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Early Detection of Deep Vein Thrombosis Using Deep Learning

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Abstract: The detection of Deep Vein Thrombosis (DVT) during the early stage is critical for preventing any adverse effect. DVT is one of the major causes of diseases that are related to blood circulatory system in human. This article proposes a methodology for the early detection of DVT through the photographic images captured using smartphones as edge de- vices. Unlike the traditional methods, the proposed methodology utilizes the edge computing as a green computing initiative. The manifestation of telangiectasia is used as the early bio marker. The proposed image analysis model uses Convolutional Neural Network (CNN) for training the detection model. The experiments were done with the globally available DVT and Varicose vein images as well as the photographic images captured through smartphones. The proposed robust approach produces excellent results without requiring any restricted environment for capturing the images.

Index Terms—Deep Vein Thrombosis, early detection, Telang- iectasia, smartphone photography, edge computing, green com- puting, Convolutional Neural Network, image analysis, varicose veins, biomarker.

I. INTRODUCTION

EEP vein thrombosis is the development of thrombosis within the deep veins of the pelvis or lower limbs. The blood clots formed inside the veins may cause major blood circulatory related problems including cardiac arrest. The major causes of DVT are age, obesity, surgery, limited movement, and injury to a vein. Symptoms of DVT include leg pain, red or light skin in the leg and warmth in the affected leg. The common complications associated with DVT are pulmonary embolism and Post-thrombotic Syndrome (Post- phlebitic syndrome). Pulmonary Embolism. Clogged blood vessel in the lungs. Usually, blockage is caused by a blood clot or one component. These lesions usually grow on the legs (DVT). A piece of clot in a leg can break and run from your body through your bloodstream to your lungs, where it gets stuck. Clinical diagnosis of DVT is performed by modifying the following methods. They are Duplex Ultrasonography- a standard imaging mechanism utilizing sound waves for monitor blood flow to arteries, a D-dimer blood test to identify blood clot of a fracture, Contrast venography - a variant of X- ray Deep and pelvic arteries, Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) are also used for evaluation. The detection of DVT in the earlier stage itself is very difficult to achieve, as there are no restricted set of bio markers. Based on the studies, it is identified that cutaneous manifestation of telangiectasia can be used as a bio marker of DVT. One of the methods use the automated analysis of photographic images that help in predicting the onset of DVT by taking the images of the lower limbs. Based on the change in the color of the skin, the system finds the region of interest (ROI) of telangiectasia and produces the results. It does require a well-organized set up of taking the photographic images. However, photographic images are taken in a controlled environment, with trained operators. Due to exponential growth in the communication and network technology, Internet of Things (IoT) has become an integral part of human lives. The IoT-Healthcare tries to provide the access of efficient healthcare services to the people in the remote areas of the landscape. The major advantage of IoT- healthcare is that, it does not require the patients to travel from faraway remote places to access the facilities. The people in developing countries benefit a lot from the development of these applications. Deep venous thrombosis (DVT) is a disorder in which blood clots form within the veins, obstructing the flow of blood through the circulatory system, and it affects people of all ages. The cause of the disease is unknown; however, it is thought to be caused by a combination of variables, including genetic factors. Genetic factors are also thought to have a role in the diagnosis of the disorder. In the field of engineering, there are two major challenges: patients suspected of DVT have no visible symptoms, and failing to diagnose it could be fatal; without symptoms, the first test (D-dimer blood) is useless; and the use of ultrasound has high certainty but comes at a high cost and necessitates the use of many instruments. DVT is a disease that must be recognized as soon as possible because the implications might be fatal for the patient. Several scientists have created various techniques and methods to diagnose the problem over the years, beginning in the 1970s

with the development of ultrasonography, which marked a breakthrough in the timely diagnosis of clots in the lower limbs of the human body. PhilipWells, a renowned scientist, has stated on numerous occasions that technology, which has been revolutionized exponentially in recent years, will support the future in the early diagnosis of diseases. This, combined with new trends in the work of computer equipment, will enable great advances in science and human health.Venous thromboembolism (VTE), the third most common vascular illness worldwide, is a complex condition impacted by various genetic and non-genetic risk factors. The patho- genesis of VTE includes Virchow's triad, which provides for hypercoagulability, reduced blood flow or stasis, and damage to blood vessels due to disease or injury; they are blood clots that can occur if the patient's blood flow changes or slows down somewhere in their body, putting the patient's life and health at risk. The annual incidence is 1 to 3 people per 1000 people. The prevalence of this condition varies with age. It can cause DVT or Pulmonary Embolism (PE) in some cases; thrombosis can also develop in other veins such as the liver, cerebral sinus, retina, and mesenteric veins. Approximately one-third of VTE patients develop a PE, while two-thirds exclusively have DVT.

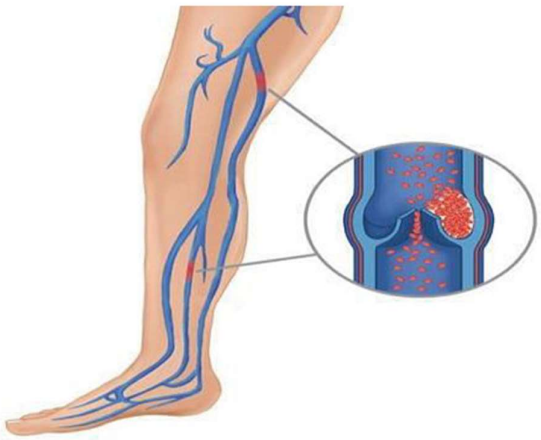

Fig 1 Depiction of DVT.

The Primary Care Unit (PCU) is the backbone of any health care system. The record of previous epidemics demonstrates the critical significance of PCU and necessitates PCU specialists' engagement in procedural decision making. The PCU serves as the entry point to the Health System (HS), which is described as the primary level of health care. The "Health Unit Clinics" (Health Units that constitute Primary Health Care) are defined by their commitment to health promotion and protection, disease prevention, diagnosis, treatment, rehabilitation, harm reduction, and health maintenance on an individual and collective level, to provide comprehensive care that has a positive impact on the health status of communities. They provide primary care services across the board, including the evaluation and diagnosis of acute illnesses and ongoing treatment for patients with chronic conditions. Nowadays, numerous ways to determine the condition are available, such as statistical analysis and clinician scoring, D-dimer blood tests, infrared imaging, ultrasonography, and even the application of deep machine learning and Neural Networks (NN). Many countries, including the United States, Italy, the United Kingdom, Germany, and Canada, have pioneered Ar- tificial Intelligence (AI) work in the diagnosis and prediction of DVT, with the percentage of accuracy and effectiveness steadily increasing over time as algorithms become more and more optimal and more data can be obtained from real cases. However, progress has been made in the development of NN in terms of debugging codes and developing new algorithms, but they have not been implemented outside of a computer. It should be noted that other types of prediction and analysis have very good effectiveness and accuracy, but the analysis is very expensive due to the difficulty of repeatability and reliability, since most diagnoses require two or more types of analysis. On the other hand, it is well known that ultrasound is the standard test for the diagnosis of DVT and that it is one of the most accurate, and recently, they are also using ML techniques for the diagnosis of DVT. However, the accuracy of the examinations improves with experience and the training that a sonographer gains in their working life, so the percentage is not always the same and is not very high at first. Although there is research that strives to combine Deep Learning (DL) and magnetic resonance imaging, with promising outcomes. Recently, it has been shown that the use of artificial neural network analysis can improve risk stratification of patients presenting with suspected DVT, the authors showed that an NN is able to diagnose DVT without the use of ultrasound, with a low false negative rate. A new ML model was developed for the efficient, less intrusive, and reliable diagnosis of DVT. This is based on pattern recognition techniques that help with rapid diagnosis as well as well-trained machine learning models that help with decision making and validating whether or not someone is suffering from this ailment. In recent years, the field of data science has been pioneered in the development of hardware and software for the application of Artificial Neural Networks (ANNs) in clinical analysis, which can be useful for the diagnosis of DVT and other diseases in general, for example, the use of ML models such as Decision Trees, Support Vector Machine (SVM), and Neural Networks. Nowadays, there are alternative methods of DVT diagnosis, some of which use AI. For example, ML models for Venous

Thromboembolism (VTE) risk assessment in China are compared to the Padua model, with the Random Forest (RF) model having a higher specificity and sensitivity than the Padua model. An automatic diagnosis model by using effective ML to predict the important risk factors of VTE collecting patient data of the medical ward at King Chulalongkorn Memorial Hospital from Thailand. Other efforts are being dedicated for the prediction of VTE with ML techniques in young and middle-aged inpatients; for example, develop VTE risk classifiers using models based on multi-kernel learning and random optimization. However, a drawback is that these systems are expensive, big, heavy, and have moderate energy consumption. On the other hand, edge computing can minimize the reaction time, increase the data processing capacity, ensure data security (since it is closer to end-users, it provides greater privacy), be easy to design, and be cheap. It has excellent application value and features such as high reliability, superior energy savings, low latency, and high real-time processing, increasing the overall data quality and utilization performance under the premise of efficient processing. Accordingly, one can take advantage of edge devices such as Raspberry Pi 4 (RPi4), which are very useful for solving real-world problems across various fields of application. In this paper, the well-known RPi4 is used as the edge-computing device to develop the ML models and to evaluate their performance in diagnosing DVT. The cost–benefit of a clinical pre-examination based on ML is noted, reducing the expenses of medical units and labor acquired using the standard method. The development of a device for the treatment of DVT that uses Bluetooth communication with a mobile app and sensors within the system to collect data for statistical analysis. The ML algorithms have advanced in the early diagnosis of DVT and other applications, moving from binary Decision Trees developed to more sophisticated algorithms that integrate image analysis by AI and are also very complex in that they go into up to 68 variables to give a final verdict of this disease. In some investigations with very big datasets, the predictors have an area under the receiver operating characteristic (AU- ROC) of 0.83 to 0.85. For the reasons stated above, the goal of this research is to propose several ML models that are trained by using a dataset of patients with the condition is collected from the state of the art to have good judgment and clinical analysis to determine the diagnosis of DVT in a patient with the symptomatology of the condition, with the purpose of having a timely response and thus saving many lives. In this research, the well-known Convolutional Neural Network (CNN) algorithm is employed as the edge-computing device to develop ML models and assess their performance in diagnosing DVT. This is to facilitate the development of smart, portable, reliable, and cost-effective instrumentation. All of this is possible thanks to pattern recognition algorithms that provide accurate diagnoses and well-trained ML algorithms that determine whether or not a patient has the condition. The assumption is that ML algorithms will outperform to- day's standard approaches as a means of early diagnosis for diagnostic aid in the health sector and primary care. The detection of deep vein thrombosis is a critical med- ical challenge that requires accurate and timely diagnosis to prevent severe complications. However, traditional methods of DVT detection may be prone to errors and delays, leading to potential adverse outcomes for patients. Therefore, there is a need to address these limitations and improve the efficiency and accuracy of DVT detection. The existing methods for DVT detection suffer from limita- tions in accuracy, speed, and efficiency, leading to potential missed diagnoses, false negatives, and delays in initiating appropriate treatment. These limitations can result in increased morbidity and mortality rates for patients with DVT. There- fore, there is a need to develop a novel approach using deep learning techniques to enhance the early detection of DVT, improve accuracy, reduce false negatives and false positives, and facilitate timely and effective treatment interventions. By leveraging the power of deep learning algorithms, which have shown remarkable performance in various medical imag- ing tasks, it is expected that the development of a deep learning model specifically tailored for DVT detection can overcome the limitations of traditional methods. This model should be able to analyze medical images, such as ultrasound or MRI scans, and accurately identify the presence of DVT at an early stage with high sensitivity and specificity[1]. The ultimate goal is to develop an efficient and reliable deep learning-based system that can assist healthcare professionals in accurately diagnosing DVT, providing prompt intervention, and improving patient outcomes. By addressing the problem statement, we aim to significantly enhance the efficiency and accuracy of DVT detection, reduce false diagnoses, and facilitate timely treatment decision-making[2]. The objectives are: To develop a deep learning model that can accurately and efficiently detect DVT at an early stage; To leverage deep learning algorithms to enhance the accuracy of DVT detection compared to traditional methods; To minimize missed cases and incorrect diagnoses through the optimization of deep learning models; To enable rapid analysis of medical images to expedite DVT detection and aid in timely treatment initiation; To enable large-scale screening programs for individuals at risk of DVT using accurate and efficient deep learning models[3]; To provide additional information and insights to healthcare professionals for making informed treatment decisions based on the extent and severity of DVTdetected through deep learning analysis. By addressing these objectives, the utilization of deep learning in DVT detection aims to improve diagnostic accuracy, efficiency, and

speed, reduce errors, enable widespread screening, and assist in treatment planning for better patient outcomes.

II. RELATED WORKS

Deep vein thrombosis is the formation of a blood clot inside a blood vessel and there are two kinds of thrombosis: venous thrombosis and arterial thrombosis. It is a fatal cardiovascular disease and has caused a lot of pain to human body. Through this passage, we analyze the potential mechanism of thrombosis from non-biomechanics and biomechanics respects[4]. Furthermore, the article concludes its current diagnosis and treatment and points out their responding advantages and disadvantages, after which I propose a possible solution for both diagnosing and curing thrombosis with photoacoustic imaging technology which would be convenient and highly efficient to diagnose and cure thrombosis. The aim of this study was to develop a diagnostic prediction model to improve identification of acute symptomatic portal vein thrombosis (PVT)[5]. We examined 47 patients with PVT and 94 controls without PVT in the Second Affiliated Hospi- tal of Soochow University and Suqian People's Hospital of Nanjing, Gulou Hospital Group. We constructed a prediction model by using a support vector machine (SVM) classifier coupled with a least absolute shrinkage and selection operator (LASSO)[6]. We applied a 10-fold cross-validation to estimate the error rate for each model. The present study indicated that acute symptomatic PVT was associated with 11 indicators, including liver cirrhosis, D-Dimer, splenomegaly, splenectomy, inherited thrombophilia, ascetic fluid, history of abdominal surgery, bloating, C-reactive protein (CRP), albumin, and abdominal tenderness[7]. In order to overcome the shortage of the current costly DVT diagnosis and reduce the waste of valuable healthcare resources, we proposed a new diagnostic approach based on machine learning pre-test prediction models using EHRs[8]. We examined the sociodemographic and clinical factors in the prediction of DVT with 518 NICU admitted patients, including 189 patients who eventually developed DVT. We used cross-validation on the training data to determine the optimal parameters, and finally, the applied ROC analysis is adopted to evaluate the predictive strength of each model. Two models (GLM and SVM) with the strongest ROC were selected for DVT prediction, based on which, we optimized the current intervention and diagnostic process of DVT and examined the performance of the proposed approach through simulations. The use of machine learning based pre-test pre- diction models can simplify and improve the intervention and diagnostic process of patients in NICU with suspected DVT, and reduce the valuable healthcare resource occupation/usage and medical costs[9].Using kernel machine learning (ML) and random opti- mization (RO) techniques, we recently developed a set of Venous Thromboembolism (VTE) risk predictors, which could be useful to devise a web interface for VTE risk stratifica- tion in chemotherapy-treated cancer patients[10].This study was designed to validate a model incorporating the two best predictors and to compare their combined performance with that of the currently recommended Khorana score (KS). Age, sex, tumor site/stage, hematological attributes, blood lipids, glycemic indexes, liver and kidney function, BMI, performance status, and supportive and anticancer drugs of 608 cancer outpatients were all entered in the model, with numerical attributes analyzed as continuous values. VTE rate was 7.1%[11]. The VTE risk prediction performance of the combined model resulted in 2.30 positive likelihood ratio (+LR), 0.46 negative LR (LR), and 4.88 HR (95% CI: 2.54–9.37), with a significant improvement over the KS [HR 1.73 (95% CI: 0.47–6.37)]. These results confirm that a ML approach might be of clinical value for VTE risk stratification in chemotherapy-treated cancer outpatients and suggest that the ML-RO model proposed could be useful to design a web service able to provide physicians with a graphical interface helping in the critical phase of decision making[12].

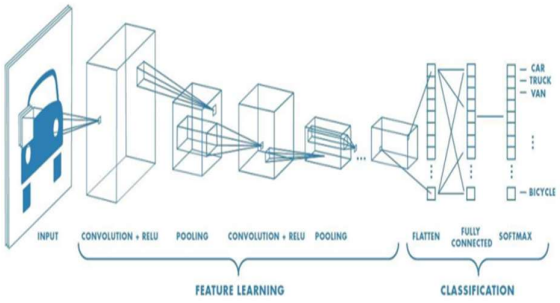

Fig 2: Covolutional Nerural Network Architecture.

Risk prediction of chemotherapy-associated venous thromboembolism (VTE) is a compelling challenge in contemporary oncology, as VTE may result in treatment delays, impaired quality of life, and increased mortality. Current guidelines do not recommend thromboprophylaxis for primary prevention, but assessment of the patient's individual risk of VTE prior to chemotherapy is generally advocated. In recent years, efforts have been devoted to building accurate predictive tools for VTE risk assessment in cancer patients. This review focuses on candidate biomarkers and prediction models currently under investigation, considering their advantages and disadvantages, and discussing their diagnostic performance and potential pitfalls[13]. The use of a back-propagation artificial neural network (ANN) to systematize the reliability of a Deep Vein Throm- bosis (DVT) diagnostic by using Wells' criteria is introduced herein. In this paper, a new ANN

model is proposed to improve the Accuracy when dealing with a highly unbalanced dataset. To create the training dataset, a new data augmentation algorithm based on statistical data known as the prevalence of DVT of real cases reported in literature and from the public hospital is proposed. The above is used to generate one dataset of 10,000 synthetic cases. Each synthetic case has nine risk factors according to Wells' criteria and also the use of two ad- ditional factors, such as gender and age, is proposed. Accord- ing to interviews with medical specialists, a training scheme was established. In addition, a new algorithm is presented to improve the Accuracy and Sensitivity/Recall. According to the proposed algorithm, two thresholds of decision were found, the first one is 0.484, which is to improve Accuracy. The other one is 0.138 to improve Sensitivity/Recall[14]. The Accuracy achieved is 90.99%, which is greater than that obtained with other related machine learning methods. The proposed ANN model was validated performing the k-fold cross validation technique using a dataset with 10,000 synthetic cases. The test was performed by using 59 real cases obtained from a regional hospital, achieving an Accuracy of 98.30%. The coronavirus outbreak (COVID-19) tested health care systems worldwide. This qualitative study aimed to explore and understand the experiences, beliefs and concerns ofPrimary Care Professionals (PCPs) regarding the prepared- ness and response of primary care to the first wave of the pandemic in Greece, a country where a public structured primary care system has been developing[15]. We conducted semi-structured telephone interviews with 33 PCPs (General Practitioners, community General Internal Medicine Specialists, community Paediatricians and nurses) recruited from all regions of Greece after the first wave of the pandemic (June 2020). Interviews were transcribed verbatim, data were anonymized and analyzed. Thematic analysis was applied developing a conceptual framework. Four main themes were identified: a) Primary care unit adaptation and issues faced during the pandemic; b) Management of suspected COVID-19 cases; c) Management of non-suspected cases; d) Consequences of the pandemic. In the first phase of the pandemic, remote management of suspected cases and their referral to the hospital were preferred as a result of a shortage of personal protective equipment and inaccessibility to coronavirus testing in primary care. Due to the discontinuation of regular medical services and the limited in-person contact between doctors and patients, chronic disease management and prevention programs were left behind. Social and emotional consequences of the pandemic, such as workplace stigma, isolation and social seclusion, deriving from fear of viral transmission, as well as burnout symptoms and exhaustion were commonly experi- enced among PCPs. Positive consequences of the pandemic were considered to be the recognition of the importance of an empowered public healthcare system by citizens and the valuable insight, knowledge and experience professionals gained in times of crisis. Primary care has a key role to play during and after the pandemic by using its information infrastructure to identify at-risk groups, detect new cases of COVID-19, provide care according to needs, and carry out vaccination programs. Central coordination and empowerment of primary care will increase its effectiveness, via public awareness, holistic patient management, and unburdening of hospitals. Background Inappropriate use of clonazepam by older adults is associated with cognitive impairment, delirium, and falls. Strategies to optimize its use are important to increase patient safety. Objective To evaluate the feasibility of a clon- azepam deprescription protocol in the elderly. Methods This is a quasi-experimental study. Elderly people with chronic use of clonazepam and attended in primary care units in two Brazilian municipalities were selected. A deprescription protocol was used, which included five fortnightly meetings between the older adults and the research team, to reduce the dose by 25%. Patients received instructions on sleep hygiene behaviors and the advantages of clonazepam deprescription; family physicians followed a flowchart for gradual dose re-duction. In the 1st and 5th meetings, there were medical appointments for anamnesis and discharge. The monitoring of patients and the application of tests were carried out by the research team. Results Of the 35 elderly people included in the study, 27 reached the end; 81.5% achieved deprescription: 22.2% stopped completely and 59.3% decreased the dose. At the last meeting, 20% of elderly patients reported an increase in blood pressure. Conclusion The high rate of deprescription and the little relevance of clonazepam withdrawal reactions, showed that the use of the protocol was effective. However, the increase in blood pressure and the worsening of sleep quality in the last meeting show the need for adjustment in the last stage of the deprescription process. With the expansion of digital health, it has imperative to consideration intervention techniques in order not to been the cause of even learn sociable health inequalities in underserved populations combat with chronic diseases. Telemedicine solu- tions for homeless individual might compensate for shortcom- ings in access to valuable health business in different settings. The main aim for our research was up examine the attitudes and openness of homeless persons regarding telecare on a Hungarian sample. Quantitative scrutinize among homeless people (n = 98) was completed in 4 shelters providing mid- and long-term accommodation in Budweis, Country. Stance regarding healthcare service accessibility and telecare were assessed by a self-developed questionnaire of the research team. Telecare attitude comparison was made with data of a Hungarian heavily reference group of non-homeless hu- mans

recruited from 2 primary care units (n = 110). A significant fraction of homeless people with mid- other long- term residency in home shelters did not oppose the use of telecare via dwell online watch consultation and there was no difference compared in one national citation group (averages of 3.09 vs. 3.15, respectively). Results of the homeless group indicate the those more satisfied with healthcare services, in general, modifications more openness to telecare. It is clearly demonstrated per and multivariate analysis that those participants in the homeless group who had problems getting health care in the previous year obviously preferred in-person doctor-patient conversations. Digital human technologies offer a potentially important new pathway for the prevention furthermore treatment of chronic conditions amongst homeless persons. Based on one attitude regarding telecare, starting any on-site telecare program for mid- and long-term residents of homeless refuges might enable better caution continual. Our results draw attention to the key factors including building trust in and implementation of such programs among underserved and other defenseless patient groups. With the massive growth in computing capacity and the con- nectivity that exists in the world today, medicine has changed drastically. These changes bring opportunity for more change to improve health care. Medical information is now available at our fingertips and can be acquired rapidly. As such, the massive memorizing tasks and learning skills of the past are less relevant. Robust clinical pathways are available in apps, online medical care tools, and health information systems, and in some cases are proven to improve patient care, with failure to follow them resulting in worse patient outcomes. Thirty years ago, there were only a handful of clinical prediction algorithms/models to assist physicians in decision making. Now there are hundreds. Despite this, the uptake of algorithms in clinical practice has been slow, sporadic, and fraught with skepticism. This uptake, or lack thereof, has been justified by arguments that predictive algorithms were developed in populations of patients that were not necessarily applicable to ”the patient in front of me.” In other words, studieswere not generalizable. Yet physicians have become all too quick to order diagnostic tests without following algorithms or predictive tools under the assumption that this is best, and ignoring the possibility of harm, including radiation exposure, false-positive tests, and the economic burden on society. It is estimated that 5% of the US gross domestic product is spent on diagnostic tests and procedures that do not result in any improvement in patient outcomes. Little is known about the prognosis of cancer discovered during or after an episode of venous thromboembolism. We linked the Danish National Registry of Patients, the Danish Cancer Registry, and the Danish Mortality Files to obtain data on the survival of patients who received a diagnosis of cancer at the same time as or after an episode of venous thromboem- bolism. Their survival was compared with that of patients with cancer who did not Have venous thromboembolism (control patients), who were matched in terms of type of cancer, age, sex, and year of diagnosis. Of 668 patients who had cancer at the time of an episode of deep venous thromboembolism, 44.0 percent of those with data on the spread of disease (563 patients) had distant metastasis, as compared with 35.1 percent of 5371 control patients with data on spread (prevalence ratio, 1.26; 95 percent confidence interval, 1.13 to 1.40). In the group with cancer at the time of venous thromboembolism, the one- year survival rate was 12 percent, as compared with 36 percent in the control group (P¡0.001), and the mortality ratio for the entire follow-up period was 2.20 (95 percent confidence interval, 2.05 to 2.40). Patients in whom cancer was diagnosed within one year after an episode of venous thromboembolism had a slightly increased risk of distant metastasis at the time of the diagnosis (prevalence ratio, 1.23 [95 percent confidence interval, 1.08 to 1.40]) and a relatively low rate of survival at one year (38 percent, vs. 47 percent in the control group; P¡0.001). Cancer diagnosed at the same time as or within one year after an episode of venous thromboembolism is associated with an advanced stage of cancer and a poor prognosis. An interrelation between cancer and thrombosis is known, but population-based studies on the risk of both arterial throm- boembolism (ATE) and venous thromboembolism (VTE) have not been performed. International Classification of Disease 10th Revision (ICD-10) diagnosis codes of all publicly insured persons in Austria (0-90 years) were extracted from the Aus- trian Association of Social Security Providers dataset covering the years 2006-07 (n = 8 306 244). Patients with a history of cancer or active cancer were defined as having at least one ICD-10 ’C’ diagnosis code, and patients with ATE and/or VTE as having at least one of I21/I24 (myocardial infarc- tion), I63/I64 (stroke), I74 (arterial embolism), and I26/I80/I82 (venous thromboembolism) diagnosis code. Among 158 675 people with cancer, 8559 (5.4%) had an ATE diagnosis code and 7244 (4.6%) a VTE diagnosis code. In contrast, among 8 147 569 people without cancer, 69 381 (0.9%) had an ATE diagnosis code and 29 307 (0.4%) a VTE diagnosis code. This corresponds to age-stratified random-effects relative risks (RR) of 6.88 [95% confidence interval (CI) 4.81-9.84] for ATE and 14.91 (95% CI 8.90-24.95) for VTE. ATE proportion was highest in patients with urinary tract malignancies (RR: 7.16 [6.74-7.61]) and lowest in patients with endocrine cancer (RR:2.49 [2.00-3.10]). The corresponding VTE proportion was highest in cancer of the mesothelium/soft tissue (RR: 19.35 [17.44-21.47]) and lowest in oropharyngeal cancer (RR: 6.62 [5.61-7.81]). The RR of both ATE and VTE are significantly higher in persons with cancer. Our population-

level meta- data indicate a strong association between cancer, ATE and VTE, and support the concept of shared risk factors and pathobiology between these diseases. Relative risk of ATE and VTE in persons with a cancer diagnosis code versus persons without a cancer diagnosis code. This article discusses the prevention of venous throm- boembolism (VTE) and is part of the Antithrombotic and Thrombolytic Therapy: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Grade 1 recommendations are strong and indicate that the benefits do or do not outweigh risks, burden, and costs. Grade 2 suggestions imply that individual patient values may lead to different choices (for a full discussion of the grading, see the ”Grades of Recommendation” chapter by Guyatt et al). Among the key recommendations in this chapter are the following: we recommend that every hospital develop a formal strategy that addresses the prevention of VTE (Grade 1A). We recommend against the use of aspirin alone as thromboprophylaxis for any patient group (Grade 1A), and we recommend that mechanical methods of thromboprophylaxis be used primarily for patients at high bleeding risk (Grade 1A) or possibly as an adjunct to anticoagulant thromboprophylaxis (Grade 2A). For patients undergoing major general surgery, we recommend thrombo- prophylaxis with a low-molecular-weight heparin (LMWH), low-dose unfractionated heparin (LDUH), or fondaparinux (each Grade 1A). We recommend routine thromboprophylaxis for all patients undergoing major gynecologic surgery or major, open urologic procedures (Grade 1A for both groups), with LMWH, LDUH, fondaparinux, or intermittent pneumatic compression (IPC). For patients undergoing elective hip or knee arthroplasty, we recommend one of the following three anticoagulant agents: LMWH, fondaparinux, or a vitamin K antagonist (VKA); international normalized ratio (INR) target, 2.5; range, 2.0 to 3.0 (each Grade 1A). For patients undergoing hip fracture surgery (HFS), we recommend the routine use of fondaparinux (Grade 1A), LMWH (Grade 1B), a VKA (target INR, 2.5; range, 2.0 to 3.0) [Grade 1B], or LDUH (Grade 1B). We recommend that patients undergoing hip or knee arthroplasty or HFS receive thromboprophylaxis for a minimum of 10 days (Grade 1A); for hip arthroplasty and HFS, we recommend continuing thromboprophylaxis ¿ 10 days and up to 35 days (Grade 1A). We recommend that all major trauma and all spinal cord injury (SCI) patients receive thromboprophylaxis (Grade 1A). In patients admitted to hospital with an acute medical illness, we recommend thromboprophylaxis with LMWH, LDUH, or fondaparinux (each Grade 1A). We recommend that, on admission to the ICU, all patients be assessed for their risk of VTE, and that most receive thromboprophylaxis (Grade 1A). Abdominal surgery for cancer carries a high risk of venous thromboembolism, but the optimal duration of postoperative thromboprophylaxis is unknown. We conducted a double-blind, multicenter trial in which patients undergoing plannedcurative open surgery for abdominal or pelvic cancer received enoxaparin (40 mg subcutaneously) daily for 6 to 10 days and were then randomly assigned to receive either enoxaparin or placebo for another 21 days. Bilateral venography was performed between days 25 and 31, or sooner if symp- toms of venous thromboembolism occurred. The primary end point with respect to efficacy was the incidence of venous thromboembolism between days 25 and 31. The primary safety end point was bleeding during the three-week period after randomization. The patients were followed for three months. The intention-to-treat analysis of efficacy included 332 patients. The rates of venous thromboembolism at the end of the double-blind phase were 12.0 percent in the placebo group and 4.8 percent in the enoxaparin group (P=0.02). This difference persisted at three months (13.8 percent vs. 5.5 percent, P=0.01). Three patients in the enoxaparin group and six in the placebo group died within three months after surgery. There were no significant differences in the rates of bleeding or other complications during the double-blind or follow-up periods. Enoxaparin prophylaxis for four weeks after surgery for abdominal or pelvic cancer is safe and significantly reduces the incidence of venographically demonstrated thrombosis, as compared with enoxaparin prophylaxis for one week. Patients undergoing major abdominal surgery for malig- nancy are at particularly high risk of developing VTE. Extra protection against this can be given to patients with can- cer by using a higher dose of LMWH than normally used for prophylaxis, with no increase in bleeding complications. Despite thromboprophylaxis with high-dose LMWH for the first postoperative week, the rate of late VTE is estimated to be between 10% and 20%. A meta-analysis of two studies using dalteparin or enoxaparin has shown that prolonging thromboprophylaxis for a further 3 weeks significantly reduces the risk of late occurring VTE by 62%. Thromboprophylaxis with LMWH for at least one month should be considered in patients undergoing surgery for malignant disease.

III. EXISTING SYSTEM

The approach to diagnosing deep vein thrombosis (DVT) has evolved significantly over time. Currently, clinicians uti- lize an algorithmic strategy that combines pretest probabil- ity assessment, D-dimer testing, and compression ultrasound imaging to safely and effectively investigate suspected lower-extremity thrombosis. The cornerstone of DVT treatment is anticoagulation therapy, while interventions such as thrombol-ysis and placement of inferior vena cava filters are reserved for special circumstances. The introduction of low-molecular-

weight heparin has enabled outpatient management for most DVT patients, improving convenience and cost-effectiveness. The duration of anticoagulation therapy depends on whether the DVT was idiopathic or secondary to a transient risk factor. For idiopathic DVT or cases related to permanent risk factors like thrombophilia, treatment typically continues for three to six months or longer. When DVT results from a temporary risk factor such as surgery or trauma, a shorter course of anticoagulation may be sufficient. Direct oral anticoagulants (DOACs) have gained popularity in DVT management due to their fixed dosing, limited monitoring requirements, and fewer drug interactions, making them a first-line treatment option for many patients.

IV. PROPOSED SYSTEM

In developing countries, many Deep Vein Thrombosis (DVT) cases go undetected due to lack of awareness about potential consequences. The proposed technique will assist in DVT detection using telangiectasia as early biomarkers, with digital images from smartphones serving as input for the tool. A key advantage of this model is that it doesn't require specific environmental conditions for image capture. The authors propose a mechanism explaining blood coagula- tion initiation without anatomically evident vessel wall injury, suggesting that Tissue Factor (TF)-bearing microvesicles from monocyte/macrophage lineage cells can fuse with activated en- dothelial cells in regions of vessel activation or inflammation. This interaction is facilitated by P-selectin glycoprotein ligand- 1 on microvesicles binding to either P-selectin or E-selectin on the endothelium, with hypoxia during blood stasis playing a crucial role in initiating local endothelial activation.

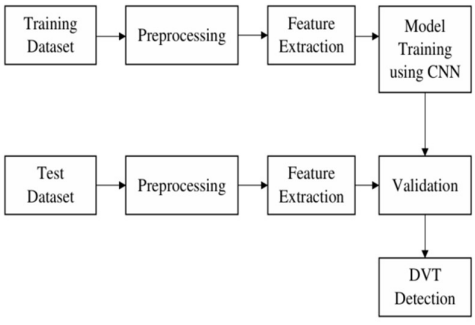

Fig 3 Block Diagram for of Proposed Diagram.

Risk factors for recurrent thrombosis vary based on their nature; patients experiencing VTE associated with major reversible risk factors like surgery have lower recurrence likelihood after discontinuing anticoagulation compared to those with persis- tent risk factors such as thrombophilia or cancer unresponsive to therapy. Individuals with minor reversible risk factors, like prolonged air travel, have intermediate recurrence risk. The proposed system uses a Convolutional Neural Network (CNN) to process medical images from ultrasound, MRI, or CT scans for DVT detection, with features extracted through convolu- tional layers followed by pooling and fully connected layers that generate probability scores indicating DVT likelihood.

V. SYSTEM ANALYSIS

The hardware requirements for this system include a Pen- tium IV 3.5 GHz or later processor, 40 GB hard disk, 14- inch color monitor, optical mouse, and 1 GB RAM. Software requirements comprise Windows 10 or 11 operating system, Python programming language, and Jupyter Notebook as the development tool. Project Jupyter, spun off from IPython in 2014 by Fernando Pe´rez, is an open-source initiative aimed at developing software, standards, and services for interactive computing across multiple programming languages, with its name referencing Julia, Python, and R while honor- ing Galileo's astronomical notebooks. Jupyter Notebook is a web-based interactive computational environment that creates JSON documents containing code, text, mathematics, and rich media, which can be converted to various output formats through the nbconvert library.

Fig 4: Jupyter Notebook.

The notebook interface runs on several open-source libraries including IPython, ØMQ, Tornado, jQuery, Bootstrap, and MathJax, with compatibility extending to numerous programming kernels. Python, created by Guido van Rossum in 1991, is an interpreted, high- level, general-purpose language emphasizing code readability through significant whitespace and a minimalist philosophysummarized in "The Zen of Python." It supports multi- ple programming paradigms including object-oriented, struc- tured, and functional programming, featuring dynamic typing, garbage collection, and a comprehensive standard library. Implementation of a new system requires careful planning and

can follow several approaches: running old and new systems in parallel for security but at higher cost, direct cutover for efficiency but with higher risk, or piloting the system in one part of the organization before full deployment, with the implementation plan detailing all necessary activities, responsible personnel, and a timeframe while anticipating potential problems.

VI. CONCLUSION

Invasive imaging techniques like venography, though formally considered the ”gold standard” for diagnosing Deep Vein Thrombosis (DVT), are rarely used in clinical practice today. Ultrasonography has emerged as the most validated and accurate non-invasive imaging method for symptomatic patients, available in either simplified form (CUS), which scans only two proximal venous spots, or extended mode (WLUS), which investigates both proximal and distal veins. Patients with unlikely pretest probability for DVT and normal D-dimer levels can safely avoid ultrasonography altogether. However, when CUS is performed, all patients with normal baseline findings must undergo a repeat CUS within one week, unless they have low pretest probability or normal D-dimer results. DVT represents a major cause of circulatory-related illness, with people in developing countries suffering from it due to lack of awareness. Early detection significantly reduces risk, with telangiectasia in the legs serving as an important early biomarker. The proposed model eliminates the need for a dedicated environment when capturing images and supports IoT-based healthcare systems, potentially benefiting millions in developing nations.

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