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Pencegahan dan Pendeteksian *Phantom Billing* dalam Jaminan Kesehatan: Sebuah Studi Literatur

Prevention and Detection of Phantom Billing in Health Insurance: A Literature Review

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ABSTRAK

Tindakan *fraud* khususnya *phantom billing* dalam program jaminan kesehatan masih terjadi di Indonesia meskipun telah ada regulasi terkait pencegahan dan penanganannya. Oleh karena itu dibutuhkan pengembangan metode baru untuk mengatasi *phantom billing*. Penelitian ini bertujuan untuk menganalisis metode pencegahan dan pendeteksian *phantom billing* dalam jaminan kesehatan melalui studi literatur. Pencarian artikel dilakukan melalui *database* Scopus, PubMed, ScienceDirect, ProQuest, dan Google Scholar, dengan kata kunci *"fraud prevention" AND "fraud detection" AND "phantom billing" AND "health insurance"*. Kriteria inklusi pada penelitian ini meliputi seluruh artikel yang tersedia dalam *open access full text*, diterbitkan antara tahun 2020-2025, dan membahas pencegahan dan pendeteksian *phantom billing* dalam jaminan kesehatan. Artikel berupa reviu, tidak dalam bahasa Inggris atau Indonesia, serta tidak relevan dieksklusi dari penelitian ini. Dari hasil skrining diperoleh 19 artikel untuk direviu pada studi ini. Terdapat berbagai metode pencegahan dan pendeteksian *phantom billing* yang dapat digunakan, namun tidak ada metode tunggal yang efektif, melainkan diperlukan kombinasi antara strategi berbasis teknologi dan tata kelola. Hasil penelitian merekomendasikan perlunya pendekatan hibrid yang memadukan inovasi teknologi, regulasi yang kuat, serta pengawasan yang ketat sehingga praktik dan kerugian akibat *phantom billing* tidak terjadi lagi.

Kata Kunci: *Deteksi; Jaminan Kesehatan; Phantom Billing; Pencegahan*

ABSTRACT

Fraud, particularly phantom billing in health insurance programs, still occurs in Indonesia despite the existence of regulations related to its prevention and handling. Therefore, new methods are needed to overcome phantom billing. This study aims to analyze methods for preventing and detecting phantom billing in health insurance through a literature review. Articles were searched for in the Scopus, PubMed, ScienceDirect, ProQuest, and Google Scholar databases, using the keywords "fraud prevention" AND "fraud detection" AND "phantom billing" AND "health insurance". The inclusion criteria for this study included all articles available in open access full text, published between 2020 and 2025, and discussing the prevention and detection of phantom billing in health insurance. Articles in the form of reviews, not in English or Indonesian, and irrelevant articles were excluded from this study. The screening results yielded 19 articles for review in this study. There are various methods of preventing and detecting phantom billing that can be used, but no single method is effective; rather, a combination of technology-based and governance strategies is needed. The results of the study recommend a hybrid approach that combines technological innovation, strong regulation, and strict supervision so that the practice and losses caused by phantom billing do not occur again.

Keywords: *Detection; Health Insurance; Phantom Billing; Prevention*

INTRODUCTION

Fraud is deception or the presentation of misleading information by individuals or entities that is done intentionally to gain benefits for those individuals or entities (1). Based on the 2024 Report to the Nations (RTTN) by the Association of Certified Fraud Examiners (ACFE), it is estimated that the total losses due to fraud experienced by organizations are around 5% annually (2). Fraud can occur in various sectors, including the health sector, and it is estimated that 3% to 10% of healthcare costs are lost due to fraud (3).

More specifically, in the context of health insurance, fraud can also occur. This phenomenon is also the case in Indonesia.

Participants, healthcare providers, suppliers of medicines and medical devices, and other stakeholders can commit fraud. Therefore, to prevent and handle fraud, especially in health insurance programs, the Indonesian government, through the Ministry of Health, has issued Minister of Health Regulation No. 16 of 2019 concerning the Prevention and Handling of Fraud and the Imposition of Administrative Sanctions for Fraud in the Implementation of Health Insurance Programs (4).

However, despite the existence of regulations related to fraud prevention and handling, fraud cases still occur. One example is based on data from the Corruption Eradication Commission (KPK) that in July 2024, there were cases of fraud in three hospitals in Indonesia, namely one hospital in Central Java Province and two hospitals in North Sumatra Province. The fraud that occurred was in the form of fictitious billing, or phantom billing, with an alleged fraud amount of 35 billion rupiah (5). Therefore, in addition to regulations, special strategies are needed so that fraud, especially in the form of fictitious billing or phantom billing, does not occur again.

Many previous studies have discussed fraud prevention and detection, such as the research by Shabiha etc. (6), Stowell etc. (7), and Firmansyah etc. (8). However, there are still limited studies specifically discussing the prevention and detection of phantom billing. Given the continued occurrence of phantom billing cases in Indonesia's health insurance program and the limited literature discussing the prevention and detection of such cases, this study aims to analyze methods for preventing and detecting fraud, particularly phantom billing, to provide insights and policy recommendations for handling phantom billing in Indonesia's health insurance program.

METHOD

This study uses a literature review design, which is a method that aims to systematically analyze and synthesize specific topics based on previous studies. The literature reviewed in this study relates to the prevention and detection of phantom billing in health insurance. The problems or questions addressed in this study are: 1) What methods can be used to prevent and detect phantom billing? 2) How effective are these prevention and detection methods? 3) What obstacles arise during the implementation of these methods?.

The literature search was conducted on the Scopus, PubMed, ScienceDirect, and ProQuest databases through direct searches, while literature from Google Scholar was extracted using the Publish or Perish (PoP) application. The keywords used in the search process were “fraud prevention” AND “fraud detection” AND “phantom billing” AND “health insurance.” The inclusion criteria for this study included all articles available in open access and full text published between 2020 and 2025 that discussed the prevention and detection of phantom billing in health insurance. The exclusion criteria included articles that were reviews, articles not in English or Indonesian, and articles that did not answer the research questions. Figure 1 provides a detailed overview of the article selection process in this study. The article search was conducted in September 2025, and articles that met the inclusion criteria were then extracted as listed in Table 1, and data analysis and synthesis were performed in the discussion section.

After the screening process, the eligible articles were reviewed using a structured extraction process. Information extracted from each study included author and year, country, study design, type of fraud addressed, prevention strategies, and detection methods, as presented in Table 1. The extracted findings were then synthesized narratively and grouped into four analytical domains: (1) prevention strategies, (2) detection methods, (3) reported effectiveness, and (4) implementation challenges. Within these domains, similar approaches were compared to identify recurring themes, complementarities between technological and governance-based strategies, differences in study findings, and gaps relevant to the implementation of phantom billing control in health insurance.

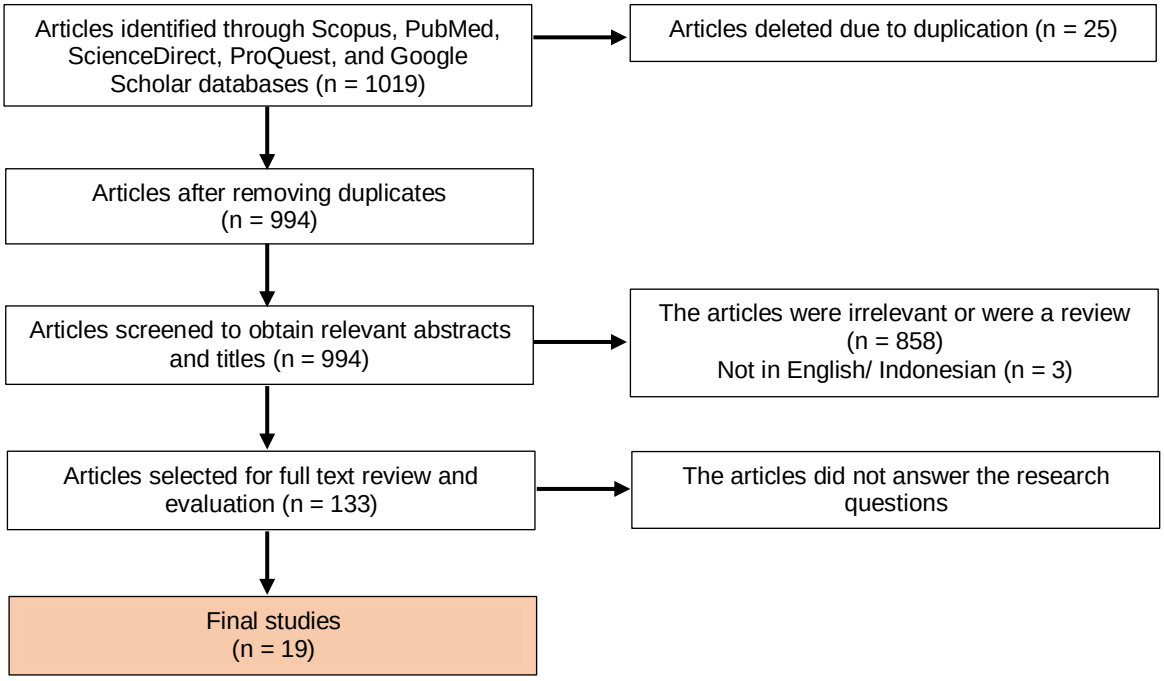


Figure 1. Literature flowchart

RESULTS

A literature search of five databases, namely Scopus, PubMed, ScienceDirect, ProQuest, and Google Scholar, using the specified keywords yielded a total of 1019 articles before screening. After screening the titles and abstracts and selecting articles based on the inclusion criteria, 19 articles were obtained for analysis and synthesis.

The search results indicated that there were no articles that specifically discussed phantom billing. However, the articles obtained discussed phantom billing along with other types of fraud and methods of prevention and detection. Since not all methods are relevant to every type of fraud, the articles reviewed in this study underwent a screening process so that they could answer the research questions, particularly those related to the prevention and detection of phantom billing in health insurance.

There were 5 studies that discussed methods that could prevent and detect phantom billing, namely the studies by Bhatia (9), Islam etc. (10), Islayem etc. (11), Mackey etc. (12), and Raad etc. (13). Meanwhile, there were 3 studies that only describe methods for preventing phantom billing and 11 studies that only described methods for detecting phantom billing. Table 1 displays the results of the article extraction included in the literature study.

Across the 19 included studies, the findings can be organized into four broad thematic categories. First, governance- and verification-based approaches included strengthening internal audit, risk identification, anti-fraud teams, clinical pathways, biometric verification, and organizational ethics (14–19). Second, data-driven detection approaches included data mining, predictive modeling, machine learning, unsupervised learning, Graph Neural Networks (GNNs), Generative Adversarial Networks (GANs), and weighted risk models (17,20–25). Third, blockchain-based approaches used permanent claim records, smart contracts, and patient or insurer validation mechanisms to improve traceability and claim verification (10–15). Fourth, several studies proposed integrated or hybrid approaches that combine technological tools with governance mechanisms, such as ERP-based controls, predictive analytics linked to policy interventions, and blockchain integrated with Large Language Models (LLMs) (9,11,17). These themes indicate that current research is moving toward combining automated detection with institutional controls rather than relying on a single mechanism.

DISCUSSION

Phantom Billing Prevention and Detection Methods

In the reviewed article, there are several methods of preventing fraud in health claims, including technological and governance-based approaches. Mackey et al. (12) developed a blockchain-based framework for permanent claim recording. Putra and Mita (14) emphasize strengthening internal audits through GIAS standards, consulting services, ethical culture, and the use of risk-based information technology. Bhatia (9) highlights the role of modern ERP systems such as SAP S/4HANA with automatic controls, AI-driven anomaly detection, and predictive analytics to identify high-risk claims before they are processed.

Mahadini et al. (15) propose fingerprint-based biometric verification, while Hana and Prabowo (16) outline nine prevention steps ranging from risk identification, organizational commitment, integrity pacts, excellent corporate governance, the formation of anti-fraud teams, cooperation with TKMKB, socialization and training, and SPM to biometric verification. Machireddy (17) integrates predictive modeling to detect anomaly patterns and translate them into concrete policy interventions, while Maluleke (18) emphasizes identity verification, electronic health records (EHR), biometrics, and ethics education campaigns. Finally, Saru et al. (19) emphasize policy formulation and prevention guidelines through clinical pathways, a culture of prevention, and the formation of quality and cost control teams. Overall, fraud prevention methods combine technological innovation with strengthened governance and organizational ethics to create a more transparent and accountable healthcare system.

Table 1. Article extraction results

No.	Title	Author (Year)	Country	Design	Types of Fraud in Research	Fraud Prevention Methods	Fraud Detection Methods
1.	Combating health care fraud and abuse: Conceptualization and prototyping study of a blockchain antifraud framework	Mackey et al (2020)	United States	Development of a blockchain-based fraud prevention and detection framework. The research has not yet used real datasets.	1. Phantom billing 2. Kickback 3. Upcoding 4. Unnecessary Services 5. Self referral	Development of a blockchain-based framework to permanently record claim data and enable patients to act as validation nodes to prevent fraud.	Development of a blockchain-based framework to permanently record claim data and enable patients to act as validation nodes to detect fraud.
2.	Enhancing healthcare data integrity: Fraud detection using unsupervised learning techniques	Bairy et al (2024)	United States	Development of fraud detection based on unsupervised learning. Using data sets from the Centers for Medicare and Medicaid Services (CMS) in the United States.	1. Phantom billing 2. Identity theft 3. Upcoding	-	Fraud detection methods based on unsupervised learning use algorithms such as Isolation Forest, Local Outlier Factor (LOF), K-Nearest Neighbors (KNN), and autoencoder.
3.	Enhancing internal audit effectiveness through global internal audit standards: Insights from a social insurance case	Putra & Mita (2025)	Indonesia	Case study on Social Security Administration Agency "X" with interviews of five key respondents, namely one director, one general manager, two senior managers, and one manager. Analysis of important documents was also conducted.	1. Phantom billing 2. Upcoding 3. Duplicate claims	Strengthening internal audit functions through the implementation of Global Internal Audit Standards (GIAS); developing consulting service guidelines to support fraud control; enhancing the culture of ethics within the organization; utilizing information technology to support risk-based auditing.	The implementation of GIAS involves risk-based audits to identify high-risk areas, analysis of audit findings based on root causes, impact, and level of significance, and classification of findings based on risk level to focus on significant fraud cases.
4.	Fraud detection in privacy preserving health insurance system using blockchain technology	Islam et al (2025)	Bangladesh	Development of a blockchain-based system to maintain patient privacy and detect fraud in health insurance claims.	1. Billing for unprovided services/ phantom billing 2. False identity or misrepresentation of identity 3. Fake billing code 4. Inflated claims 5. Multiple claims 6. Duplicate billing 7. Falsifying medical conditions 8. Misrepresentation of coverage 9. Underpayment detected 10. Fake provider 11. Policy misuse	-	Fraud detection using blockchain technology and insurance providers verify claims using smart contracts.

No.	Title	Author (Year)	Country	Design	Types of Fraud in Research	Fraud Prevention Methods	Fraud Detection Methods
5.	Fraud detection in supplementary health insurance based on smart contract in blockchain network	Raad et al (2024)	Iran	Development of fraud detection through smart contracts in blockchain networks. The data used is primary data collected by the author through experience and programming knowledge.	1. Billing manipulation (including phantom billing) 2. Pinging the system 3. Waiving co-payments 4. Managed care fraud 5. Self-referral 6. Doctor shopping 7. Identity theft 8. Prescription fraud 9. Commission-based fraud	-	Detecting fraud through smart contracts in blockchain networks.
6.	Graph neural network models for detecting fraudulent insurance claims in healthcare systems	Hasan (2022)	United States	Using a mixed method design, combining quantitative experiments with various GNN architectures such as Graph Convolutional Networks, Graph Attention Networks, and GraphSAGE, with qualitative insights gathered from fraud investigators in the healthcare sector to evaluate their interpretation and usefulness. The study used a dataset consisting of anonymous health insurance claims.	1. Phantom billing 2. Unnecessary services 3. Kickbacks 4. Provider–patient collusion	-	Detecting fraud with Graph Neural Networks (GNNs) models.
7.	Healthcare finance modernization with SAP S/4HANA: Transparency, compliance, and fraud prevention	Bhatia (2025)	United Kingdom	Development of fraud prevention and detection with SAP S/4HANA.	1. Phantom billing 2. Upcoding 3. Duplicate claims 4. Collusion	The study highlights how SAP S/4HANA uses automated controls, AI-driven anomaly detection, and predictive analytics to prevent fraud, such as identifying high-risk claims before they are processed.	The SAP S/4HANA system, integrated with the SAP Business Technology Platform (BTP), also detects suspicious patterns, such as billing outliers or duplicate claims, using machine learning algorithms and predictive analytics. This enables real-time fraud identification, thereby reducing the financial impact.
8.	Healthcare insurance fraud detection using data mining	Hamid et al (2024)	United States	Development of fraud detection using data mining, using a dataset from the Centers	1. Billing for services not provided (phantom billing) 2. Upcoding 3. Identity theft	-	Detecting fraud using data mining.

No.	Title	Author (Year)	Country	Design	Types of Fraud in Research	Fraud Prevention Methods	Fraud Detection Methods
				for Medicare and Medicaid Services (CMS) 2008-2010.	4. Collusion among healthcare providers 5. Unnecessary treatments 6. Duplicate billing		
9.	*Implementasi kebijakan sistem finger print pasien khusus rawat jalan BPJS Kesehatan di Rumah Sakit PKU Muhammadiyah Gombong*	Mahadini et al (2024)	Indonesia	This study used a qualitative research method with a descriptive approach. The technique for determining informants in this study was purposive sampling with data collection methods through interviews, observation, and documentation.	1. Phantom billing 2. Identify theft	Prevention of fraud through fingerprint systems.	-
10.	Implementing fraud prevention and detection strategies in Indonesia's National Health Insurance: A case study at BPJS Kesehatan Yogyakarta	Hana & Prabowo (2025)	Indonesia	Using a qualitative case study approach, the analysis was conducted using NVivo 12 software based on in-depth interviews with four key informants.	1. Phantom billing 2. Claim manipulation 3. Upcoding 4. Fragmentation 5. Conflict of interest	1. Risk identification 2. Organizational commitment 3. Integrity pact 4. Principles of good corporate governance (GCG) 5. Formation of an Anti-Fraud Team 6. Cooperation with the Quality and Cost Control Team (TKMKB) 7. Socialization and training 8. Letter of Absolute Responsibility (SPM) 9. Biometric verification	1. Regular audits 2. Information technology support 3. Monitoring of participant contributions 4. Compliance checks 5. Strengthening internal oversight 6. Regular data updates 7. Real-time verification of participant data 8. Whistleblowing system (WBS)
11.	Integrating predictive modeling with policy interventions to address fraud, waste, and abuse (fwa) in us healthcare systems	Machireddy (2022)	United States	Development of a framework to integrate predictive models and policy interventions in efforts to mitigate fraud, waste, and abuse (FWA) in the US healthcare system.	1. Phantom billing 2. Identity theft 3. Upcoding 4. Unbundling 5. Medically unnecessary services 6. Kickbacks 7. Misrepresentation of services	Integration between predictive modeling (to detect anomalous patterns and risky behavior in a data-driven manner) and policy intervention (to translate these findings into concrete measures that prevent further losses).	Integration between predictive modeling (to detect anomalous patterns and risky behavior in a data-driven manner) and policy intervention (to translate these findings into concrete measures that prevent further losses).

No.	Title	Author (Year)	Country	Design	Types of Fraud in Research	Fraud Prevention Methods	Fraud Detection Methods
12.	Machine learning for fraud detection and error prevention in health insurance claims	Mishra (2023)	United States	The use of machine learning for fraud detection in health insurance claims.	1. Phantom billing 2. Double billing 3. Unbundling 4. Upcoding 5. Identify theft	-	Fraud detection using machine learning, combining supervised learning, unsupervised learning, natural language processing (NLP), and deep learning techniques.
13.	Optometrists' experience of healthcare fraud, waste and abuse (FWA) and strategies to combat it	Maluleke (2024)	South Africa	Quantitative research used a cross-sectional design with random sampling of 206 valid respondents out of a total of 317 respondents.	1. Phantom billing 2. Upcoding 3. Unbundling 4. Self-referral 5. Kickbacks 6. Identify theft	The programs include identity verification, staff training, accurate medical record keeping, use of technology such as electronic health records (EHR) and biometrics, internal policies regarding the prohibition of altering medical records, as well as ethics campaigns and education.	-
14.	Potential fraud and its' prevention in the implementation of national health insurance at Dadi Regional Hospital	Saru et al (2023)	Indonesia	Using qualitative methods with a phenomenological design to explore the experiences and awareness of the research subjects. The research informants were two hospital internal supervisors (SPI), two coders, one specialist doctor, one BPJS Kesehatan verifier, one hospital relations officer, one person from the pharmacy department, and two family members of BPJS patients.	1. Phantom billing 2. Upcoding 3. Unbundling 4. Kickbacks 5. False claims	The process involves formulating policies and guidelines related to fraud prevention, establishing clinical pathways, implementing a culture of prevention, establishing a quality control and cost control team, and establishing a fraud prevention team.	-
15.	Uncovering healthcare inefficiencies: A data-driven solution for market saturation and fraud	Hin et al (2024)	United States	Using datasets from the Centers for Medicare and Medicaid Services (CMS) Data 2019-2023. Ten machine learning models were evaluated to identify which was most suitable for the dataset, using logistic regression as the base model, including Ridge classifier, Lasso classifier, XGBoost, neural networks, quadratic discriminant	1. Phantom billing 2. Double billing 3. Unbundling 4. Upcoding 5. Identity theft 6. Prescription fraud	-	Detecting fraud using machine learning techniques to identify abnormal patterns in data that may indicate fraud, waste, and abuse (FWA).

No.	Title	Author (Year)	Country	Design	Types of Fraud in Research	Fraud Prevention Methods	Fraud Detection Methods
				analysis, bagging classifier, stochastic gradient descent classifier, Adaboost, and support vector machines.			
16.	Unsupervised anomaly detection of healthcare providers using generative adversarial networks	Naidoo & Marivate (2020)	South Africa	Development of fraud detection using a Generative Adversarial Networks (GANs) approach. The study used two datasets, one public dataset from Medicare in the United States and one private dataset from a claims administration organization in South Africa.	1. Phantom billing 2. Improper coding 3. Kickback schemes 4. Wrong diagnosis 5. Abusive or wasteful costs	-	Fraud detection using a Generative Adversarial Networks (GANs)-based approach.
17.	Utilization analysis and fraud detection in medicare via machine learning	Tajrobehkaret al (2024)	United States	Development of fraud detection using machine learning. The dataset used in this study was obtained from the Medicare Provider Utilization and Payment Data (MPUPD), which is publicly available on the Centers for Medicare & Medicaid Services (CMS) website.	Effective for detecting overutilization. As an early indicator for investigating phantom billing, upcoding, and cloned documentation.	-	Fraud detection using machine learning. Models used include: K-Nearest Neighbor (KNN), Logistic Regression (LR), Support Vector Machines (SVM), Extreme Gradient Boosting (XGB), Multilayer Perceptron (MLP).
18.	Weighted risk models for dynamic healthcare fraud detection	Rolfe (2021)	United States	The study proposes a weighted risk-based model to detect potentially fraudulent behavior by healthcare providers.	1. Phantom billing 2. Improper coding 3. Unbundling 4. Geolocation fraud 5. New fraud schemes that have not yet been identified.	-	Detect fraud with weighted risk-based models.
19.	Using large language models for enhanced fraud analysis and detection in blockchain based health insurance claims	Islayem et al (2025)	Collaboration between researchers from the United Arab Emirates (UAE), the United States (USA), and Saudi Arabia.	Development of a model for fraud detection by integrating blockchain technology and Large Language Models (LLMs) enhanced with Retrieval-Augmented Generation (RAG).	1. Phantom billing 2. Upcoding 3. Unbundling 4. Inflated claim 5. Unnecessary service 6. Service not rendered	-	Fraud detection using blockchain technology and Large Language Models/LLMs.

When compared across studies, the prevention strategies converge on two complementary layers: technology-enabled verification and organizational governance. Biometric verification, electronic health records, automated ERP controls, and blockchain aim to reduce opportunities for fictitious claims by improving identity validation, data integrity, and traceability (9,12,15,18). In contrast, internal audit standards, anti-fraud teams, clinical pathways, ethical culture, and staff training address the organizational conditions in which fraud can occur (14,16,19). The studies therefore do not suggest that one layer replaces the other; rather, technological controls appear to be most useful when embedded within clear governance, accountability, and follow-up mechanisms.

In addition to prevention methods, there are also various studies that propose approaches to detecting phantom billing and other types of healthcare fraud. Unsupervised learning-based methods are widely used, as demonstrated by Bairy et al. (20) with the Isolation Forest, Local Outlier Factor (LOF), K-Nearest Neighbors (KNN), and autoencoder algorithms, which are capable of identifying anomalous claims without requiring prior data labels. Similar approaches are enriched with the integration of predictive modeling to detect anomaly patterns in a data-driven manner and link them to policy interventions (17).

More broadly, machine learning-based methods are also gaining attention. Mishra (26) combines supervised learning, unsupervised learning, natural language processing (NLP), and deep learning in a single framework to detect fraud. Hin and Ou (27) emphasize the use of more accurate ensemble machine learning in identifying fraud, waste, and abuse (FWA), while Tajrobehkar et al. (21) use various models such as KNN, logistic regression, support vector machines (SVM), extreme gradient boosting (XGB), and multilayer perceptron (MLP). Bhatia (9) also utilizes machine learning integrated with modern ERP systems (SAP S/4HANA) to detect billing outliers in real time.

In addition, other studies adopted data mining-based approaches (22) and risk-based auditing (14,16) as part of early detection of high-risk areas. More advanced methods have also been developed using Graph Neural Networks (GNNs) (23) to uncover collusion patterns, as well as Generative Adversarial Network (24) to recognize abnormal claim patterns.

Furthermore, blockchain-based solutions have emerged as a promising alternative for fraud detection. Mackey et al. (12) developed a blockchain framework that not only records claims permanently and transparently but also allows patients to play an active role as validation nodes in the network. This mechanism is considered innovative because it expands the supervisory function from merely the authority of service providers to direct patient participation, making the claim validation process more decentralized and accountable. Similar approaches were further developed through the use of smart contracts (10,13) and even integration with Large Language Models (LLMs) to support complex claim investigations (11).

From this synthesis, it can be concluded that fraud detection methods have evolved from classic audit- and data mining-based approaches to the use of advanced machine learning algorithms and the integration of cutting-edge technologies such as blockchain, GNNs, GANs, and LLMs. This reflects a paradigm shift in fraud detection from mere administrative identification to a more proactive and adaptive data- and artificial intelligence-based approach.

Across these studies, detection approaches differ in the function they are best positioned to perform. Machine learning, anomaly detection, GNNs, GANs, and data mining are primarily oriented toward identifying unusual patterns at scale, whereas blockchain and smart contracts emphasize data integrity, traceability, and rule-based verification of transactions (10,11,12,13,20–24,26). Risk-based auditing and internal control approaches add interpretability and institutional follow-up that automated models alone may not provide (14,16,25). Accordingly, these approaches are better viewed as complementary components of a fraud-detection architecture than as directly interchangeable alternatives.

Effectiveness of Phantom Billing Prevention and Detection Methods

Based on the reviewed literature, fraud detection methods in healthcare claims

consist of various approaches, ranging from machine learning and anomaly detection, blockchain and smart contracts, Graph Neural Networks (GNNs), Generative Adversarial Networks (GANs), and data mining to risk-based internal audit approaches and modern ERP systems. This variety of methods indicates a shift from traditional models to advanced algorithms and the integration of new technologies to improve accuracy, transparency, and speed in detecting phantom billing and other forms of fraud.

Machine learning and anomaly detection-based methods have proven to be very effective. Bairy et al. (20) reported that Isolation Forest was able to detect 100% of fraud data with 99.86% accuracy when combined with Decision Tree Classifier, while Hin and Ou (27) found that Bagging Classifier achieved 90% accuracy in detecting fraud, waste, and abuse (FWA). Tajrobehkar et al. (21) emphasized the high accuracy of KNN, logistic regression, SVM, XGBoost, and MLP models in detecting overutilization, while Naidoo and Marivate (24) demonstrated the effectiveness of GANs with an AUC of up to 97.4% on private datasets. Other innovations, such as Hasan (23), who used GNNs, also showed high performance with 92% accuracy in uncovering collusion, and Hamid et al. (22), who combined association rule mining with unsupervised learning, proved to speed up processing time while increasing detection effectiveness.

Blockchain-based approaches also show promising results. Mackey et al. (12) designed a proactive system that involves patients as validation nodes and provides incentives in the form of tokens to increase participation and transparency. These tokens can be used to obtain copayment discounts or discounts on health services. Islam et al. (10) showed that smart contracts can automatically verify claims and maintain patient privacy through anonymous credentials, while Raad et al. (13) emphasized validation speeds of less than one second with a high level of data security. Furthermore, Islayem et al. (11) prove the effectiveness of integrating blockchain with Large Language Models (LLMs), which achieve 99% accuracy with perfect precision and a detection time of only 13 seconds. From an audit and governance perspective, Putra and Mita (14) demonstrate the effectiveness of GIAS implementation in improving transparency and generating claim refunds, while Bhatia (9) notes that SAP S/4HANA integration can reduce fraud losses by up to 58%. Overall, these various methods demonstrate high effectiveness with their respective advantages, both in terms of algorithmic accuracy and improvements in governance and organizational efficiency.

Although several studies reported high accuracy, AUC, or rapid validation times, these performance indicators should be interpreted cautiously. The reviewed studies used different datasets, study designs, target fraud patterns, and validation settings; some relied on CMS or Medicare claims, some used private datasets, and others were prototypes or case studies. Consequently, the reported performance of one method cannot be directly compared with another or assumed to translate automatically to phantom billing within Indonesia's National Health Insurance system. This heterogeneity reinforces the need for local validation in the JKN claim context before large-scale implementation.

Challenges in Implementing Phantom Billing Prevention and Detection Methods

Despite the development of various fraud detection and prevention methods, their implementation encounters numerous technical and non-technical challenges. From the perspective of advanced technologies such as machine learning and anomaly detection, the main obstacles are the complexity of high-dimensional health data, class imbalance between normal claims and fraudulent claims, and data quality that is often incomplete or inconsistent (20,22,27). In addition, low model interpretability makes prediction results difficult for auditors and regulators to understand (23,25), while high computational requirements demand large infrastructure that is not always available in healthcare institutions.

Challenges also arise in the application of blockchain technology. Several studies highlight issues of scalability, high costs, and integration with legacy systems as major obstacles (10,12,13). In addition, data privacy regulations such as GDPR or HIPAA must be complied with, while the adoption of new technologies is often hampered by resistance from stakeholders and limited user understanding (11). Furthermore, the

potential for collusion between patients and providers also poses a risk, which could weaken the effectiveness of blockchain if not accompanied by additional validation mechanisms (12).

In terms of internal auditing and governance, regulatory limitations, bureaucracy, and synchronization between institutions often slow down follow-up on indications of fraud (14,16). Some of the obstacles reported include a lack of coordination, weak verification mechanisms in primary health facilities, and delays in centralized audits that allow fraud claims to escape early detection. Another challenge is the availability of competent human resources and limited budgets to support biometric verification technology and risk-based audits (15,18).

Knowledge Gaps

The synthesis identified several important gaps. First, none of the included studies focused exclusively on phantom billing; most examined it together with other forms of healthcare fraud, limiting the availability of evidence specific to fictitious claims. Second, only a limited number of studies were conducted in Indonesia, whereas many technology-based studies were developed using overseas insurance datasets or prototype systems. Third, evidence on real-world implementation and interoperability with existing claim systems remains limited. These gaps indicate the need for Indonesian studies that evaluate the feasibility, accuracy, cost, and governance requirements of fraud-detection models in actual JKN service and claim contexts.

Implications for Indonesia's National Health Insurance

For BPJS Kesehatan and healthcare facilities participating in JKN, the findings support a phased hybrid strategy rather than immediate reliance on a single advanced technology. At the healthcare facility level, identity verification, electronic records, clinical pathways, anti-fraud teams, and risk-based internal audits can strengthen claim verification before submission (14–16,18,19). At the payer level, machine learning and anomaly-detection tools may be used to prioritize high-risk claims for further verification, while human audit remains important for interpreting anomalies and determining follow-up (14,16,20–27). Blockchain or smart-contract applications may be considered gradually for selected high-risk verification processes after data quality, interoperability, privacy, and infrastructure requirements are addressed (10–13). At the policy level, these technological developments should be accompanied by clear standards for data governance, audit accountability, cross-institutional coordination, and the roles of BPJS Kesehatan, healthcare facilities, and regulators in responding to suspected phantom billing.

CONCLUSION

Based on the results of this literature study, it can be concluded that efforts to prevent and detect phantom billing cannot rely on a single method but rather require a combination of technological and governance strategies. To prevent and detect phantom billing from occurring again, several efforts can be made: (1) improving data quality and building an integrated health data warehouse; (2) combining adaptive machine learning models with risk-based audit systems to improve accuracy while maintaining transparency; (3) gradually utilizing blockchain and smart contracts, starting with limited implementation for high-risk claim verification; and (4) strengthening human resource capacity and cross-institutional collaboration so that advanced technology can be operated effectively. With a hybrid approach that combines technological innovation, strong regulations, and human oversight, the healthcare system can be more resilient in preventing practices and losses due to phantom billing.

In the Indonesian context, these findings imply that BPJS Kesehatan and JKN-participating healthcare facilities should prioritize a phased implementation of integrated controls: strengthening identity and claim verification at the facility level, applying risk-based analytics to prioritize suspicious claims, maintaining human audit and anti-fraud oversight, and piloting advanced technologies only after data and governance readiness are ensured. Future policy development should therefore focus not only on adopting new detection technologies, but also on establishing interoperable data

systems, clear accountability mechanisms, and coordinated follow-up procedures for suspected phantom billing.

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