, and health benefits, making them suitable for garments such as underwear and fitness wear. This innovation stands out for its ability to combine functional health care properties with excellent physical and eco-friendly characteristics in a single yarn.

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Title: [Antibacterial guanidine protein Tencel fiber preparation method](#)

Publication Number: CN110656389A

Publication Date: January 6, 2020

Assignee: University Taiyuan Technology, Shanxi Ruisaige Textile Tech Co Ltd

Summary: This patent introduces an innovative method for producing antibacterial guanidized protein Tencel fibers. The invention enhances conventional Tencel fiber by chemically modifying proteins with guanidine compounds to imbue them with antibacterial properties while maintaining excellent mechanical and textile performance. By leveraging the nucleophilic addition reaction of proteins and dicyandiamide, the guanidized proteins are blended into the cellulose spinning solution prepared with NMMO. This approach solves challenges in earlier methods, such as protein oxidation in the NMMO process, weak binding between proteins and cellulose, and poor washing durability. The resulting fibers exhibit a bacteriostatic rate of $\geq 92\%$, improved biocompatibility, and superior wearability compared to standard protein-enhanced fibers. This technology addresses the demand for functionalized textiles with health care benefits, offering a scalable, cost-effective process suitable for industrial application. It is particularly impactful for textiles in clothing, healthcare, and hygiene products.

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Title: [Processing method of healthcare silk fabric](#)

Publication Number: CN104562716A

Publication Date: April 28, 2015

Assignee: Qingdao Xinyifa Industry & Trade Co Ltd

Summary: This patent describes a novel method for processing silk fabric to enhance its health care and environmental properties, making it a natural, skin-friendly, and eco-conscious textile. The invention addresses issues in traditional silk processing, such as chemical contamination, bacterial growth, and loss of silk's natural benefits. The method involves using environmentally friendly dyes and additives, treating the silk to remove impurities and bacteria while restoring its porous structure, adjusting its pH to match human skin, and introducing active substances to improve amino acid activity and skin-care properties. Unlike other health-care textiles, this silk fabric does not rely on antibacterial agents, offering a pure and natural solution that supports skin health and can aid in conditions like pruritus without side effects. The innovation advances the functionality of silk while maintaining its luxurious quality and environmental sustainability.

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Title: [Protective patient procedure chair/table toe protective cover with improved hygienic and adaptable design for medical treatment furnishings](#)

Publication Number: US11304868B1

Publication Date: April 18, 2022

Assignee: Marta Gainza

Summary: This patent describes an innovative protective cover for the toe end of medical furnishings, such as dental or surgical chairs, designed to enhance hygiene, durability, and universal adaptability. The cover is made of flexible medical-grade vinyl with antimicrobial and antifungal properties and includes features such as grommets and a latex-free PVC cord for secure attachment. Unlike existing solutions, this design eliminates hard-to-clean nooks and crannies, avoids non-removable fasteners, and ensures that all components are easily disinfected. The cover also resists microbial contamination, latex allergies, and footwear damage, while being adaptable to various furnishing sizes. This invention addresses the challenges of infection control, durability, and ease of cleaning in healthcare environments, improving upon traditional furniture covers by providing a universally adaptable, hygienic, and visually appealing solution.

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Emerging Smart Textile Technologies

The research and technology landscape of smart textiles in healthcare is rapidly evolving, focusing on creating solutions for diagnostic, therapeutic, and assistive applications. Smart textiles integrate advanced materials and sensor technologies into fabrics, enabling them to monitor physiological signals, deliver treatments, or assist patients in mobility and communication. Examples include diagnostic sensors for heart rate and respiratory monitoring, thermotherapy textiles for musculoskeletal injuries, and drug-delivery fabrics that release medication in controlled doses. Innovations such as triboelectric nanogenerators and piezoelectric platforms allow these textiles to harvest energy from body movements, enabling self-sustaining operation.

Challenges in the field include achieving durability, scalability, and cost-effectiveness. Current limitations involve the wear and tear of functional layers, the complexity of integrating multiple functionalities into a single textile, and the environmental impact of materials used. Solutions such as the use of robust functional materials like conductive polymers and carbon nanotubes, as well as advanced fabrication techniques like 3D printing and thermal drawing, are helping to address these issues. Efforts are also being made to develop biocompatible and biodegradable smart textiles to reduce their environmental footprint.

Further research is needed to optimize the washability and long-term performance of smart textiles. Uniform deposition of functional layers and scalable manufacturing processes remain key challenges. Additionally, there is a need for regulatory frameworks and clinical validation to ensure these textiles meet healthcare standards. Integration with data management systems, leveraging advances in 5G and IoT, can also expand the applications of smart textiles in personalized healthcare, making them more accessible and practical for widespread use.³

³ [Smart textiles for personalized healthcare \(Libanori et al., 2022\)](#)

Research Papers

Title: [An integrated design of self-care textile wearables: Exploration of thermal-stimuli effects and drug delivery function](#)

Publication Date: September 3, 2018

Authors: Tin Wai Cheung, Chenxiao Yang, Li Li

Institution: The Hong Kong Polytechnic University

Abstract: Fiber technology has become increasingly essential in various industries, such as the fashion clothing, medical, cosmetic and upholstery industries. It can be used to overcome some existing challenges of textile–skin interaction in response to medical functions. This research aims to study the thermal-stimuli effects and biological performances of drug delivery textiles so as to develop a personal self-care textile that is wearable for a wide range of adaptive medical treatments.

The proposed study is interdisciplinary and focuses on the following: (1) developing a long-term continuous self-care drug delivery textile wearable for patients by using different textile materials and structure layering; (2) examining the loading capability of synthetic staple crimped hollow fibers in the assembly of the non-woven structure; (3) comparing the drug loading performance between direct infiltration with magnetic stirring and vacuum loading; (4) observing the thermal distribution of the thermal-stimuli drug delivery textile layers. Designing a specially made textile wearable for breast cancer patients (i.e. a bra for females and a sweatshirt/pullover for males) is a conceptual example of the proposed self-care textile wearable. Silver-coated conductive yarns were fabricated into hollow fiber-based non-woven fabrics for thermal stimulation. Significant drug delivery through the non-wovens was shown by the anti-breast cancer analysis. Drugs in different phases, liquid and crystal solid, could be carried by the lumens of the hollow fibers. If the proposed study is successfully commercialized, it will be a great technological breakthrough in preparing a future generation of drug delivery medical textiles. A variety of medical applications can hence be provided and it could also be an alternative for topical healthcare.

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Title: [AI-enabled photonic smart garment for movement analysis](#)

Publication Date: March 8, 2022

Authors: Letícia Avellar, Carlos Stefano Filho, Gabriel Rueda Delgado, Anselmo Frizera, Eduardo Rocón, Arnaldo Leal-Junior

Institutions: Federal University of Espírito Santo (Brazil) , University of Campinas (Brazil), Center for Automation and Robotics (Spain)

Summary: This paper presents the development of an AI-enabled photonic smart garment designed for remote healthcare monitoring and human movement analysis. The garment integrates 30 multiplexed polymer optical fiber (POF) sensors combined with machine learning algorithms, such as k-nearest neighbors (kNN), to classify activities like sitting, walking, running, and squatting with a high accuracy of 94%. Unique to this approach is the use of intensity variation-based optical sensing and sensor multiplexing, which ensures low cost, compactness, and high portability compared to conventional optical sensing techniques. This technology addresses challenges like the need for bulky, high-cost systems, and the discomfort or inefficiency of existing wearable devices. Additionally, it extracts movement-related parameters, such as cadence and breathing rate, with minimal error. The study advances wearable healthcare by providing a scalable, comfortable, and efficient solution for real-time health monitoring outside clinical environments.

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Patents

Title: [Biological intelligent healthcare garment](#)

Publication Number: CN108606373A

Publication Date: October 1, 2018

Assignee: Nantong Snakebite Therapy Inst

Summary: This patent describes a bio-intelligent health-care garment that incorporates advanced nano-ceramic materials and coatings to provide multifunctional benefits. The garment combines far-infrared and negative ion-emitting materials with antibacterial, anti-UV, flame-retardant, moisture-permeable, and temperature-regulating properties. It utilizes a blend of natural and synthetic fibers, bio-ceramic powders, and functional coatings to achieve health-related advantages, such as improving microcirculation, promoting skin care, and enhancing the wearer's overall well-being. The invention uniquely integrates materials like aloe vera, tourmaline, and chitosan for health benefits, along with advanced processing techniques to ensure durability, comfort, and environmental safety. Compared to conventional textiles, this technology addresses challenges like limited functionality, poor durability, and lack of health-enhancing properties, creating a garment that is suitable for medical, fitness, and everyday applications.

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Notable Entities and Products

Several leading companies operate at the intersection of textiles and healthcare, providing specialized products such as medical garments, bedding, upholstery, and flooring solutions.

Medline Industries

- [PerforMAX® Scrubs](#): Antimicrobial scrubs designed to reduce bacterial transmission.

Cardinal Health

- [Surgical Gowns](#): Gowns offering advanced fluid protection and comfort.
- [Surgical Drapes](#): Drapes designed to reduce infection risks during surgery.

Ahlstrom

- [TrustShield™ Surgical Fabrics](#): High-barrier materials for surgical gowns and drapes.

Noble Biomaterials

- [X-STATIC® Antimicrobial Technology](#): Incorporates silver ions into fabrics for permanent antimicrobial protection.
- [Circuitex® Conductive Yarns](#): Enables smart textile applications like biometric monitoring.
- [IONIC+™ Technology](#): Advanced antimicrobial solutions for healthcare textiles.

Forbo Flooring Systems

- [Flotex® Flooring](#): Combines the comfort of carpet with the hygiene of a hard floor, suitable for healthcare environments.

Standard Textile

- [DermaTherapy® Bedding](#): Clinically proven to reduce the incidence of pressure ulcers.

Vestagen Protective Technologies

- [VESTEX® Active Barrier Apparel](#): Combines fluid repellency with antimicrobial properties for healthcare uniforms.

Relevant IP

Title: [Fluid-repellant, antimicrobial fabrics and methods for making same](#)

Publication Number: US2022087349A1

Publication Date: December 27, 2021

Assignee: VXK Products, LLC

Summary: This patent describes an innovative method and fabric for creating fluid-repellent, antimicrobial garments, particularly suitable for healthcare and other professional environments. The invention involves a foam finishing process that applies a treatment containing a fluid repellent and antimicrobial compound exclusively to the fabric's outer surface, leaving the inner surface hydrophilic. This unique approach ensures that the outer side provides protection against fluids and microorganisms, while the inner side wicks away moisture, enhancing wearer comfort. The fabric retains these properties through multiple laundering cycles due to a cross-linking agent that ensures durability. By addressing challenges in existing garments that compromise comfort or fail to provide effective protection, this technology improves healthcare worker safety and garment functionality, making it a significant advancement over traditional, non-adaptive fabrics.

Hexoskin

- [Hexoskin Smart Shirts](#): Measure cardiac, respiratory, and activity data for clinical and research applications.
- [Health Monitoring Platforms](#): Integrated systems for continuous patient monitoring.
- [Data Analytics Software](#): Provides insights from biometric data collected through smart textiles.

Sustainability Trends⁴

Environmental challenges in healthcare textiles stem from the significant use of harmful chemicals during production and disposal, posing risks to both human health and the environment. Formaldehyde, used for crease-resistant finishes, is classified as a Group 1 human carcinogen and can lead to dermal irritation, respiratory issues, and long-term carcinogenic risks. Similarly, phthalates, commonly used as plasticizers in healthcare upholstery fabrics, are not chemically bound to the material, allowing them to leach out over time. This can lead to endocrine disruption and environmental contamination. These challenges are seen across textile sub-areas such as garments, upholstery, flooring, and medical bedding, demonstrating a critical need for safer practices.

Sustainability trends in healthcare textiles focus on reducing chemical use and increasing the adoption of safer materials. Certifications such as OEKO-TEX and Cradle-to-Cradle ensure reduced exposure to toxic substances like VOCs, phthalates, and formaldehyde. For instance, healthcare upholstery is seeing a shift away from polyvinyl chloride (PVC), a major contributor to dioxin emissions, toward safer alternatives like bio-based polymers and inherently flame-retardant

⁴ [The greening of healthcare: Fabrics used in health care facilities \(Laing and Kean, 2011\)](#)

textiles. Recycled polyester from PET bottles is gaining traction, offering durability and reducing reliance on virgin raw materials. Additionally, solution-dyed textiles provide a sustainable alternative due to their enhanced durability and reduced dye waste.

Despite progress, there are areas where further research is needed. The efficacy of antimicrobial treatments, such as nanosilver-based technologies, requires more thorough testing to evaluate long-term health and environmental impacts. Additionally, while bio-based polymers such as polylactic acid (PLA) offer promising alternatives, challenges like the high energy demands of production and potential competition with food crops must be addressed. Recycling infrastructure for healthcare textiles also remains underdeveloped, particularly for mixed fibers used in garments and medical bedding. Advancing closed-loop recycling and enhancing durability standards will be critical for achieving a truly sustainable healthcare textile ecosystem.