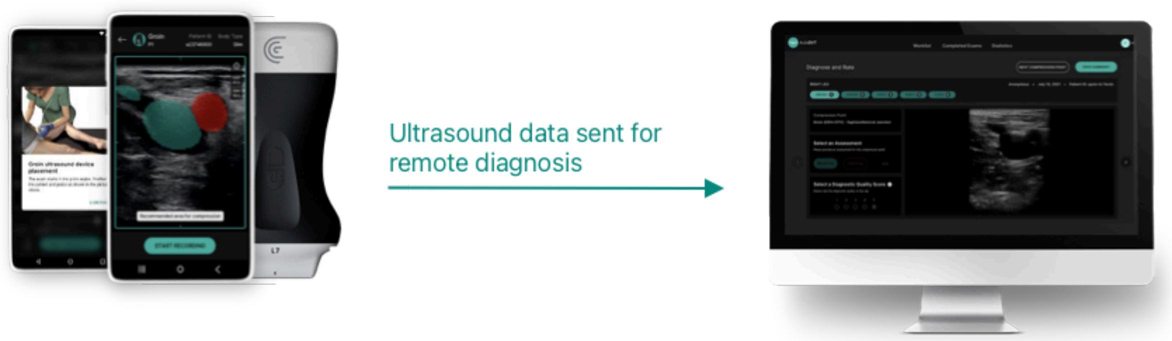
Document version date: Aug 5, 2024

ThinkSono Guidance System



ThinkSono Guidance Mobile App

ThinkSono Guidance Cloud Dashboard

The ThinkSono Guidance System (previously called 'AutoDVT') is a novel ultrasound AI technology that has the potential to improve the DVT clinical pathway and ultimately patients' lives. Due to the flexibility of the technology, it may be used in the emergency department, radiology department, ICU, haematology, and indeed in almost any clinical or community setting.

The ThinkSono Guidance software enables non-ultrasound-trained healthcare staff (e.g. nurses or junior doctors) to perform an AI-guided ultrasound scan on suspected DVT patients. The data is remotely reviewed by a qualified clinician (e.g. sonographer or radiologist) in order to rule out proximal DVT.

A video summary is available at thinksono.com/nhs*

Key Takeaways

- ThinkSono Guidance has a sensitivity of 90.2% which is comparable to the sensitivity of standard of care proximal DVT ultrasound (90.1%).
- A total of 7 studies with more than 500 patients have been run to gather the clinical evidence. 5 of these are prospective, double-blinded clinical studies.
- Up to 84% of all suspected DVT cases can be ruled out safely depending on the clinical context, e.g. D-dimer utilisation or qualified clinician reviewers.
- Cost effectiveness modelling according to NICE Guidelines has shown a net monetary benefit of £72 to £208 per patient (assuming £20,000/QALY).
- The clinical pathway could be improved by reducing the need for a full duplex ultrasound, improving A&E waiting times, or avoiding the need to transport patients.

Note: ThinkSono Guidance (previously called "AutoDVT") has a Class IIb CE mark under EU MDR (EUDAMED SRN Number: DE-MF-000034914) and its full instructions for use are found at: https://thinksono.com/ifu/. ThinkSono GmbH (the manufacturer) is also ISO13485 Certified. Please visit www.thinksono.com for further information or contact hello@thinksono.com for regulatory information. ThinkSono Guidance is also registered with the UK MHRA with reference number: 24531.
*The video was recorded prior to Class IIb CE Mark, but it is now cleared for clinical use. Also, note the product name "AutoDVT" was the product name of "ThinkSono Guidance" at the time of recording. The names are interchangeable.

Table of Contents

ThinkSono Guidance used by clinical staff across the UK, during the 'ADVENT' study.

Executive Summary

The ThinkSono Guidance System is a novel AI technology that has the potential to improve the DVT clinical pathway and ultimately patients' lives. Due to the flexibility of the technology, it may be used in the emergency department, radiology department, ICU, haematology, and indeed in almost any clinical or community setting.

The software has been through extensive testing in multiple clinical studies across multiple countries, including the UK. More than 500 patients have been scanned using the ThinkSono Guidance System and the evidence for its safety and efficacy is robust. Extensive health economic modelling for the NHS has already been carried out and predicts strong cost-effectiveness when implemented in practice.

Early implementation and adoption protocols ensure maximum safety while providing room for customization and optimisation of the system locally for each NHS Trust. ThinkSono's remote review service and full implementation and training package minimise demands on constrained radiology resources.

The licence cost is based on NHS cost-effectiveness models to provide maximum net monetary benefit and can be amended to meet each NHS Trust's financial needs and constraints. Each licence includes comprehensive training and support, including all software and hardware.

Finally, the set-up of the ThinkSono Guidance System is designed to be frictionless. Training for non-ultrasound trained healthcare staff using the ThinkSono Guidance System takes approx. 1 hour and is provided directly by ThinkSono. This means that an NHS Trust can start using the ThinkSono System in as little as 1 working day after the licence agreement has been signed. All service and support is also directly provided through ThinkSono, ensuring consistent, responsive, high quality support.

For any questions or to reach out to discuss this document, please contact hello@thinksono.com

Clinical evidence and comparison against standard of care

Key Takeaways

- ThinkSono Guidance has a sensitivity of 90.2% which is comparable to the sensitivity of standard of care proximal DVT ultrasound (90.1%).
- ThinkSono Guidance has a specificity of 87% compared to the specificity of standard of care proximal DVT ultrasound (98.5%).
- A total of 7 studies with more than 500 patients have been run to gather the clinical evidence. 5 of these were prospective, double-blinded clinical studies.
- ThinkSono Guidance is best used as a proximal DVT rule out tool, and prioritises the positive/indeterminate cases as "high-risk" to obtain a follow-up ultrasound within 4 hours.

Extensive clinical evidence has been gathered via multiple double blinded, multi-centred, clinical studies to test the ThinkSono Guidance Systems safety and efficacy. The studies have been carried out in the UK, Germany and Greece. Patients were first scanned using the ThinkSono System and then compared to subsequent scans by a specialist (e.g sonographer) using their local standard of care DVT ultrasound scan. Figure 1 shows this process in general.

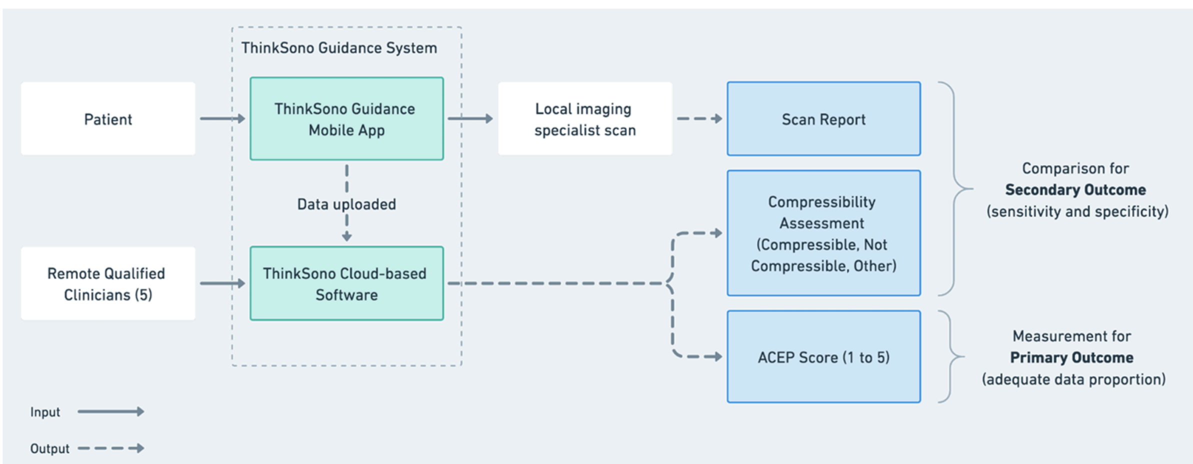
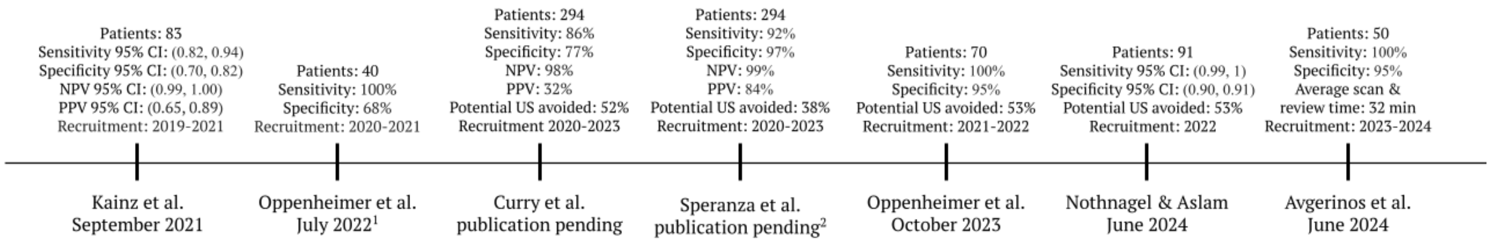


Figure 1: Shows patient flow from left to right. The patient was scanned by a non-ultrasound trained healthcare professional (e.g nurse) and then subsequently scanned by a "local imaging specialist" such as a sonographer. Both the nurse and the sonographer are blinded to each other. All the data collected by the nurse was then reviewed by 5 remote qualified clinicians (e.g radiologist or emergency care doctors with DVT ultrasound experience). The remote qualified clinicians (blinded to each other) were also blinded to the local imaging specialist scan. Image quality, sensitivity and specificity was then compared assuming the local imaging specialist diagnosis is correct.

A timeline of several studies testing the ThinkSono Guidance System from 2021-2024 is shown in Figure 2 below, with their corresponding results:



[1]Data originates from the same patient cohort as in Kainz et al.
[2]Data originates from the same patient cohort as in Curry et al.

Figure 2: A timeline of performance of the studied guidance system in peer-reviewed publications. The timeline is ordered by patient recruitment start date to reflect the latest development stages and optimisation of ThinkSono Guidance chronologically. (CI = Confidence Interval, NPV = negative predictive value, PPV = positive predictive value, US = Ultrasound). All studies are summarised in section [Appendix - Clinical Evidence Reference.](#)

To compare ThinkSono Guidance performance with the standard of care proximal compression ultrasound, all studies above are compared with the results of a meta-analysis published by Bhatt et al [1], see Figure 3 and 4.

In Bhatt et al, test accuracy for proximal compression ultrasound was pooled from 13 studies, including 4,036 participants. Studies used venography as a reference standard for proximal compression ultrasound, with some studies also including clinical follow-up.

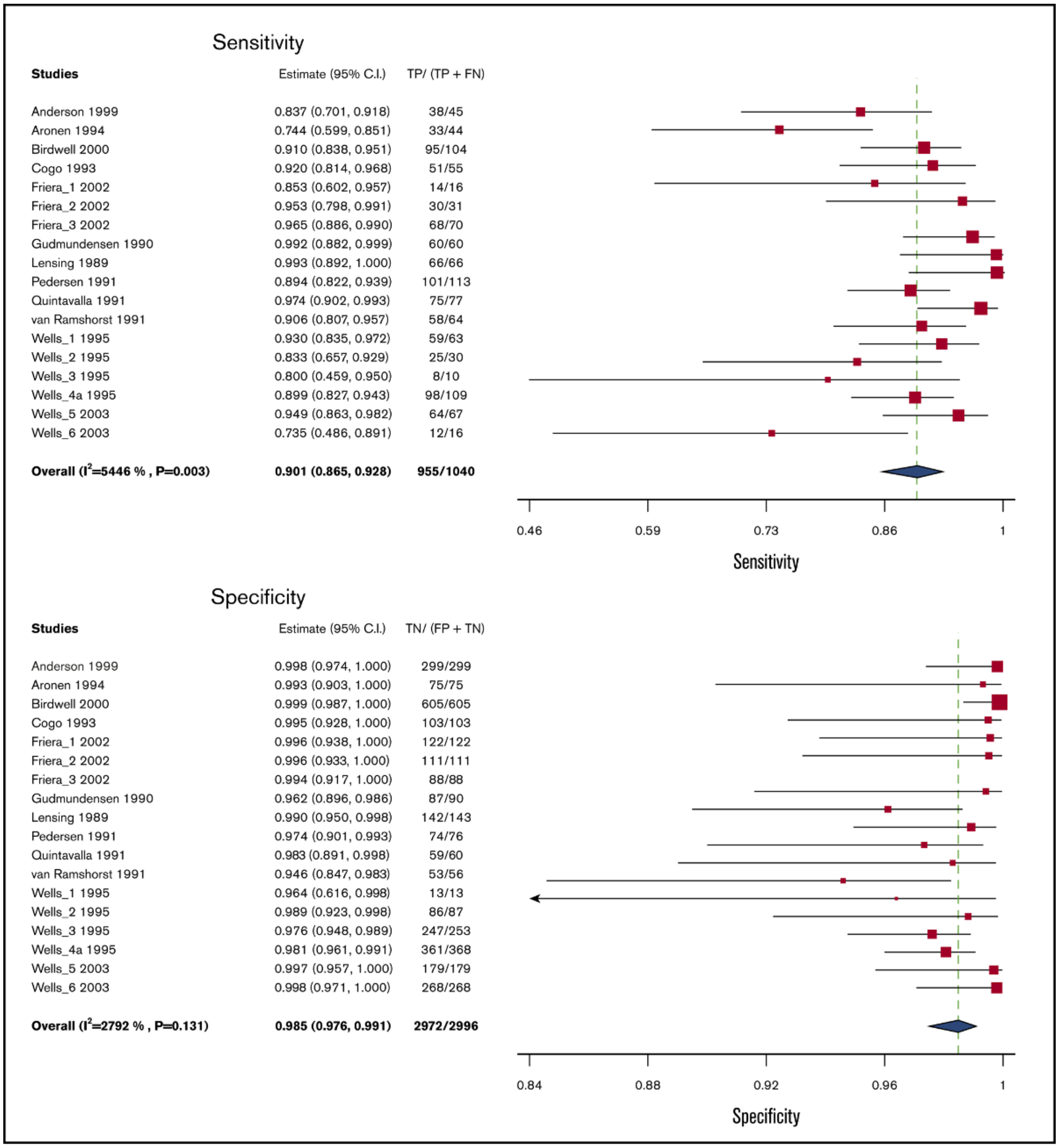
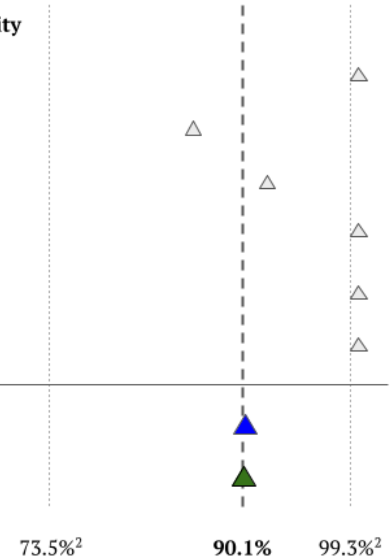


*Figure 3: Pooled sensitivity of 90.1% (95% confidence interval 86.5-92.8%) and specificity of 98.5% (95% confidence interval 97.6-99.1%) proximal compression ultrasound for diagnosis of lower extremity DVT (results highlighted in **bold**) [1].*

As shown in Figure 3, the sensitivity of detection of proximal DVT with compression ultrasound based on Bhatt et al ranges from 73.5-99.3% with pooled sensitivity of **90.1**% (95% confidence interval, 86.5-92.8%).

ThinkSono Guidance is shown to have a sensitivity range between 86-100% and a pooled sensitivity of **90.2%**. Thus it is within the sensitivity range expected in all the prospective studies carried out as visualised in Figure 4.

Study, Publication Year	Recruitment Period (N = Sample Size)	TP / (TP + FN)[2]	Sensitivity
Oppenheimer, 2022	2020-2021 (N = 43)	3 / 3	100%
Curry (publication pending)	2020-2023 (N = 294)	26 / 31	86%
Speranza (publication pending)[1]	2020-2023 (N = 294)	28 / 31	92%
Oppenheimer, 2023	2021-2022 (N = 70)	6 / 6	100%
Nothnagel, 2024	2022-2022 (N = 91)	5 / 5	100%
Avgerinos, 2024	2023-2024 (N = 50)	6 / 6	100%
Pooled ThinkSono Sensitivity		**74 / 82**	**90.2%**
Bhatt et al, 2020 (meta-analysis pooled sensitivity)			**90.1%**

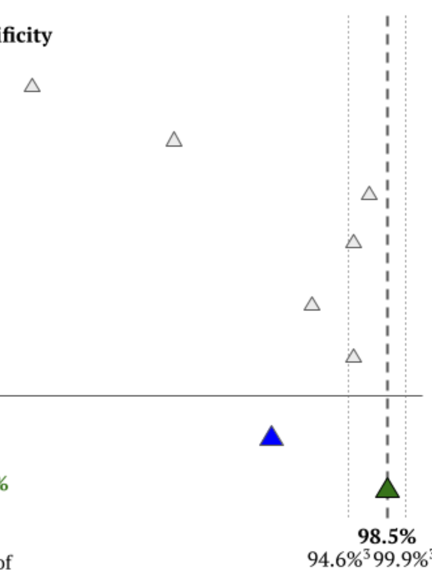


[1]Same patient cohort as Curry et al but different set of qualified clinician reviewers.
[2]Due to bootstrapping methodology, we estimated TP + FN to reflect the reported sensitivity of each study.
[3]Range of sensitivity of studies referenced by Bhatt et al.

*Figure 4: Sensitivity distribution and pooled sensitivity (highlighted in **bold**) of qualified clinician review in prospective ThinkSono Guidance studies (**90.2%**). Results are compared to the range of sensitivities and total pooled sensitivity (**90.1%**) as reported in the Bhatt et al [1] meta-analysis. FN = False Negative, TP = True Positive. Note, the **green** triangle shows the pooled sensitivity of ThinkSono Guidance and the **blue** triangle shows the pooled sensitivity reported by Bhatt et al reflecting standard of care.*

The specificity of detection of proximal DVT with compression ultrasound ranges from 94.6-99.9% with overall specificity of 98.5% (95% confidence interval, 97.6-99.1) [1].

Study, Publication Year	Recruitment Period (N = Sample Size)	TN / (TN + FP)[2]	Specificity
Oppenheimer, 2022	2020-2021 (N = 43)	25 / 40	63%
Curry (publication pending)	2020-2023 (N = 294)	202 / 263	77%
Speranza (publication pending)[1]	2020-2023 (N = 294)	255 / 263	97%
Oppenheimer, 2023	2021-2022 (N = 70)	39 / 41	95%
Nothnagel, 2024	2022-2022 (N = 91)	48 / 53	91%
Avgerinos, 2024	2023-2024 (N = 50)	42 / 44	95%
Pooled ThinkSono Specificity		**611 / 704**	**87%**
Bhatt et al, 2020 (meta-analysis pooled specificity)			**98.5%**



[1]Same patient cohort as Curry et al but different set of qualified clinician reviewers.
[2]Due to bootstrapping methodology, we estimated TN + FP to reflect the reported specificity of each study.
[3]Range of sensitivity of studies referenced by Bhatt et al.

*Figure 5: Specificity distribution and pooled specificity (highlighted in **bold**) of qualified clinician review in prospective ThinkSono Guidance studies (**87%**). Results are compared to the range of sensitivities and*

*total pooled sensitivity (**98.5%**) as reported in the Bhatt et al [1] meta-analysis. TN = True Negative, FP = False Positive. Note, the **green** triangle shows the pooled sensitivity of ThinkSono Guidance and the **blue** triangle shows the pooled sensitivity reported by Bhatt et al reflecting standard of care.*

ThinkSono Guidance has shown to have a pooled specificity of 87% vs 98.5% found in standard of care. The ThinkSonO Guidance specificity depends on the qualified clinician reviewing the data and their experience with compression ultrasound. This was shown clearly in Speranza et al [6], where a specificity as high as 97% may be achieved. Overall, qualified clinicians using ThinkSono Guidance will tend to be more conservative with their diagnosis and this reflects the high sensitivity, but a lower specificity in order to reduce the risk of missed DVTs.

In any case, when implementing ThinkSono Guidance in clinical practice, patients will have a follow up ultrasound in any positive or indeterminate case (as described in the *Implementation in Clinical Practice section of this document*, thus reducing treatment risk.

Up to 87% [2] of suspected DVT patients do not have a DVT. Utilising ThinkSono as a proximal DVT rule out tool will improve the clinical pathway in multiple ways, for example by reducing the need for a full duplex ultrasound, improving A&E waiting times, and avoiding the need to transport patients, both within and outside the hospital.

Patients with a positive and/or indeterminate ThinkSono Guidance scan can also be prioritised for a confirmation ultrasound and treatment due to the increased probability of proximal DVT, and all suspected DVT patients may have better access to a diagnostic result within 4-hours as per the NICE Guidelines [3].

Overall Performance

Key Takeaways

- 80-100% of all ThinkSono Guidance ultrasound scans are considered to be of diagnostic quality.
- 29-84% of all suspected DVT cases can be ruled out safely depending on the clinical context, e.g. D-dimer utilisation or qualified clinician reviewers.
- A ThinkSono Guidance ultrasound scan takes on average between 5-6 min. The review of the data by a qualified clinician takes between 1-2min on average.

The ThinkSono Guidance software has been prospectively evaluated in a range of non-ultrasound trained operators, clinical settings, countries and patient populations. A variety of remote qualified clinicians (i.e radiologists and emergency care doctors with DVT ultrasound experience) were also used to assess the performance of the software.

The quality of the data acquisition of the software has been shown to be robust and consistent across all studies, ranging from 80-100% of all scans being considered of diagnostic quality. The sensitivity of the software with a qualified clinician review has also shown to be high, having a pooled sensitivity of 90.2%. The pooled negative predictive value is 98.9% (ranging from 97-100%). The ranges depend on the experience and training of the qualified reviewer, as is expected from standard of care as shown by Bhatt et al [1].

Retrospective clinical trial results have shown consistently that full duplex ultrasound can be safely avoided after a negative ThinkSono scan in 29-84% of cases, depending on the qualified clinician reviewers utilised and the d-dimer blood test protocol followed.

A ThinkSono Guidance ultrasound scan takes on average between 5-6 min. The review of the data by a qualified clinician takes between 1-2min on average. The median time from a ThinkSono Guidance scan being completed to data review has been shown to be 31min and 44s. The typical length of time from scan initiation to final determination is less than one hour.

Further details about each study carried out showing the performance of ThinkSono Guidance, please refer to the *Appendix - Clinical Evidence Reference* of this document.

Implementation in Clinical Practice

Key Takeaways

- 1h training is required to use ThinkSono Guidance. The training is provided directly by ThinkSono.
- Qualified clinician review can be provided by ThinkSono or by local NHS staff.
- ThinkSono Guidance is designed to fit the clinical pathway needs of the local NHS Trust.
- Further details provided to implement ThinkSono Guidance in primary and secondary care given in Appendix.

Non-ultrasound trained staff (e.g nurses or junior doctors) operating the ThinkSono Guidance system will receive a 1 hour training session from the ThinkSono team. A "super user" can also be trained so that this experienced user can train further operators independently of the ThinkSono team. The training procedure is documented and reproducible.

The highest sensitivity and negative predictive value were obtained when having qualified clinicians with “point-of-care” DVT ultrasound experience review the data. Hence, for optimal results, clinicians who are expected to review the data from ThinkSono Guidance should first be assessed for competency (through review of example ThinkSono data). This will be done prior to routine clinical use by the ThinkSono team.

A range of clinical protocols allow for flexible integration of ThinkSono Guidance into each NHS Trust’s workflows. The aim of the software will be to rule out proximal DVT in suspected DVT patients since up to 87% of cases are negative [2]. Any indeterminate or positive case will be referred for a standard of care ultrasound scan.

Overall, ThinkSono Guidance can be used to *rule out* proximal DVT following the same clinical decision making as recommended by the NICE Guidelines with respect to a proximal DVT ultrasound scan [3].

Below we have listed multiple **optional** ways to implement ThinkSono Guidance in clinical practice. These will follow the existing NICE guidelines for proximal DVT, but with additional suggestions that allow *temporary* monitoring and/or safety assessment (e.g by including d-dimer tests and/or additional imaging).

1. Scan all suspected DVT patients using ThinkSono Guidance and have a follow-up ultrasound scan in 6-8 days, as is standard for a proximal compression ultrasound DVT scan as per the NICE guidelines, see Figure 3.

2. Using a d-dimer blood test on all patients initially, and rule out DVT in patients with a negative ThinkSono scan and negative d-dimer (e.g as shown in [2]). All other cases can be referred for a local standard of care ultrasound scan.

   Monitoring can be implemented to track software performance over time (e.g a period of 3, 6 or 12 months) and a decision to remove the d-dimer test can then be made by the local clinical team, see Figure 4.

3. Initially scan all suspected DVT patients using the ThinkSono Guidance system and also their local standard of care scan. This can be done over a period of 3, 6 or 12 months to re-validate ThinkSono Guidance performance before deciding to avoid a full duplex scan on patients with a negative ThinkSono Guidance scan, see Figure 5.

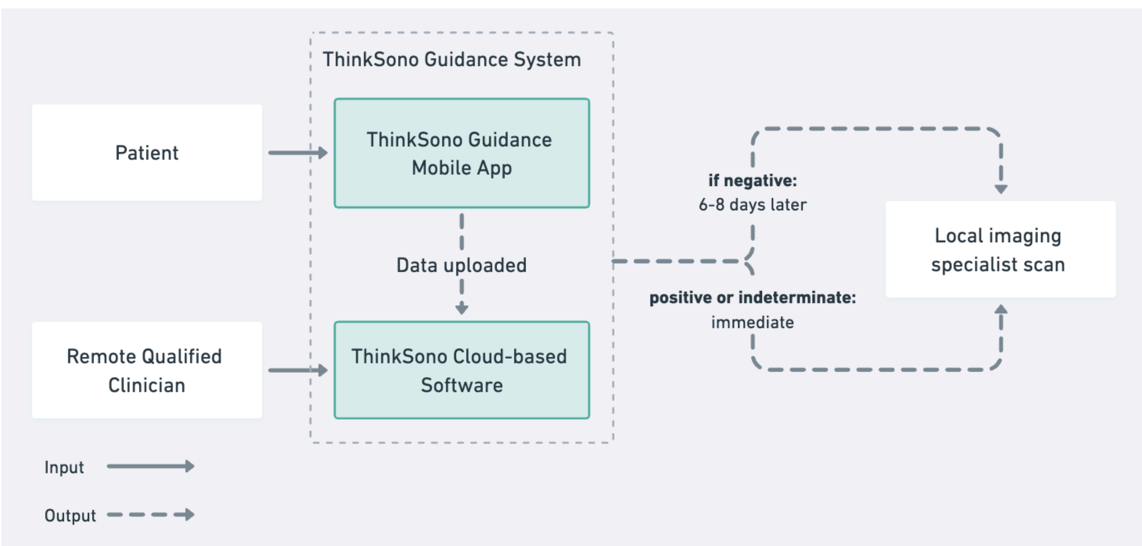


Figure 3: Pathway with repeated local standard of care scan 6-8 days after a negative ThinkSono Guidance assisted scan.

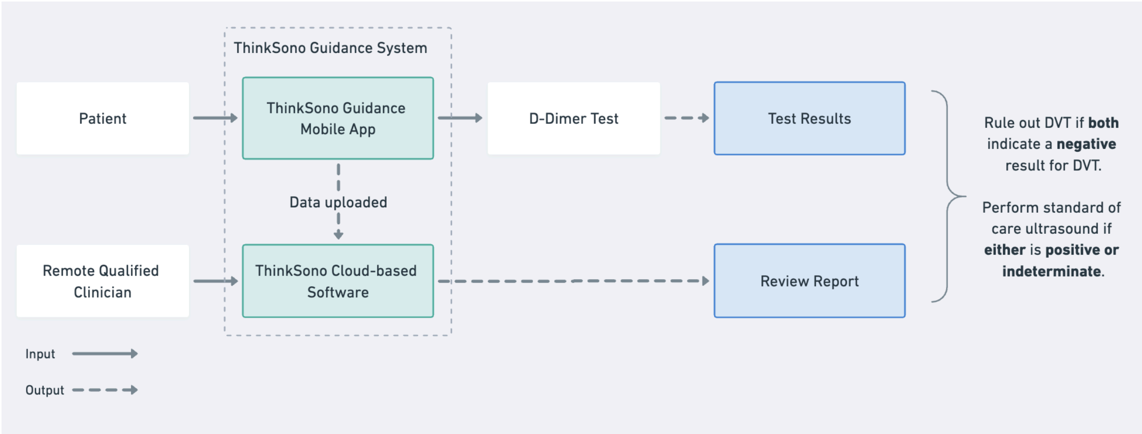


Figure 4: Alternative pathway performing both a ThinkSono Guidance scan and a D-Dimer blood test.

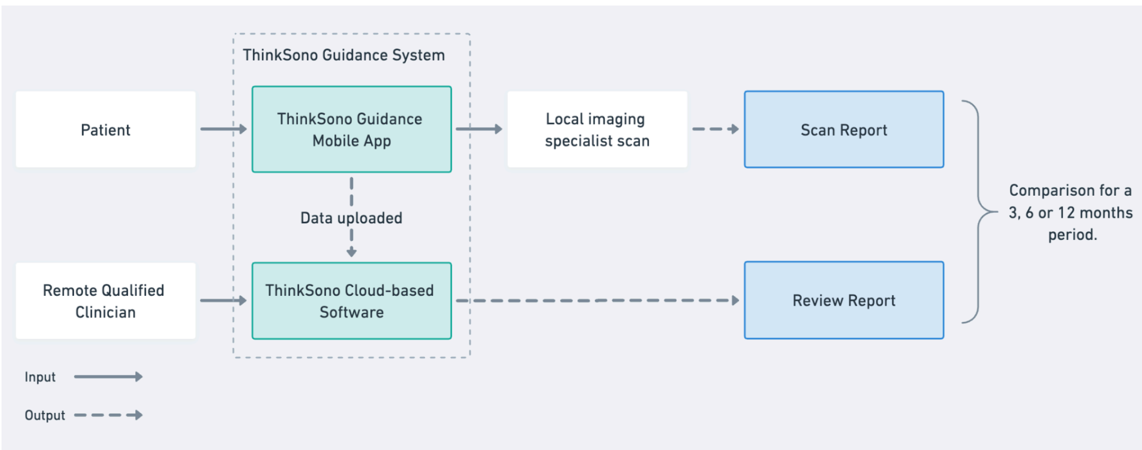


Figure 5: Alternative pathway with repeated local standard of care scan.

The options above are given as ***examples*** for NHS Trusts that wish to further assess the software internally and base their decision on their local pathway and needs. ThinkSono can support any option that is decided by the local clinical team. For full clarity, the exact implementation can be discussed with the local clinical team at each NHS Trust to ensure the most optimal use of the software to serve the needs of the NHS Trust and the patients.

Further support can be provided by ThinkSono for NHS Trusts that do not have access to their own qualified clinicians to review scans (e.g due to difficulty with having existing radiology departments review the ThinkSono data) or other issues with IT integration.

In this case, ThinkSono can carry out the remote reviews via its own network of UK based qualified clinicians and provide a report as per the needs of the NHS Trust. This can be discussed on a case-by-case basis. Of course, for NHS Trusts that want to have their own radiology department review the data may also do so.

Finally, further details of implementation of ThinkSono Guidance within primary and secondary care is given in the Appendix section of this document titled “Hospital Based - Secondary Care

Pathway Implementation for DVT Diagnosis” and “Implementation in Clinical Practice (Primary Care).

Health Economics and Licence Costs

Key Takeaways
- Cost effectiveness modelling according to NICE Guidelines has shown a net monetary benefit of £72 to £208 per patient (assuming £20,000/QALY).
- A yearly licence fee is based on an estimated number of suspected DVT patients, e.g. £72 for 1000 patients resulting in a £72,000 fee per year. This cost is inclusive of all hardware, software and training.

Extensive health economic modelling for the NHS has been provided and published by Kainz et al [4] with support from the School of Health and Related Research department of the University of Sheffield (SCHARR). The NICE cost-effectiveness guidelines have been followed during this process [5]. This takes into account multiple clinical pathways and is estimated to generate a positive net monetary benefit at costs from £72 to £208 per software-supported examination, assuming a willingness to pay of £20,000/QALY [4][6].

Based on this analysis, ThinkSono offers a single yearly licence based on £72 per software-supported examination to the first NHS Trusts using the ThinkSono Guidance system. An estimate will be made of the average number of suspected DVT patients per year and the annual licence fee will be based on this. For example, an NHS Trust that is estimated to scan 1,000 suspected DVT patients per year will have a licence fee of £72,000.

This initial licence fee can then be adjusted appropriately after 12 months of use to ensure full cost-effectiveness is provided. Further adjustments to the licence fee can be made based on other budget or resource restraints of the NHS Trusts if required. This can be discussed during the contracting phase when purchasing the licence. Overall, the aim will be to ensure full cost effectiveness when using the ThinkSono Guidance System.

Cyber Security and IT Integration

Key Takeaways
- ThinkSono Guidance is provided as a standalone kit (consisting of hardware and software) with no requirements of IT system integration.
- All data is encrypted by default following all relevant cybersecurity regulations.
- Bespoke healthcare IT integration can be provided on a case-by-case basis.

To use the ThinkSono Guidance System, a kit is provided that contains a smartphone (pre-loaded with the ThinkSono App) a handheld ultrasound device and other accessories. The kit is fully self-contained and no further hardware or software is required. All data is encrypted and stored locally in the ThinkSono App on the phone.

Once a scan is carried out, the data can be securely uploaded to the ThinkSono Cloud Dashboard for qualified clinician review. A notification is sent to the remote qualified clinician to review the results of a scan via SMS and/or email.

The qualified clinician can securely log-into the ThinkSono Dashboard from any device via the browser on a laptop, desktop or smartphone.

This data is anonymous and encrypted by default. If a local qualified clinician (e.g at the NHS Trust) wishes to review the data, they may have access to identifying patient information, but this is optional and can be enabled depending on the local requirements of the NHS Trust.

The ThinkSono System is designed to be set-up with little or no need for any hospital IT integration, as the system is self-contained. However, local hospital IT integration can be carried out if required by the Trust (e.g to the electronic health record or PACS).

Generally, it is recommended for the Trust to implement the ThinkSono System “as is” to streamline the initial adoption period prior to full IT integration. Within the “ADVENT” study this was done successfully with little friction across 11 NHS sites.

However, the details of IT integration and set-up can be discussed with ThinkSono directly to ensure an optimal set-up is carried out. Other IT support is also available if or when required. Please contact hello@thinksono.com for further details or questions.

Appendix

Hospital Based - Secondary Care Pathway Implementation for DVT Diagnosis

Deep Vein Thrombosis (DVT) is a critical condition that requires prompt and accurate diagnosis to prevent severe complications such as pulmonary embolism. In secondary care settings, current challenges include delays in diagnosis, resource constraints, and inefficiencies that can impact patient outcomes. The implementation of ThinkSono's handheld ultrasound technology presents a transformative opportunity to streamline DVT diagnosis and management across hospital departments.

Model 1: Ambulatory Emergency Care Unit (AECU) / Same day emergency care (SDEC) Integration
Current Challenges:

- **High Patient Volume:** AECUs manage several hundred patients monthly, leading to resource strain and long wait times.
- **Scheduling Delays:** Limited ultrasound availability delays diagnosis, forcing patients on anticoagulation treatment without confirmed DVT.
- **Multi-Condition Management:** Competition for resources due to varied conditions complicates prioritisation as ambulatory care units often manage multiple patients presentations.

ThinkSono Implementation:

- **Immediate Scanning:** ThinkSono enables healthcare providers to perform on-the-spot DVT scans, bypassing traditional ultrasound scheduling.
- **Efficient Patient Flow:** Rapid diagnosis allows for same-day discharge or follow-up coordination, reducing hospital stay durations.
- **Resource Optimization:** Traditional ultrasound equipment is freed for complex cases, enhancing department efficiency.

Benefits:

- **Enhanced Patient Experience:** Quicker diagnosis and discharge improve patient satisfaction.
- **Operational Efficiency:** Increased throughput and reduced reliance on full-time sonographers or radiologists for DVT cases.
- **Cost-Effectiveness:** Savings on unnecessary anticoagulation (if D dimer testing is included) and reduced operational costs.

Model 2: Emergency Department (ED) Utilisation
Current Challenges:

- **Limited Imaging Availability:** After-hours ultrasound access is restricted, leading to multiple patient visits and overburdened staff.
- **Recurrent Visits:** Patients often require several visits before definitive diagnosis.

ThinkSono Implementation:

- **Rapid Triage:** Nurses and healthcare professionals can perform ultrasounds immediately, streamlining diagnostics.
- **24/7 Accessibility:** ThinkSono operates independently of department hours, reducing return visits.
- **Streamlined Processes:** Efficient triage and diagnosis free ED resources for critical emergencies.

Benefits:

- **Reduced ED Pressure:** Faster diagnosis alleviates congestion, particularly during peak hours.
- **Patient-Centric Care:** Timely treatment improves patient experiences and reduces anxiety.
- **Enhanced Workflow:** ED staff can focus on more severe cases, optimising resource use.

Model 3: Intensive Care Unit (ICU) Integration
Current Challenges:

- **High DVT Risk:** ICU patients are susceptible to DVT due to immobility and complex medical conditions.
- **Logistical Hurdles:** Transporting critically ill patients for ultrasounds is risky and resource-intensive.
- **Diagnostic Delays:** Time-sensitive needs may result in adverse outcomes due to delayed diagnosis.

ThinkSono Implementation:

- **Bedside Ultrasound:** ThinkSono facilitates bedside diagnostics, eliminating patient transport risks.
- **Regular Monitoring:** Continuous assessments allow for early detection and proactive care.
- **Resource Efficiency:** Frees conventional ultrasound resources for other critical tasks.

Benefits:

- **Early Intervention:** Timely diagnosis leads to immediate treatment and reduced complications.
- **Patient Safety:** Patients remain in the ICU, minimising movement-related risks.
- **Cost-Effective Care:** Efficient diagnostics reduce costs and improve resource allocation.

Model 4: Ward-Based Scanning

Current Challenges:

- **Shared Equipment Limitations:** Resource competition delays DVT diagnosis and strains staff.
- **Diagnostic Delays:** Arranging traditional ultrasound services is time-consuming, increasing patient anxiety.

ThinkSono Implementation:

- **Portable Solution:** ThinkSono allows for bedside scanning across wards, similar to bladder scanners.
- **Consistent Availability:** Multiple wards can have its own device sharing, ensuring immediate access.
- **Improved Patient Care:** Faster scans lead to quicker treatment decisions and improved outcomes.

Benefits:

- **Operational Efficiency:** Reduced scheduling bottlenecks enhance overall ward efficiency.
- **Cost Savings:** Minimises need for centralised ultrasound services and associated costs.
- **Empowered Staff:** Trained staff can independently perform diagnostics, optimising hospital operations.

Model 5: Walk-In Centre and Urgent Care Centre Pathways
Current Challenges:

- **Limited Diagnostic Capabilities:** Reliance on hospital referrals for imaging delays treatment.
- **Increased Workload:** High referral rates place additional strain on both centers and hospitals.

ThinkSono Implementation:

- **On-Site Diagnostics:** ThinkSono enables immediate DVT assessments at walk-in centers, reducing referrals.
- **Seamless Integration:** Easy integration into existing workflows with minimal infrastructure changes.
- **Patient-Centric Approach:** Reduces patient travel and improves satisfaction by providing comprehensive care in one location.

Benefits:

- **Expanded Services:** Walk-in centers can handle a wider range of medical conditions.
- **Reduced Hospital Burden:** Fewer referrals alleviate pressure on hospital systems.
- **Cost Efficiency:** Efficient operations contribute to significant cost savings.

Conclusion

Integrating ThinkSono technology into secondary care pathways for DVT diagnosis offers a powerful solution to existing challenges, enhancing efficiency and improving patient outcomes across various hospital settings. By equipping healthcare professionals with portable, AI-guided ultrasound devices, hospitals can provide faster, more reliable care, optimise resource utilisation, and deliver a more patient-centred healthcare experience.
Overall Impact:

- **Speed and Accuracy:** Fast, accurate diagnostics reduce wait times and enhance care quality.
- **Accessibility:** Broad access to ultrasound scanning empowers more healthcare professionals.
- **Cost Savings:** Reduced unnecessary treatments and visits save valuable resources.
- **Patient Satisfaction:** Improved diagnosis and treatment pathways lead to better patient experiences.

ThinkSono's integration in secondary care promises to revolutionise DVT management, ensuring patients receive prompt, effective care while optimising hospital operations for better health outcomes.

Implementation in Clinical Practice (Primary Care)

Current Issues in DVT Pathways:

The current diagnostic pathway for DVT is predominantly hospital-based, leading to costly, inefficient, delayed care for many patients. Typically, when a patient presents to their GP with a suspected DVT, they are referred to the hospital's Same Day Emergency Care (SDEC) or Ambulatory Emergency Care (AEC) unit. For each patient with a suspected DVT, a GP must take time away from seeing patients to complete the lengthy process of contacting the hospital service and setting up a referral. Patients following this pathway are burdened with significant travel time and expense, and frequently are unable to receive DVT ultrasound until several days later due to appointment and resource constraints in hospitals.

Modernising the DVT Pathway:

To improve the efficiency and patient satisfaction of DVT diagnosis and management, the service can be moved to a primary care setting. This transition can be achieved through two potential models:

Model 1: Primary Care Hub Integration

In some Integrated Care Boards (ICBs), there is a central primary care hub, such as an acute illness clinic or primary care hub, which handles acute day cases, overflow cases, or urgent cases. These hubs already have the necessary healthcare staff, appropriate rooms, and appointment slots to conduct DVT ultrasound using the ThinkSono Guidance System.

Implementation Steps:

1. **Referral to Central Hub:** When a patient is being triaged after contacting their GP with a suspected DVT, they can be directly referred to the central hub, bypassing the need for a GP appointment and the need to contact the SDEC or AEC unit.
2. **ThinkSono Guidance System Utilisation:** At the central hub, patients can undergo a ThinkSono proximal DVT scan. Similar to the NICE guidelines for a proximal DVT scan:

   (a) If the scan is negative, a follow up scan in 6-8 days should be scheduled.
   (b) If the ThinkSono proximal scan is positive, then a follow up full duplex scan can be scheduled to confirm the diagnosis prior to full treatment.

   Note that anticoagulant (e.g DOAC) prophylaxis may be given in the interim of a confirmed diagnosis (e.g in the 6-8 days or the scheduled full duplex scan).

   Benefits:

- **Efficiency:** Direct referral to the central hub saves time for both the GP and the patient.
- **Cost-Effectiveness:** Reduces the need for hospital visits and the associated costs, as well as eliminating up to 84% of duplex ultrasound scans.
- **Improved Patient Satisfaction:** Provides quicker diagnosis and reduces the waiting time and inconvenience of hospital visits.
- **Enhanced Primary Care Funding:** Adding this service to the primary care hub can lead to new funding opportunities and improved resource allocation.

Model 2: Lead Primary Care Practice

In ICBs without a central primary care hub, certain services are often managed by a lead primary care practice. This practice provides additional services to other practices in the area and can take on the role of managing the DVT pathway.

Implementation Steps:

1. **Lead Practice Management:** A designated lead practice can receive referrals for suspected DVT from other practices in the area.
2. **ThinkSono Guidance System Utilisation:** Similar to Model 1, the lead practice can use the ThinkSono system to exclude proximal DVT or refer to full duplex scan.
3. **Follow-up Appointments:** The lead practice can schedule necessary follow-up appointments for patients with confirmed DVT.

Benefits:

- **Resource Optimization:** Utilises existing resources and infrastructure within the lead practice.
- **Cost Savings:** Significant cost savings for the NHS by reducing hospital-based diagnoses and the number of duplex ultrasounds.
- **Improved Access:** Provides a streamlined pathway for DVT diagnosis and management within primary care settings.

Conclusion:

By implementing these models, the primary care pathway for DVT diagnosis and management can be significantly improved. Moving the service to a primary care setting enhances efficiency, reduces costs, and increases patient satisfaction. The ThinkSono Guidance System plays a crucial role in this transition, providing a reliable, cost-effective, and easy-to-use diagnostic tool that fits seamlessly into existing primary care structures.

Clinical Evidence Reference

For clarity, ThinkSono Guidance was previously called *"AutoDVT"*. Thus, any reference to AutoDVT is interchangeable with ThinkSono Guidance. Also note, many studies investigated ThinkSono Guidance as a standalone diagnostic tool without qualified clinician review as well as *with* qualified clinician review. The Class IIb CE mark **only** applies to ThinkSono Guidance **with qualified clinician review**. Therefore, this clinical evidence reference will focus on ThinkSono Guidance performance with qualified clinician review.

The clinical evidence has been further summarised for presentation in this document. Full texts are available at the given sources or upon request at hello@thinksono.com.

Remote Expert Review Can Significantly Improve Deep Vein Thrombosis Clinical Pathway with AI-guided Ultrasound Acquisition.

Giancarlo Speranza, Sven Mischkewitz, Fouad Al-Noor, Bernhard Kainz, and the ADVENT Investigators. Under review, manuscript attached.

Objective: To extend the analyses of the ADVENT study to assess ThinkSono Guidance system performance across a wider variety of conditions and further investigate the economic implications of these results.

Methods: We reviewed the entire population from the ADVENT trial, comprising 381 patients. This includes 294 participants from the original ADVENT analysis and 87 participants initially excluded due to distal DVT, protocol deviations, and technical issues. Each scan was reviewed by the same five UK-based radiologists from the ADVENT trial and by five additional independent American Emergency Medicine (EM) physicians, all certified in POCUS image interpretation. The primary endpoint is the sensitivity of the AI guidance system with qualified clinician review. The secondary endpoints included specificity, positive predictive value, negative predictive value, diagnostic image quality, inter-observer agreement on image quality, and compressibility assessment. Inter-observer agreement was measured by the mean pairwise Cohen's kappa. The potential pathway improvement was measured by the proportion of ultrasound scans that could be avoided when using the AI guidance system.

Results: Eighty percent (n = 304) of all scans were rated with an ACEP image quality score of 3 or higher. For the radiology ADVENT reviewers, sensitivity ranged from 86% to 91%, specificity from 74% to 87%, NPV from 98% to 99%, PPV from 29% to 47%. and sonographer performed ultrasounds avoided from 39% to 53%. Inter-observer agreement for adequate image quality was 0.15 and for compressibility was 0.60. EM reviewer sensitivity ranged from 92% to 96%, specificity from 97% to 100%, NPV from 99% to 99%, PPV from 81% to 100%, and sonographer performed ultrasounds avoided from 29% to 40%. Inter-observer agreement for adequate image quality was 0.58 and for compressibility assessments was 0.66. Economic analyses revealed a net monetary benefit of £90-£208 per scan depending on the reviewer group.

Conclusion: The use of AI-guided image acquisition for diagnosing lower extremity DVT is feasible. Our results show that the performance of the ThinkSono Guidance system is influenced more by the expertise of remote clinical reviewers. Additionally, our analysis suggests a potential positive impact on health economics, including safely avoiding ultrasound scans carried out by a sonographer. Determining the optimal integration of AI guidance systems with remote review into clinical workflows remains to be determined.

The ADVENT Study: A multi-centre, prospective, double-blinded, pilot study evaluating the sensitivity of artificial intelligence driven automatic detection of proximal deep vein thrombosis.

Curry N, Allen E, Silsby L, Goodacre S, Deane C, Deary A, Foster A, Griffiths J, Sharma R, Thomas H, Mischkewitz S, Al-Noor F, and the ADVENT Investigators. Under review, manuscript attached.

Objective: This prospective, double blinded, test accuracy study was designed to test whether an artificial-intelligence guided software device (ThinkSono Guidance) could guide non-radiology specialists to diagnose proximal DVT. It was compared to the reference standard of compression ultrasound completed by trained sonographers.

Methods: Eleven regional hospital DVT diagnostic clinics enrolled adult patients who were referred for investigation, including a compression ultrasound, of symptoms suggestive of DVT. Prior to the clinical compression ultrasound, a ThinkSono Guidance system scan was performed. These scans were then analysed standalone by the AI software system, and were also reviewed by 5 remote expert qualified physicians**.** The main primary outcome was sensitivity of the standalone AI system and the sensitivity of ThinkSono Guidance with expert review. Other outcomes included: specificity and positive/negative predictive value (PPV/NPV) of the standalone AI system and ThinkSono Guidance with expert review.

Results: 414 participants were enrolled. Proximal DVT was detected in 10.5% of those analysed. ThinkSono Guidance with expert review resulted in 85% (95% CI: 65 – 96%) sensitivity and 73% (95% CI: 66 – 79%) specificity for detection of proximal DVT. NPV for ThinkSono Guidance with expert review was 97% (95% CI: 93 – 99%) with a PPV of 29% (95% CI: 19 -40%).

Conclusion: ThinkSono Guidance can detect proximal DVT. Test accuracy was not sufficient for this device to be used safely. Further optimisation of the software is required prior to use in clinical practice by non-radiology trained healthcare professionals.
Further optimisation was carried out and results presented in the sister paper by Speranza et al [6]. Please refer to the results above. Further prospective studies have also been run and are presented below.

Evaluating the benefits of machine learning for diagnosing deep vein thrombosis compared to gold standard ultrasound- a feasibility study.

Kerstin Nothnagel and Mohammed Farid Aslam. BJGP Open 12 June 2024; BJGPO.2024.0057. DOI: https://doi.org/10.3399/BJGPO.2024.0057

Objective: To evaluate the feasibility of remote deep venous thrombosis (DVT) detection via ThinkSono Guidance system point of care compression ultrasound scans. The aim is to assess the effectiveness of AI-guided scans conducted by non-ultrasound trained healthcare staff in capturing ultrasound images for remote diagnosis of DVT.

Methods: Over a 3.5-month period, patients with suspected DVT underwent AI-guided point of care ultrasound (POCUS) scans conducted by non- specialists using a handheld ultrasound probe connected to the ThinkSono Guidance app. These ultrasound sequences were uploaded to a cloud-dashboard for remote specialist review. Patients also received standard of care DVT scans.

Results: Among 91 predominantly elderly female participants, 82% of scans were able to be completed. 91% of these were rated with an ACEP image quality score of 3 or higher, making them acceptable for interpretation, with 64% categorised by remote clinicians as "compressible" or "incompressible." Sensitivity and specificity for adequately imaged scans were 100% and 91%, respectively. 53% of scans were identified as low-risk and compressible; these patients could potentially avoid sonographer-performed ultrasounds.

Conclusion: ThinkSono Guidance effectively directed non-ultrasound trained staff to acquire high quality ultrasound images allowing for remote review and detection of DVT. It may reduce the need for formal ultrasound scans, particularly with negative findings, and extend diagnostic capabilities to primary care, emergency department, and other care settings. The study highlights AI-assisted POCUS potential in improving DVT assessment.

Novel DVT diagnostic pathway incorporating non-expert AI guided compression ultrasound sparing vascular lab venous testing

Avgerinos E, Spiliopoulos S, Psachoulia F, Yfantis A, Plakas G, Grigoriadis S, Mischkewitz S, Al Noor F, Kakisis J. To appear in Proceedings European Society for Vascular Surgery 38th Annual Meeting 2024 [7].

Objective: To evaluate the clinical performance of the ThinkSono Guidance System and its ability to obviate the need for venous duplex ultrasounds and reduce waiting times for patients.

Methods: 50 patients with a suspected DVT were prospectively recruited through the emergency room of our institution. Enrolled patients underwent an AI-guided two-region proximal DVT compression examination by non-ultrasound-trained healthcare staff using a handheld ultrasound device and the ThinkSono Guidance System. D-Dimers were obtained in all patients. The ultrasound images were transferred to the ThinkSono cloud platform automatically and remotely reviewed by the on-call radiologist who in turn rated the images for diagnostic quality using the American College of Emergency Physicians score from 1 to 5.
All images with a score of 3 or more are considered of sufficient quality for the reviewer to label each scan negative for DVT or positive for DVT. All negative ThinkSono Guidance patients with negative D-Dimers were discharged. All patients negative for DVT but with positive D-Dimers and all patients positive for DVT were sent for a full venous duplex scan. Sensitivity and specificity of ThinkSono Guidance against D-Dimers and full duplex scans were measured. Time to diagnosis with ThinkSono Guidance was calculated.

Results: 50 patients (average age 54 (± 18) years, 44% females) were scanned with ThinkSono Guidance by 3 non-ultrasound-trained healthcare professionals. ThinkSono Guidance with radiologist review yielded 42 negative DVT diagnosis (84%); 15 of these were discharged (30%) with negative D-dimers, and full duplex ultrasound testing was performed in 22 patients (due to positive D-dimers) and 5 patients due to unavailability of D-dimer testing. All these cases were negative (100% sensitivity for ThinkSono Guidance).
8 patients were suspected of DVT by the reviewing radiologist and subsequent vascular lab testing confirmed a DVT diagnosis in 6 patients (95% specificity for ThinkSono Guidance). The radiologist rated all ThinkSono Guidance data as adequate diagnostic quality.
A ThinkSono Guidance ultrasound scan took on average 5min 22s. The review of the cine loops took on average 1min 22s, thus a total time of 6min 44s for scan and review. The median time from a ThinkSono scan being completed to review was 31min 44s (range 10min 49s - 8h 32min). In a representative case, a patient received a ThinkSono Guidance scan and a diagnosis was given in 13min 38s. The standard pathway for the same patient took 4h 51min to complete D-dimer testing and receive a full-duplex scan with the same negative diagnosis.

Conclusion: Incorporating the ThinkSono Guidance System in the DVT diagnostic pathway suggests a significant proportion of suspected DVT patients could safely avoid the need for a full duplex ultrasound and D-dimer testing. The wide time range from ThinkSono scan to image review reflects the hospital logistics, mainly the availability of qualified clinicians to review the data due to collateral tasks. Careful resource planning can maximize the efficiency of the AI-assisted pathway by reducing DVT diagnostics to a 5 minute compression sonography by a non-expert health care professional. This can have a significant impact in patient waiting times and vascular lab resource optimization.

Remote Expert DVT Triaging of Novice-User Compression Sonography with AI-Guidance.

Oppenheimer J, Mandegaran R, Staabs F, Adler A, Singöhl S, Kainz B, et al. Annals of Vascular Surgery. 2024 Feb 1;99:272–9. Epub 2023 Oct 10.

Objective: The purpose of this study was to assess the ThinkSono Guidance system and test non-specialist image acquisition and remote triaging in a clinical setting.

Methods: Patients with a suspected deep vein thrombosis (DVT) were recruited at 2 centers in Germany and Greece. Enrolled patients underwent a ThinkSono Guidance two-point compression examination by a non-ultrasound-trained operator using a handheld ultrasound device prior to a full duplex ultrasound scan. Images collected by the ThinkSono software were uploaded to the ThinkSono Cloud Dashboard for blind review by 5 qualified physicians. All reviewers rated the quality of all sequences on the American College of Emergency Physicians (ACEP) image quality scale (score 1-5, 3 or more defined as adequate imaging quality) and for an ACEP score of 3 or more, chose ‘‘Compressible’’, ‘‘Incompressible’’, or ‘‘Other’’. Sensitivity and specificity were calculated for adequate quality scans with an assessment as ‘‘Compressible’’ or ‘‘Incompressible’’. We define this group as diagnostic quality. To simulate a triaging clinical algorithm, a post hoc analysis was performed merging the ‘‘incomplete’’, the ‘‘low quality’’, and the ‘‘Incompressible’’ into a high-risk group for proximal DVT.

Results: Seventy-three patients (average age 64.2 years, 44% females) were eligible for inclusion and scanned by 3 non-ultrasound-trained healthcare professionals. Three patients were excluded from further analysis due to incomplete scans. Sixty two of 70 (88.57%) of the completed scans were judged to be of adequate image quality with an average ACEP score of 3.35. Forty seven of 62 adequate scans were assessed as diagnostic quality, of which 8 were interpreted as positive for proximal DVT by the reviewers resulting in a sensitivity of 100% and specificity of 95.12%.

When simulating a triaging algorithm, 34/73 (46.58%) of patients would be triaged as high risk and 8 would be confirmed as positive for proximal DVT (6 in the diagnostic and 2 in the low-quality cohort). Of 39/73 patients triaged as low risk, all were negative for proximal DVT in standard duplex; thus, this triaging algorithm could potentially avoid 53.42% of standard duplex scans performed by sonographers.

Conclusion: The ThinkSono Guidance system was able to aid non-ultrasound-trained operators in acquiring valid venous compression ultrasound images and allowed for remote review and triaging. This strategy allows faster diagnosis and treatment of high-risk patients and can spare the need for multiple unnecessary duplex scans, the vast majority of which are negative.

AI-guided novice-user compression sonography with remote expert DVT diagnosis.

J. Oppenheimer, R. Mandegaran, B. Kainz, M. P. Heinrich, F. Noor, S. Mischkewitz, A. Ruttloff, P. Klein-Weigel. ECR 2022/ C-10357. DOI: 10.26044/ecr2022/C-10357.

Objective: To assess the performance of the ThinkSono Guidance system in allowing non-ultrasound trained staff to acquire appropriate compression ultrasound sequences for remote DVT assessment.

Methods: Patients with a suspected DVT were recruited at a German tertiary care clinic via the emergency department or primary care referral. Each patient underwent one ThinkSono Guidance scan by a non-specialist and one standard, full leg ultrasound examination by a highly-trained angiology consultant with 26 years of experience with DVT ultrasound diagnosis. ThinkSono scans were either 2-point compression scans (groin and popliteal fossa) or 3-point compression scans (groin, thigh, and popliteal fossa).
ThinkSono scans were uploaded to the ThinkSono Cloud Dashboard for expert review by an external board-certified radiologist with nine years of experience and a final-year medical student with four years of training in ultrasound DVT-diagnosis. These reviewers also reviewed the standard ultrasound images. Both reviewers also rated each scan on the 5-point American College of Emergency Physicians (ACEP) Emergency Ultrasound Reporting Guidelines image quality scale. Full scans with an ACEP score below 3 were defined as non-diagnostic. Sensitivity and specificity were defined in comparison to the results of the standard compression ultrasound performed by the specialist on site. Results are displayed as means with 95% confidence intervals (±) to better convey relevant differences in scoring.

Results: 40 patients were included in the study, of which 13 patients received scanning of both legs. 47 complete 2-point DVT-scans from 37 patients, including 43 complete 3-point DVT-scans from 33 patients were collected and uploaded to the platform. 4 patients showed positive results for DVT in the gold standard, on-site diagnostic scan (7.1%) of which full scans were acquired for 3 patients.

For 3-point compression scans, both raters showed a 100% sensitivity for DVT-diagnosis, with specificities of 62.50% and 65.00% respectively. Negative predictive value (NPV) was 100% for both reviewers and positive predictive value (PPV) 16.67% and 17.65%. 93.02% of scans were of diagnostic quality (ACEP ≥ 3) for both raters, average scoring was 3.86 (±0.25) and 3.84 (±0.12).

Subgroup analysis for 2-point compressions showed an increase of specificity to 63.64% and 68.18% with Sensitivity and NPV remaining at 100%, showing no DVT missed when excluding the thigh compression. PPV 15.79% and 17.65%. 100% of ACEP image quality scores were of diagnostic quality for both reviewers. Average scores increased to 4.40 (±0.12) and 3.87 (±0.06).

Conclusion: Machine learning methods can safely aid non-experts in acquiring valid ultrasound images of venous compressions. These can then be externally reviewed for final expert triage and potential diagnosis, resulting in a very high NPV. This ensures that all patients receiving a negative result from the remote expert were in fact DVT-negative. Over 90% of scans taken by a non-expert with the help of AutoDVT were of diagnostic image quality, this increased to 100% with 2-point compression exams excluding the thigh. This study constituted a small dataset with

only few positive DVT cases, representing an average rate of positive to negative cases in clinical settings. The proposed remote triage and diagnostics method allows for fast screening at the point-of-care, without the need for an expert radiologist present, thereby reducing costs, need for patient transportation, and possible disease transmission in COVID-settings.

Non-invasive diagnosis of deep vein thrombosis from ultrasound imaging with machine learning.

Kainz, B., Heinrich, M.P., Makropoulos, A. et al.npj Digit. Med. 4, 137 (2021). https://doi.org/10.1038/s41746-021-00503-7

Objective: To investigate a deep learning approach for the guidance of image acquisition and automatic interpretation of compression ultrasound images. Our method provides guidance for venous ultrasound and aids non-specialists in detecting deep vein thrombosis (DVT).

Methods: We train a deep learning algorithm on ultrasound videos from 255 volunteers and evaluate on a sample size of 53 prospectively enrolled patients from an NHS DVT diagnostic clinic and 30 prospectively enrolled patients from a German DVT clinic. To assess the potential benefits of this technology in healthcare we evaluate the entire clinical DVT decision algorithm and provide cost analysis when integrating our approach into diagnostic pathways for DVT.

Results: Algorithmic DVT diagnosis performance results in a sensitivity within a 95% CI range of (0.82, 0.94), specificity of (0.70, 0.82), a positive predictive value of (0.65, 0.89), and a negative predictive value of (0.99, 1.00) when compared to the clinical gold standard. Our system is estimated to generate a positive net monetary benefit at costs up to £72 to £175 per software-supported examination, assuming a willingness to pay of £20,000/QALY.

Conclusion: This study describes the first step of a larger clinical trial programme which we will use to ultimately evaluate the clinical efficacy of the AutoDVT software for the diagnosis of proximal DVT. The study we describe confirms that the AutoDVT software can diagnose DVT accurately. Our study shows the potential of a ML-powered system using ultrasound to identify DVT in clinical populations with high-throughput requirements and at the primary care level. Since access to ultrasound imaging is increasing and amplified through cost-effective mobile ultrasound devices, a machine learning-supported examination by non-specialist health care workers has the potential to be adopted for proximal DVT detection and screening.

Clinical Evidence Cited by the Instructions for Use

Instructions for Use of ThinkSono Guidance are available at https://thinksono.com/ifu.

The clinical evidence referenced by the Instructions for Use originates from data presented by Oppenheimer et al (2023) and Nothnagel et al.[8][9]. Oppenheimer at el consented a total of 76 patients and Nothnagel et al consented a total of 91 patients, totalling the 167 patients referenced in the Instructions for Use. Note, that at the time of writing the Instructions for Use, the clinical investigations presented by Avgerinos et al, Curry et al and Speranza et al were still actively recruited patients and hence are not referenced in the Instructions for Use (v1.0).

Compression ultrasound protocols: 2-point, 3-point and full-leg ultrasound

Point of care compression ultrasound (POCUS) for detection of proximal DVT has been validated against duplex ultrasound by a large body of literature spanning tens of thousands of patients, with sensitivity and specificity of proximal compression ultrasound each above 90% [1][10]. Compression ultrasound may be performed as a "2-point" exam, compressing the common femoral vein in the groin and the popliteal vein behind the knee, or as a "3-point" exam, including the femoral vein in the thigh as well. Globally, studies have shown excellent sensitivities, specificities, and NPVs above 90% for both 2 and 3-point compression ultrasound, though some demonstrate a higher sensitivity with 3-point compression ultrasound [10][11].

A 3-point ultrasound has been shown to provide accurate and timely results in NHS Trusts, and is a standard component of the Focused Acute Medicine Ultrasound accreditation pathway of the Society for Acute Medicine (FAMUS), the UK's national representative body for acute medicine professionals [12][13].

The ThinkSono guidance system follows a 3-point compression ultrasound exam protocol.

Full-leg ultrasound scans including the calf are not part of the point of care ultrasound recommendations for the diagnosis of DVT. The NICE Guidelines only consider proximal DVT ultrasound and The American College of Emergency Physicians (ACEP) and the Society of Radiologists in Ultrasound recommend the 3-point compression ultrasound protocol as the most appropriate [14][15][3].

Below-knee POCUS has reported sensitivities ranging from 57% to as low as 38%, raising questions of its clinical utility [16][17]. It is also considered to be very operator and patient dependent, and reliability is a challenge [18]. Even if isolated calf DVTs are detected, benefit from treatment has not been consistently demonstrated [18][19][20]. These are hypothesised to be among the reasons that venous thromboembolic outcomes are equivalent following negative proximal compression ultrasounds and full-leg compression ultrasounds [18][21][22].

Given the performance characteristics and failure to impact outcomes of calf ultrasound for DVT, guidelines, including NICE, conclude that proximal compression ultrasound protocol with a 6-8 day follow up is safe and effective, although variation does exist in clinical practice between NHS Trust. To rule out DVT *without* a 6-8 day follow up, a negative d-dimer may be used with a negative proximal compression ultrasound as stated in [NICE Venous thromboembolic diseases: diagnosis, management and thrombophilia testing 1.1.7](https://www.nice.org.uk/guidance/ng158) [3].[1]

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[1] A visualisation of the NICE-recommended DVT pathway is available at https://www.nice.org.uk/guidance/ng158/resources/visual-summary-pdf-11193380893

In any case, ThinkSono Guidance will follow the current and any future NICE guidelines recommendations and may update the software to incorporate a below the knee DVT compression ultrasound protocol if required by specific NHS Trusts or other relevant bodies.

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