What do Prevention of Future Death Reports tell us about maternity care in UK hospitals?

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PREVENTION OF FUTURE DEATH (PFD) REPORTS

Introduction: Despite UK government goals to reduce maternal deaths by 50% by 2025, maternal mortality rates increased by 3% between 2010-2012 and 2018-2020 (excluding COVID-19 deaths).

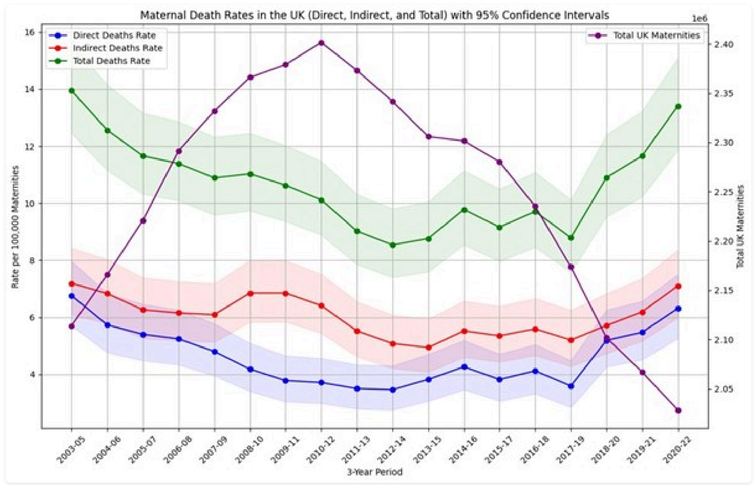

Figure 1: Maternal Mortality Trends

What are PFD Reports? Independent judicial assessments issued by coroners following inquests into unexpected deaths, providing cross-organisational perspectives on patient safety issues.

Research Question: What do Prevention of Future Death reports reveal about the key safety themes and system-level failures in UK maternity care, and how can automated multi-framework analysis enhance patient safety intelligence?

DATA

51	UK	2014-2025
PFD Reports	Judiciary Data	Study Period

Data Collection Method: Specialised web scraping tool extracted PFD reports from UK Judiciary website using maternal healthcare search terms including: midwifery, birth, baby, maternal, infant, obstetrics, neonatal, perinatal, pregnancy, postnatal, antenatal, maternity, stillbirth, antepartum, foetal/foetal.

Data: Publicly accessible coroners' reports from UK Judiciary website
Ethics: No ethical approval required for public data analysis

FRAMEWORK DEVELOPMENT

Three Complementary Frameworks:

1. **Safety Intelligence Research framework (SIRch):** Sociotechnical categories based on SEIPS model - person factors (staff performance, decision errors), job/task factors (care planning, monitoring), organisation factors (team culture, communication), technologies & tools (equipment issues), environment factors (physical layout, external pressures).

2. **Black maternal health framework:** Equity dimensions from House of Commons Women & Equalities Committee report - communication (dismissed concerns), fragmented care (poorly coordinating providers), informed consent/agency (informed decisions), dignity/respect (discrimination faced), care quality issues (microaggressions, racism), socioeconomic factors and deprivation.

3. **Extended safety framework:** Emerging themes from textual analysis - medication safety, diagnostic testing & specimen handling, time-critical interventions, human factors & cognitive aspects, service design & patient flow, emergency preparedness, staff wellbeing & burnout, electronic health record issues.

Triangulation approach: Simultaneous analysis across three frameworks enables comprehensive coverage whilst revealing framework-specific blind spots in safety investigation and maintaining analytical rigour.

PFD VS HSIB COMPARISON

PFD reports (n=51)		HSIB reports (n=188)	
Medication Safety (*)	78.4%	Communication Factor	84.6%
Staff Performance (+)	78.4%	Teamworking	82.4%
Team Culture (+)	74.5%	Assessment Investigation	79.8%
Informed consent/agency (-)	66.7%	Patient physical characteristics	62.8%
Diagnostic Testing & Specimens (*)	64.7%	Staff-Slip or Lapse	52.7%
Patient Record Attendance (+)	62.7%	Escalation/Referral Factor	51.6%
Physical Layout & Environment (+)	56.9%	National & Local Guidance	48.9%
Staff Decision Error (+)	41.2%	Technologies & Tools-Interpretation	47.9%
Peer Support & Supervision (*)	39.2%	Obstetric Review	47.3%
External Societal Factor (+)	39.2%	Staff Decision Error	47.3%

House of Commons Women & Equalities Committee themes in PFD reports: informed consent/agency ranked 4th (66.7%), followed by guidance gaps (37.3%), care quality issues (31.4%), and communication (29.4%).

TECHNICAL ARCHITECTURE

Enhanced ML Pipeline with Implementation Details

1. **Automated Web Scraping**
BeautifulSoup4 + rate-limited batch processing with PDF extraction & regex-based metadata parsing

2. **Advanced Data Preparation**
Multi-file merging, record-level deduplication, temporal extraction, missing value imputation & content validation

3. **Exploratory Analysis**
Interactive dashboards with data quality validation, distribution analysis & cluster evaluation

4. **Multi-Framework Concept Annotation**
Bio_ClinicalBERT-based semantic analysis with 768D contextual embeddings, generating thematic annotations across three frameworks simultaneously

5. **Advanced Scoring & Theme Identification**
Dual-component scoring system (70% semantic similarity + 30% keyword density) with contextual window analysis & confidence thresholds (High ≥0.8, Medium 0.65-0.8, Low <0.65)

6. **Advanced Analytics Dashboard**
Interactive Plotly dashboards analysing PFD reports by year, coroner area, framework distribution, theme co-occurrence networks, correlation matrices with multi-format export

CONCLUSIONS & IMPACT

Clinical implications: PFD reports identify system-level failures not apparent through individual healthcare provider investigations, providing unique insights that complement existing incident reporting systems.

Research impact: This first systematic analysis of maternity-related PFD reports establishes a novel data source for patient safety intelligence. The findings reveal priority areas spanning clinical practice, organisational culture, and patient rights, providing evidence for comprehensive safety improvement initiatives across UK maternity care systems.

Future directions: Development of a unified framework applicable across healthcare specialities including maternity, mental health, and other clinical domains to enable cross-speciality learning and comparative safety analysis.

Study Limitations: Ethnicity data was not available as PFD reports focus on systemic issues rather than demographic characteristics.

RESEARCH RESULTS & ANALYSIS

Document: Eclipse Morrison: Prevention of future deaths report

Identified Themes

Framework	Theme	Confidence	Score	Matched Keywords	Color
Extended Analysis	Diagnostic Testing and Specimen Handling	High	0.852	analysis, interpretation	
House of Commons	Guidance gaps	High	0.886	information, guidance	
House of Commons	Fragmented care	High	0.883	clear, care	
House of Commons	Care quality and access issues	High	0.881	access, quality, treatment	
House of Commons	Inadequate maternity care	High	0.868	maternity, care	
House of Commons	Socioeconomic factors and deprivation	High	0.863	factors	
I-SIRch	Organisation - National and/or local guidance	High	0.884	guidance	
I-SIRch	Person - Patient (characteristics and performance) - Characteristics - Training and education (e.g., attendance at ante-natal classes)	High	0.876	training, education	
I-SIRch	Jobs/Task - Care planning	High	0.872	care, planning	
I-SIRch	Person - Patient (characteristics and performance) - Characteristics - Record of attendance (e.g., failure to attend antenatal classes)	High	0.865	record	
I-SIRch	External - Geographical factor (e.g. Location of patient)	High	0.86	factor	

Highlighted Text

are as follows - Evidence was given at the inquest and it is accepted, that many of the concerns identified in relation to Eclipse's birth have now been addressed, but some remain. 1. Risk analysis / mode and timing of birth A significant factor was the failure to consider an elective Caesarean Section (CS). It is not clear why on this history and consideration of mode of delivery did not include a consideration of an elective CS at any stage, by any of the doctors involved. Evidence was given that existing policies in place at GEH were not followed and the reason for this failure has not been identified. Whilst Badgernet could be a useful tool, the evidence suggested that it is being regarded as a first line of defence rather than a failsafe. I am told that the Badgernet maternity system implemented in October 2021 will resolve the problems relating to mode and timing of birth, in that the system will require a consultant to approve a decision for CS/induction of labour (IOL) and that IOL's will not be approved by the labour ward coordinator unless the paper booking has been approved on paper. However, on the evidence received it is not clear how this will assist if the risk factors and the need to consider IOL/elective CS have not been identified, by junior staff, thus triggering the need for escalation to/approval by a consultant. I am not clear what has been done to ensure that junior doctors and locums have sufficient technical knowledge to ensure that they are able to identify serious risk factors and alert the consultant to these, so that the consultant may consider the appropriate mode of delivery. No information was provided as to the availability of regular face to face training for all grades concerning high-risk pregnancies not just for career trainees and foundation doctors. I am told that a memo was sent to all junior doctors reminding them that any plan for either IOL or elective CS must be approved by a consultant and that an induction pack containing that information is provided to new starters and locums. I have seen the Women's and Children Clinical Education Guideline introduced in November 2022. I am told that the information was placed in a prominent position on notice boards, staff rooms and in blogs. It is not clear how the assimilation of this knowledge is tested. It was suggested that this may be in appraisal, but this seems only likely to identify problems after they arise. In any event it seems these methods of dissemination of information and the appraisal system were in place at the time of Eclipse's birth but did not ensure that the doctors involved in her mother's care appreciated the impact of the risk factors in this pregnancy. It was not explained how Badgernet or any policy or procedure in place, would ensure that there is a holistic review (including ultrasound scan findings) when planning for timing and mode of birth. The concern remains that there will be further failure to ensure that appropriate timing and mode of delivery will be provided in high-risk pregnancies. 2. Access to Badgernet portal / full implementation of the Badgernet software It seems that the Badgernet system is being relied on to address a number of issues which were identified in this case, and heavy reliance is being placed on a system which is not yet fully implemented. The concern remains that there is insufficient quality assurance in this system. 4. Procedure for escalating concerns arising out of Ultrasound Scans (USS) I understand that the procedure for escalating concerns arising out of a USS where it is not possible to obtain an accurate measurement in a high-risk pregnancy is currently under review. I am told that the new policy is not in place. The concern remains that no date has been set for its implementation. 5. Counselling for mothers at increased risk of shoulder dystocia I have not seen any indication that all mothers identified to have an increased chance of shoulder dystocia now receive counselling regarding the risks and benefits associated with vaginal birth or CS. Assisting mothers to understand the implications of risks they face is fundamental to supporting them to make fully informed decisions, in accordance with Montgomery. The concern remains that there is no clear plan in place to ensure mothers receive the support they require to make fully informed decisions in relation to mode of delivery where there is risk of shoulder dystocia. 6. Interpretation of Montgomery Ante-natal care is unique in that decisions have to be made for the benefit of two patients (the mother and the baby) and the treatment options for each may, as in this case have competing risks and benefits. In addition, in ante-natal care, the circumstances may change and action may need to be taken very quickly. On the basis of evidence given at the inquest, there seems to be a lack of clarity as to the way in which Montgomery guidelines are interpreted. It was acknowledged in evidence that parents often want a steer as to the best/safest course of action and that may require medical professionals to express opinions as to the weight to be placed on different risk factors. In some cases, parents may prefer to rely on the viewpoint of an experienced medical professional. It seems that medical professionals do not feel they can offer this assistance as it might be interpreted as trying to impose their opinion on the parent. The way in which Montgomery is interpreted and the extent to which medical professionals can offer an opinion is of wider concern than just the actions of those at GEH and should be considered by those who produce the guidance and deliver training to medical professionals.

Framework	Theme	Color	Matched Keywords	Extracted Sentence
Extended Analysis	Diagnostic Testing and Specimen Handling + I-SIRch_External - Geographical factor (e.g. Location of patient)	#D1ECF1	analysis + factor	Risk analysis / mode and timing of birth A significant factor was the failure to consider an elective Caesarean Section (CS).
House of Commons	Fragmented care	#FFECB3	clear	It is not clear why on this history and consideration of mode of delivery did not include a consideration of an elective CS at any stage, by any of the doctors involved.
House of Commons	Inadequate maternity care	#F3E5F5	maternity	I am told that the Badgernet maternity system implemented in October 2021 will resolve the problems relating to mode and timing of birth, in that the system will require a consultant to approve a decision for CS/induction of labour (IOL) and that IOL's will not be approved by the labour ward coordinator unless the paper booking has been approved on paper.

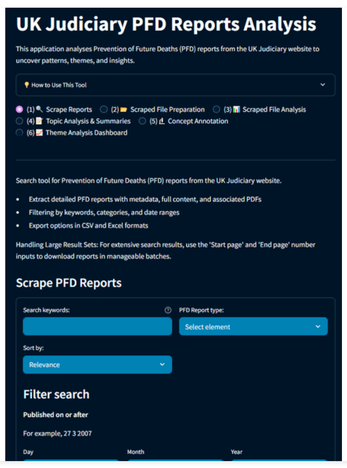

Figure 3: Analysis Results

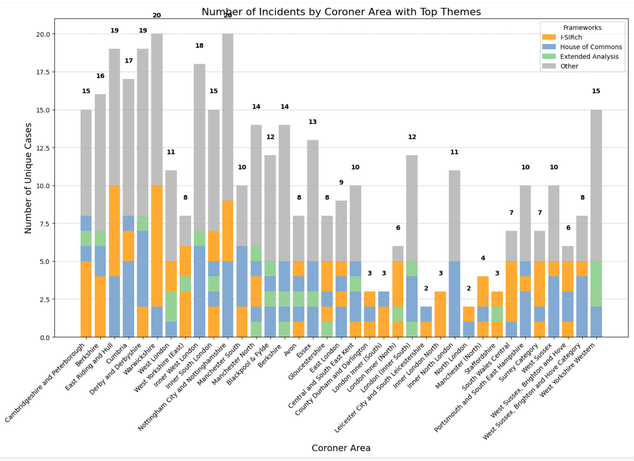

Figure 4: Regional Distribution Analysis

Figure 5: Detailed Regional Distribution

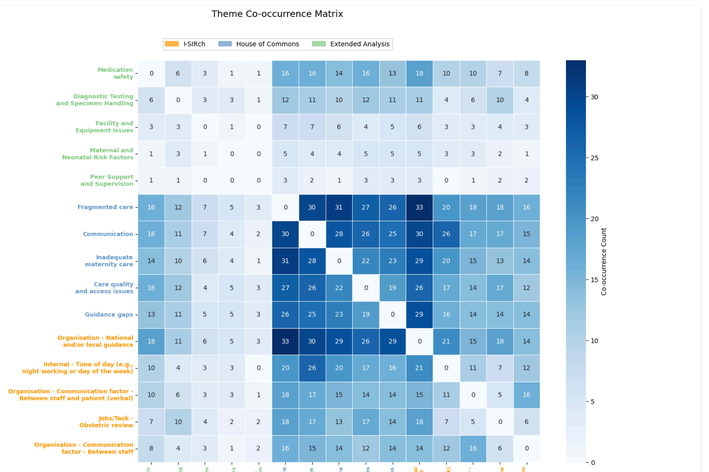

Figure 6: Top 15 Theme Co-occurrence Network

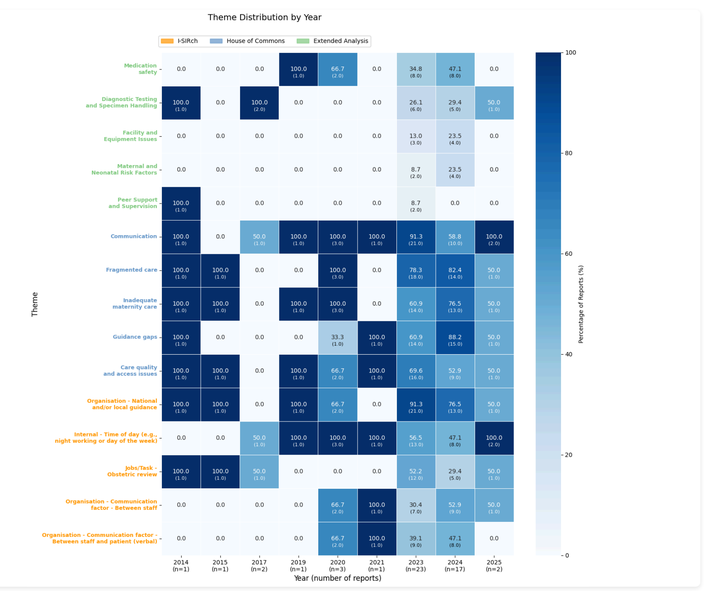

Figure 7: Top 15 Theme Distribution by Year

REFERENCES

[1] Knight M, Bunch K, Tuffnell D, et al. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2016-18. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2020.

[2] House of Commons Women and Equalities Committee. Black maternal health. First Report of Session 2019-21. HC 19. London: House of Commons; 2019.

[3] Cosma G, Waterson P, Jun TG, Back J. Using artificial intelligence to extract safety intelligence from investigation reports: The case of maternal healthcare. Safety Science. 2023;158:105996.

[4] Jun GT, Waterson P, Cosma G. Patient safety intelligence: a systematic review of using artificial intelligence in healthcare safety. Journal of Patient Safety. 2022;18(4):e621-e631.

[5] Cosma G, Jun TG, Waterson P. Leveraging AI for enhanced patient safety intelligence in maternity care investigation reports. Proceedings of HealTAC 2025.

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