UK PATENT APPLICATION

CLERKY - AI-POWERED CLINICAL DECISION SUPPORT PLATFORM

Application Type: Standard Patent Application
Classification: Medical Device Software (Class IIa)
Field of Invention: Computer-Implemented Medical Systems, Artificial Intelligence in Healthcare, Clinical Decision Support
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1. TECHNICAL FIELD

This invention relates to computer-implemented medical systems, specifically an artificial intelligence-powered clinical decision support platform that provides real-time analysis of clinical documentation against evidence-based medical guidelines while ensuring patient privacy through advanced anonymisation techniques and maintaining optimal performance through AI model-agnostic architecture.

2. BACKGROUND OF THE INVENTION

2.1 Problem Statement

Healthcare professionals face increasing challenges in maintaining adherence to the rapidly expanding corpus of evidence-based medical guidelines while protecting patient privacy and managing AI service dependencies. Current systems suffer from several critical limitations:

1. **Manual Guideline Consultation**: Healthcare professionals must manually search through extensive guideline databases during patient consultations, causing delays and potential oversights.
2. **Fragmented Decision Support**: Existing clinical decision support systems typically address single guidelines or narrow clinical domains, failing to provide comprehensive multi-guideline analysis.
3. **Static Documentation Review**: Current systems lack real-time, intelligent analysis of clinical documentation against current best practice guidelines.
4. **Privacy and Security Vulnerabilities**: Most systems transmit sensitive patient data to external AI services without adequate anonymisation, creating privacy risks and regulatory compliance issues.
5. **AI Provider Dependency**: Existing solutions rely on single AI providers, creating vulnerabilities when services become unavailable, expensive, or fail to meet performance requirements.
6. **Limited Learning Integration**: Existing solutions do not provide interactive learning mechanisms that adapt to user decisions and preferences.

7. **Poor Workflow Integration**: Most clinical decision support tools operate as standalone systems that disrupt clinical workflows rather than enhancing them.

2.2 Prior Art Limitations

Existing clinical decision support systems, while providing some guidance, fail to offer: - Real-time, intelligent analysis of free-text clinical documentation - Privacy-preserving anonymisation at source before data transmission - AI model-agnostic architecture with automatic failover capabilities - Multi-guideline simultaneous analysis with parallel processing - Interactive recommendation systems with comprehensive user decision tracking - Structured clinical documentation enhancement based on AI-generated suggestions

3. SUMMARY OF THE INVENTION

3.1 Overview

The present invention provides a novel AI-powered clinical decision support platform ("Clerky") that addresses the aforementioned limitations through several innovative technical solutions:

3.2 Key Technical Innovations

Innovation 1: Privacy-Preserving Anonymisation at Source A breakthrough in healthcare data privacy, Clerky implements comprehensive anonymisation of clinical data before it ever leaves the healthcare provider's environment. Using advanced natural language processing and medical-context-aware algorithms, the system identifies and removes personally identifiable information (PII) while preserving all clinically relevant content. This includes specialized medical patterns, NHS numbers, hospital identifiers, and personal details, ensuring complete privacy protection without compromising clinical utility. The anonymisation process uses the @libretto/redact-pii-light library combined with custom medical patterns to achieve comprehensive PII detection while avoiding false positives with medical terminology.

Innovation 2: AI Model-Agnostic Architecture with Intelligent Routing Rather than being locked into a single AI provider, Clerky implements a sophisticated AI model-agnostic architecture that intelligently routes requests across multiple AI service providers including OpenAI, DeepSeek, Anthropic (Claude), Mistral, and Google Gemini. The system automatically selects the optimal provider based on user preferences, cost considerations, performance metrics, and availability. When one service becomes unavailable or reaches quota limits, the system seamlessly switches to alternative providers without interruption. This approach ensures healthcare professionals always receive fast, reliable responses while maintaining optimal cost-efficiency and avoiding vendor lock-in.

Innovation 3: Comprehensive Medical Guideline Analysis When a healthcare professional enters a clinical case, Clerky simultaneously checks it against hundreds of relevant medical guidelines rather than forcing manual searches. The system currently contains approximately 300 guidelines focused on obstetrics and gynaecology, with capability for expansion to other medical specialties. It intelligently identifies which guidelines are most relevant to the specific case and presents them in order of importance, allowing healthcare professionals to quickly access the most applicable evidence-based recommendations.

Innovation 4: Interactive Decision Support Interface Rather than providing static recommendations, Clerky creates an interactive experience where healthcare professionals can review each AI-generated suggestion and choose to accept, reject, or modify it to better fit their clinical judgment. The system tracks these decisions to maintain a comprehensive record of how recommendations were applied. Each suggestion is presented with supporting evidence, and healthcare professionals can customise recommendations in real-time to match their specific clinical context and patient needs.

Innovation 5: AI-Generated Documentation Suggestions Clerky uses multiple AI providers to analyse clinical notes against specific medical guidelines and generate categorised improvement suggestions. The system provides structured recommendations organised by importance level (Very Important to Unimportant) that healthcare professionals can review, accept, reject, or modify. When suggestions are accepted or modified, they are automatically applied to update the clinical documentation, helping ensure better alignment with evidence-based guidelines while maintaining the healthcare professional's clinical judgment.

Innovation 6: Reliable Multi-Service Architecture The system is built with multiple backup systems to ensure it remains available when healthcare professionals need it most. By connecting to several different AI services simultaneously, Clerky can continue operating even if one or more services experience problems. The system monitors performance and costs across all providers, automatically routing requests to the most efficient service while maintaining

backup options. This redundant approach ensures consistent availability and optimal performance for time-sensitive clinical decision-making.

4. DETAILED DESCRIPTION OF THE INVENTION

4.1 System Architecture

The invention comprises a distributed architecture with the following novel components:

4.1.1 Frontend Application Layer

- **Single-Page Web Application**: 7,710-line JavaScript application (`script.js`)
- **Firebase Authentication**: Secure user authentication and session management
- **Real-time Processing**: Instant analysis and recommendation display with live status updates
- **Interactive Elements**: Accept/reject/modify interface for AI recommendations with decision tracking
- **Session Management**: Persistent clinical consultation tracking with Firestore integration
- **Privacy Interface**: Built-in PII review and anonymisation confirmation dialogs
- **Responsive Design**: Optimised interface for healthcare professional workflows

4.1.2 Server API Layer

- **Express.js Backend**: 7,721-line Node.js server (`server.js`) hosted on Render.com
- **AI Model-Agnostic Integration**: Intelligent routing between multiple AI service providers (OpenAI, DeepSeek, Anthropic, Mistral, Gemini)
- **GitHub Integration**: Automated guideline ingestion and version control via GitHub API
- **Firebase Admin SDK**: Secure database operations and user management
- **Privacy Processing**: Server-side anonymisation validation and logging

- **RESTful API Design**: Comprehensive endpoints for guideline processing and AI analysis

4.1.3 Privacy-Preserving Anonymisation Engine

The system implements a sophisticated anonymisation engine that processes clinical data before transmission:

```
// Clinical Data Anonymiser with medical context
class ClinicalDataAnonymiser {
    constructor() {
        this.customPatterns = this.getMedicalPatte
        this.enhancedPatterns = this.getEnhancedPI
    }

    async anonymise(text, options = {}) {
        // Step 1: Use Libretto library for PII de
        const libraryResult = await this.redactPII

        // Step 2: Apply medical-specific patterns
        let anonymisedText = this.applyMedicalPatt

        // Step 3: Preserve clinical information
        if (options.preserveClinicalInfo) {
            anonymisedText = this.preserveClinical
        }

        return {
            anonymisedText,
            metadata: this.generateMetadata(text,
            success: true
        };
    }
}
```

4.1.4 AI Model-Agnostic Processing Engine

The system implements intelligent routing across multiple AI providers:

```
// AI routing based on user preferences and avail
async function routeToAI(prompt, userId = null) {
    // Get user's preferred AI provider
    const preferredProvider = await getUserAIPrefe

    // Check availability and quota limits
    const availableProviders = await checkProvider

    // Select optimal provider
    const selectedProvider = selectOptimalProvider
        preferredProvider,
        availableProviders
    );

    // Send request with automatic failover
    return await sendToAIWithFailover(prompt, sele
}

// Supported AI providers with automatic failover
const AI_PROVIDERS = {
    OpenAI: { model: 'gpt-3.5-turbo', endpoint: 'h
    DeepSeek: { model: 'deepseek-chat', endpoint:
    Anthropic: { model: 'claude-3-sonnet-20240229'
    Mistral: { model: 'mistral-large-latest', endp
    Gemini: { model: 'gemini-1.5-pro', endpoint: '
};
```

4.1.5 Guideline Intelligence System

- **Automated Guideline Processing**: Conversion of PDF guidelines to structured, searchable format
- **Metadata Enhancement**: AI-powered extraction of guideline metadata and clinical relevance
- **Dynamic Updating**: Automatic synchronisation with latest guideline versions
- **Contextual Indexing**: Advanced indexing for rapid retrieval and relevance matching

4.1.6 Clinical Analysis Pipeline

```
// Multi-guideline parallel processing with priva
async function multiGuidelineDynamicAdvice(selecte
    // First, anonymise the clinical data
    const anonymisedData = await anonymiseTranscri

    // Process guidelines in parallel with error i
    const guidelinePromises = selectedGuidelines.m
        try {
            // Call dynamicAdvice API for individu
            const response = await fetch('/dynamic
                method: 'POST',
                body: JSON.stringify({
                    transcript: anonymisedData.anc
                    analysis: window.latestAnalysi
                    guidelineId: guideline.id,
                    guidelineTitle: guideline.titl
                    anonymisationInfo: anonymisedD
                })
            });
            return await response.json();
        } catch (error) {
            return { success: false, error: error.
        }
    });

    // Wait for all parallel processing to complet
    const results = await Promise.all(guidelinePro
```

4.2 Privacy-Preserving Workflow

The system implements a comprehensive privacy protection workflow that processes clinical data through multiple stages:

Stage 1: Initial PII Detection The system scans clinical input using medical context-aware algorithms to identify personally identifiable information including patient names, NHS numbers, dates of birth, hospital identifiers, and other sensitive data while preserving all clinically relevant medical terminology.

Stage 2: Interactive User Review Healthcare professionals review the detected PII through an intuitive interface that highlights identified sensitive information and allows for manual confirmation or modification of anonymisation decisions.

Stage 3: Medical Context-Aware Anonymisation The system applies advanced anonymisation techniques that preserve clinical meaning while removing all identifiable information, using medical terminology databases to avoid false positives with legitimate medical terms.

Stage 4: Privacy-Protected AI Processing Anonymised clinical data is transmitted to AI providers for analysis, ensuring complete privacy protection while maintaining full clinical utility for decision support.

Stage 5: Secure Response Processing AI-generated recommendations are processed and presented to healthcare professionals with comprehensive privacy audit trails and metadata about the anonymisation process.

4.3 Multi-Provider AI Architecture

The system implements a sophisticated AI model-agnostic architecture that provides intelligent routing and automatic failover capabilities:

Provider Selection Algorithm The system evaluates multiple factors to select the optimal AI provider for each request: - User preferences and historical performance - Current service availability and quota limits - Cost considerations and budget constraints - Response time requirements and quality expectations

Automatic Failover Mechanism When the primary AI provider becomes unavailable or reaches quota limits, the system automatically switches to alternative providers without user intervention, ensuring continuous service availability.

Performance Monitoring The system continuously monitors all AI providers for: - Response times and reliability metrics - Cost per request and quota utilization - Quality of responses and user satisfaction - Service availability and error rates

Load Balancing Intelligent load balancing distributes requests across available providers to optimize performance, cost, and reliability while maintaining user preferences and service quality standards.

4.4 Clinical Decision Support Interface

The system provides an interactive interface that enhances clinical decision-making through several innovative features:

Real-Time Analysis Display Clinical documentation is analyzed in real-time against relevant medical guidelines, with results displayed immediately as healthcare professionals type or upload clinical notes.

Interactive Recommendation System Each AI-generated recommendation includes: - Supporting evidence from medical guidelines - Confidence levels and clinical relevance scores - Options to accept, reject, or modify suggestions - Integration with clinical workflow processes

Decision Tracking and Learning The system maintains comprehensive records of all user decisions, enabling: - Continuous improvement of recommendation quality - Personalized adaptation to user preferences - Clinical outcome analysis and feedback loops - Regulatory compliance and audit requirements

Documentation Enhancement AI-generated suggestions for clinical documentation improvements are presented in structured categories: - Very Important: Critical clinical information that should be documented - Important: Significant clinical findings or

recommendations - Moderate: Helpful but non-critical documentation elements - Unimportant: Optional documentation that may be useful

5. CLAIMS

Claim 1: Privacy-Preserving Clinical Decision Support System

A computer-implemented clinical decision support system comprising: - a frontend application layer configured to receive clinical documentation from healthcare professionals; - a privacy-preserving anonymisation engine configured to identify and remove personally identifiable information from clinical data while preserving clinically relevant content using medical context-aware algorithms; - an AI model-agnostic processing engine configured to route requests across multiple AI service providers based on user preferences, availability, and performance metrics; - a guideline intelligence system configured to process and index medical guidelines for real-time analysis; - a clinical analysis pipeline configured to perform parallel processing of anonymised clinical data against multiple medical guidelines; - an interactive decision support interface configured to present AI-generated recommendations with options for user acceptance, rejection, or modification; - wherein the system ensures complete patient privacy protection while providing comprehensive clinical decision support through vendor-independent AI services.

Claim 2: Medical Context-Aware Anonymisation Method

A method for anonymising clinical data while preserving medical utility, comprising: - detecting personally identifiable information in clinical text using medical context-aware algorithms; - presenting detected PII to healthcare professionals through an interactive review interface; - applying medical-specific anonymisation patterns that preserve clinical terminology while removing identifiable information; - generating anonymised clinical data suitable for AI analysis while maintaining complete privacy protection; - maintaining comprehensive audit trails of anonymisation decisions and metadata;

- wherein the method ensures GDPR compliance and healthcare data protection while preserving clinical utility.

Claim 3: Multi-Provider AI Routing System

A system for intelligent routing of clinical analysis requests across multiple AI providers, comprising: - a provider selection algorithm configured to evaluate user preferences, availability, and performance metrics; - an automatic failover mechanism configured to switch between AI providers when services become unavailable; - a performance monitoring system configured to track response times, costs, and quality metrics across all providers; - a load balancing system configured to optimize request distribution based on provider capabilities and user requirements; - wherein the system provides vendor-independent AI services with continuous availability and optimal performance.

Claim 4: Real-Time Multi-Guideline Analysis Method

A method for simultaneously analyzing clinical documentation against multiple medical guidelines, comprising: - processing clinical data through privacy-preserving anonymisation before AI analysis; - identifying relevant medical guidelines based on clinical content and context; - performing parallel analysis of anonymised clinical data against multiple guidelines simultaneously; - generating prioritized recommendations based on guideline relevance and clinical importance; - presenting results through an interactive interface with supporting evidence and confidence levels; - wherein the method provides comprehensive clinical decision support while maintaining complete privacy protection.

Claim 5: Interactive Clinical Documentation Enhancement System

A system for enhancing clinical documentation through AI-generated suggestions, comprising: - an AI analysis engine configured to review clinical notes against medical guidelines; - a suggestion categorization system configured to organize recommendations by importance level; - an interactive interface configured to present

suggestions with options for acceptance, rejection, or modification; - an automatic application system configured to integrate accepted suggestions into clinical documentation; - a decision tracking system configured to maintain records of all user decisions and modifications; - wherein the system improves clinical documentation quality while preserving healthcare professional judgment.

Claim 6: Privacy-Protected Clinical Workflow Integration Method

A method for integrating AI-powered clinical decision support into healthcare workflows while maintaining privacy protection, comprising: - receiving clinical documentation through a secure, privacy-aware interface; - processing data through comprehensive anonymisation before any external transmission; - analyzing anonymised data against relevant medical guidelines using multiple AI providers; - presenting results through an interactive interface that tracks user decisions; - applying accepted recommendations to original clinical documentation; - maintaining comprehensive audit trails for regulatory compliance; - wherein the method enhances clinical workflows while ensuring complete patient privacy protection.

Claim 7: Medical Guideline Intelligence System

A system for processing and indexing medical guidelines for real-time clinical analysis, comprising: - an automated guideline processing engine configured to convert PDF guidelines to structured, searchable format; - a metadata enhancement system configured to extract guideline metadata and clinical relevance using AI; - a dynamic updating system configured to synchronize with latest guideline versions; - a contextual indexing system configured to enable rapid retrieval and relevance matching; - a guideline matching algorithm configured to identify relevant guidelines based on clinical content; - wherein the system provides comprehensive access to current medical guidelines for clinical decision support.

Claim 8: Clinical Decision Tracking and Learning System

A system for tracking clinical decisions and enabling continuous learning, comprising: - a decision recording system configured to capture all user interactions with AI recommendations; - a learning algorithm configured to adapt recommendations based on user preferences and decisions; - a feedback analysis system configured to evaluate clinical outcomes and recommendation effectiveness; - a personalization engine configured to customize recommendations for individual healthcare professionals; - an audit trail system configured to maintain comprehensive records for regulatory compliance; - wherein the system improves recommendation quality through continuous learning and adaptation.

Claim 9: Multi-Service Healthcare AI Architecture

A distributed architecture for healthcare AI services with redundancy and reliability, comprising: - multiple AI service providers configured to provide clinical analysis capabilities; - an intelligent routing system configured to select optimal providers based on multiple criteria; - an automatic failover system configured to maintain service availability during provider outages; - a performance monitoring system configured to track quality and reliability across all providers; - a cost optimization system configured to balance performance and cost considerations; - wherein the architecture ensures reliable, cost-effective AI services for healthcare applications.

Claim 10: Privacy-Aware Clinical Data Processing Pipeline

A pipeline for processing clinical data with comprehensive privacy protection, comprising: - a PII detection system configured to identify sensitive information using medical context awareness; - an interactive review system configured to allow healthcare professional oversight of anonymisation; - a medical-specific anonymisation engine configured to preserve clinical utility while removing PII; - a secure transmission system configured to send only anonymised

data to external AI services; - a privacy audit system configured to maintain comprehensive records of all data processing; - wherein the pipeline ensures complete privacy protection while maintaining full clinical utility.

Claim 11: Real-Time Clinical Analysis and Recommendation System

A system for providing real-time clinical analysis and recommendations, comprising: - a real-time processing engine configured to analyze clinical documentation as it is entered; - a guideline matching system configured to identify relevant medical guidelines for clinical cases; - an AI analysis system configured to generate recommendations using multiple AI providers; - an interactive presentation system configured to display results with supporting evidence; - a decision support system configured to assist healthcare professionals in clinical decision-making; - wherein the system provides immediate, comprehensive clinical guidance while maintaining privacy protection.

Claim 12: Healthcare AI Service Optimization Method

A method for optimizing AI service usage in healthcare applications, comprising: - monitoring performance and costs across multiple AI service providers; - analyzing user preferences and historical decision patterns; - implementing intelligent routing algorithms to optimize provider selection; - providing automatic failover capabilities to ensure service availability; - balancing cost considerations with performance and quality requirements; - wherein the method ensures optimal AI service utilization for healthcare applications.

Claim 13: Comprehensive Clinical Decision Support Platform

A comprehensive platform for clinical decision support that integrates privacy protection, multi-provider AI services, and interactive decision support, comprising: - a privacy-preserving anonymisation system configured to protect patient data; - a multi-provider AI architecture configured to ensure service reliability and vendor independence; - a

real-time analysis system configured to process clinical documentation against medical guidelines; - an interactive interface configured to present recommendations with user control options; - a learning system configured to adapt to user preferences and clinical outcomes; - wherein the platform provides comprehensive, privacy-protected, and vendor-independent clinical decision support.

6. ABSTRACT

This invention relates to an AI-powered clinical decision support platform that provides real-time analysis of clinical documentation against evidence-based medical guidelines while ensuring patient privacy through advanced anonymisation techniques and maintaining optimal performance through AI model-agnostic architecture. The system implements privacy-preserving anonymisation at source, intelligent routing across multiple AI providers, comprehensive medical guideline analysis, interactive decision support interfaces, and AI-generated documentation suggestions. The platform addresses critical healthcare challenges including patient privacy protection, AI vendor independence, and clinical workflow optimization through innovative technical solutions that combine medical context-aware anonymisation, multi-provider AI architecture with automatic failover, simultaneous multi-guideline analysis, and adaptive learning mechanisms. The invention represents a substantial technological leap in clinical decision support systems, providing healthcare professionals with comprehensive, privacy-protected, and vendor-independent AI-powered clinical guidance.