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Professional Practice Report

Establishing a Pan-European, multi-disciplinary taphonomic research Infrastructure: The 'UK-Netherlands decomposition experimental research (UNDER) Group'

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ABSTRACT

This study unveils the establishment of the United Kingdom-Netherlands Decomposition Experimental Research (UNDER) working group, marking a pioneering initiative in practical Forensic Taphonomy within the UK. Our primary objective was to craft a cohesive multidisciplinary framework, designed to ethically orchestrate, execute, and assess human decomposition. Concurrently, we aimed to amass data through human burials, fostering collaboration among diverse forensic experts across Europe. The compilation of data collected over the year, elucidates the comprehensive utilisation of cadavers through a multifaceted scientific methodology. This paper discusses the triumphs, challenges, and innovative solutions encountered during this undertaking, providing a blueprint for forthcoming European research in Forensic Taphonomy. Our efforts support the comparability of longitudinal studies and give strategies to address the challenges posed by the scarcity and diversity of human donors in forensic science. Moreover, we propose the adoption of a dynamic scientific research management framework, which includes thorough identification, measurement, analysis, and application of solutions. Emphasis is also placed on adeptly managing business processes to ensure sustained relevance in both research and other stakeholders.

1. Introduction

There are currently 12 human taphonomy facilities (HTFs) worldwide, located in the United States, Canada and Australia, plus the ARISTA facility in Europe [1] producing valuable data designed to improve current standards within operational forensic science [2,3,4]. Geographical differences in decomposition are well-founded in existing studies [5,6], making it imperative that human taphonomy facilities are more widely established to gather robust, relevant datasets for local casework comparisons as well as for studying international geographical variations. For more than a decade in the United Kingdom (UK), several researchers from a wide array of disciplines have attempted to establish

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a HTF [7,8], but with efforts hampered by site location limitations, legislation and financial constraints. A HTF is perceived by some as overdue, necessitating input from both scientific and operational domains within forensic science. Its benefits include implementation of standards within the criminal justice system, making forensic taphonomy evidence and intelligence robust and reliable, such in cases of 'no-body' convictions [9,10]. These can be difficult to prosecute as they primarily rely upon circumstantial evidence, but it has been possible [11]. Forensic science has the responsibility to assist the courts to exonerate as well as convict, relying on research to highlight the complexities relating to evidence [12].

Cross et al (2010) described the establishment of an animal-based taphonomic research facility (Preston, UK), to overcome the absence of an HTF in the UK. This report identified issues including site selection, biosecurity and the considerable investment of time and resources to address the external government level agencies, local community, and the numerous government legislative acts that required addressing in the application and in the monitoring phases of the facility. HTF establishment can spark controversy, but their value is becoming recognised [7,8]. The use of cheaper animal models in higher replicates [13] to continually test, validate, and expand research, whilst supporting an indication of an existing taphonomic process, cannot fully substitute human material [9], as shown by multiple disparities [14–18]. Animals cannot replicate human donor variability in origin, diet, level of exercise, weight, and manner of death, which complicates within-human comparisons [8].

In 2018, the Forensic Science Regulator and Crown Prosecution Service released a directive regarding the admissibility of evidence; it must be relevant and reliable [19]. Uncertainties loom regarding the reliability of employing animal models to gather data or address inquiries pertaining to human decomposition, and expert witnesses are mandated to testify solely on matters within their area of expertise and backed by relevant experience. Presently, the pool of individuals in the UK possessing knowledge and experience regarding human decomposition is very small. Extrapolating findings from animal studies introduces the risk of facing criticism from opposing counsel in court. As articulated by Wallman [20], "by granting access to actual human cadavers rather than non-human proxies, HTFs can serve as a crucial mechanism for upholding evidentiary standards within disciplines such as forensic entomology and mitigating the reliance on unreliable assumptions". Recent research conducted at various HTFs, where human and animal cadavers have been allowed to decompose simultaneously, has shown that animals decompose differently to humans [21–25]. Future taphonomic research should therefore include the use of human remains rather than limiting experiments to the use of just animal analogues [5,21,23,24].

The establishment of ARISTA in Europe [1], which opened in Amsterdam in 2018, lagged behind others by several years [2,3]. The UK is still experiencing this delay and to help move forwards, a pan-European, multi-disciplinary, collaborative research group was formed. This paper describes the construction of the United Kingdom-Netherlands Decomposition Experimental Research (UNDER) group established in 2018, that has been working at the ARISTA facility, whose goal is to a) expand the current understanding of HTF facility management for development of a UK facility in future and b) study human decomposition in Europe. Some of the current HTFs attract excellent 'resident' researchers to explore a wide variety of taphonomic variables within their own specific discipline [2,3,26]; the UNDER group is aiming to bring a wider range of expertise together, more collaboratively, than has previously occurred in Europe, to truly achieve the multi-disciplinary goals for taphonomic investigation. The group comprises a non-hierarchical group of stakeholders, including academics, researchers and practitioners from primarily across Europe (Table 1), who have come together collaboratively to maximise whole-body-donor usage, paying full respects and ethical duty to them, embodied in the Declaration of Helsinki (as later outlined). We demonstrate a framework aimed at advancing ethical and methodologically sound practices within police, forensic, and biological scientific investigations. Data will be presented in future publications.

Table 1
List of collaborating organisations as part of the UNDER consortium.

Organisation (alphabetical)	Country of Origin
Amsterdam University Medical Centre (AMC) Academic Medical Centre	Amsterdam, The Netherlands
Coventry University	Coventry, UK
Dutch Police	Amsterdam, The Netherlands
Keele University	Stoke-on-Trent, UK
Linnaeus University	Vaxjo, Sweden
Netherlands Forensic Institute	The Hague, The Netherlands
Northumbria University	Newcastle upon Tyne, UK
Saxion University	Enschede, The Netherlands
Staffordshire University	Stoke-on-Trent, UK
University College London	London, UK
University of Central Lancashire	Preston, UK
University of Leicester	Leicester, UK
University of Lincoln	Lincoln, UK
University of Portsmouth	Portsmouth, UK
University of Salzburg	Saltzburg, Germany
University of Wolverhampton	Wolverhampton, UK
Université du Quebec à Trois Rivières	Quebec, Canada
Vrije Universiteit Amsterdam	Amsterdam, The Netherlands

Although numerous journal articles on scientific aspects of human forensic taphonomy have been published over the past 20 years [26–29], with worldwide consideration, there has been a limited number of reports concerning elements of the facility structure [1–3]. In this paper, we report for the first time the operational activities of the only European outdoor facility that allows exclusively for the burial of human donors for research purposes. This includes the importance of identifying developmental policy, practice, procedure, and protocol. It reports upon the flow process and mechanisms by which such facilities can effectively operate ethically and productively in Europe; especially in the light of a diverse, large group of stakeholders from over eighteen organisations – the UNDER group. It also indicates operational requirements to maximise the generation of complex diverse data sets, varying from analytical chemistry to the compilation of facility photography – the integration of which contributes to a holistic approach to move forensic taphonomy forward, particularly in the UK and Europe.

2. The ARISTA facility

The ARISTA facility, a burial-only site or 'Forensic Cemetery', was created and developed by Professor Roelof-Jan Oostra and Professor Maurice Aalders at the University Medical Centre (UMC) located in Amsterdam. The first two donors were buried at the facility on the 20th of March 2018, receiving considerable news coverage [1]. It is a facility open to any self-managing research group to use, with donors from the UMC and experimental design and completion controlled by the research group. An image of the facility can be seen in Fig. 1.

The body donation program and the related legal guidelines in the Netherlands have been reported by Oostra et al (2020). Unlike in the United Kingdom, there is no European equivalent of the Human Tissue Act that needs to be considered when applying for licensing of premises and/or for the storage of human tissue for research purposes.

The layout of the ARISTA facility is shown in Fig. 2. The details of the building structures, the telemetric sensing and video surveillance facilities are outlined in Oostra et al (2020). Additional Lux sensors were added on site, to record temperatures across the site at different times of the day.

3. UNDER project management – workflow

An initial visit by some of the authors to ARISTA took place in 2018,

Fig. 1. Image of ARISTA Facility (two weeks before working group donor placement).

hosted by the facility partner (Amsterdam Medical Centre, AMC), which instigated whole group discussions and identification of potential research projects involving human subjects and human tissues for forensic, policing, and biological scientific studies. To maximise the data gathered from the donors, it was deemed essential to work in a way that did not adversely affect the validity of each researcher's work. The value of this multi-disciplinary approach to research was not underestimated, as the aim was to provide the baseline data and ethical working structure for the successful development of a future UK HTF. The UK-Netherlands Decomposition Experimental Research (UNDER) group was therefore founded to realise this vision.

Newly created taphonomic facilities in recent years have focussed on a discussion surrounding the approval and permission aspects (legal and ethical, geographical etc.) of these facilities [1,2]; a primary reason for the absence of a current UK HTF. This report focuses more on the practicalities that influenced the experimental design and conduction of taphonomic experimentation. Although it might appear straightforward, the actuality of navigating through multiple layers of requirements, all of which are bound by the critical factor of 'time since death' and the relentless progression of the decomposition process, mean that this was a complex and multi-dimensional investigative endeavour. This complexity is inherent in ensuring the optimal outcome for each individual donor. As per research groups operating at other HTF's, the UNDER group strive to optimise whole-donor-body usage to ensure that we conduct fully respectful and ethical research, with respect to the donors wishes. The principles embodied in the Declaration of Helsinki, regarding the use of donated human remains from the Amsterdam Medical Centre, have been followed. In particular, but not exclusively; ensuring respect for all human (deceased) subjects who have donated voluntarily through informed consent, protecting their confidentiality and rights; based on a thorough knowledge of the scientific literature and grounded in generally accepted principles; appropriate ethics, education, training and qualifications for the research and its investigators; and all ethical, legal and regulatory norms and standards followed.

The nature and scope of creating a working system within the ARISTA site for multiple individuals (UNDER in this instance) and numerous organisations required careful consideration, as each stakeholder had different requirements, expectations, and planned outcomes, which had to be accommodated with flexibility and built in processes. This complex network, therefore, required the construction of a workflow process. This may be evaluated as a series of sequential tasks that are carried out based on user-defined rules or conditions. It is a collection of data, rules, and tasks that need to be completed to achieve the specific outcome, in this case, experimental data collection. The workflow process was complex in that it had to be designed around the needs of the wider community (the ARISTA programme), fit within the needs of the umbrella organisation of the UNDER group (18+ organisations), cater for the individual stakeholders (researchers in many forensic disciplines), whilst considering the donors' ethical rights. This required a comprehensive framework, demanded substantial effort, time, and logistical coordination to assemble staff from across Europe and beyond to converge in Amsterdam. Ensuring the availability of donors added another layer of complexity, as did sourcing the necessary equipment, much of which was either borrowed or repurposed from the respective institutions of stakeholders. The spectrum of technology and equipment ranged from fundamental tools like digging implements and body bags to sophisticated and expensive resources such as mobile chemical analytical equipment, 3-D scanners, and thermal imaging kits.

The facility is a short flight (1.5 h) from any southern UK airport, making it readily accessible for UK researchers. When regular in-person visits were limited, communication was maintained by online conference calls through Microsoft Teams. This made it very flexible and effective when multiple invitees from around the world were required to attend as well as the sharing of live links and documents. For those who were unable to attend, all online meetings were recorded. This was more

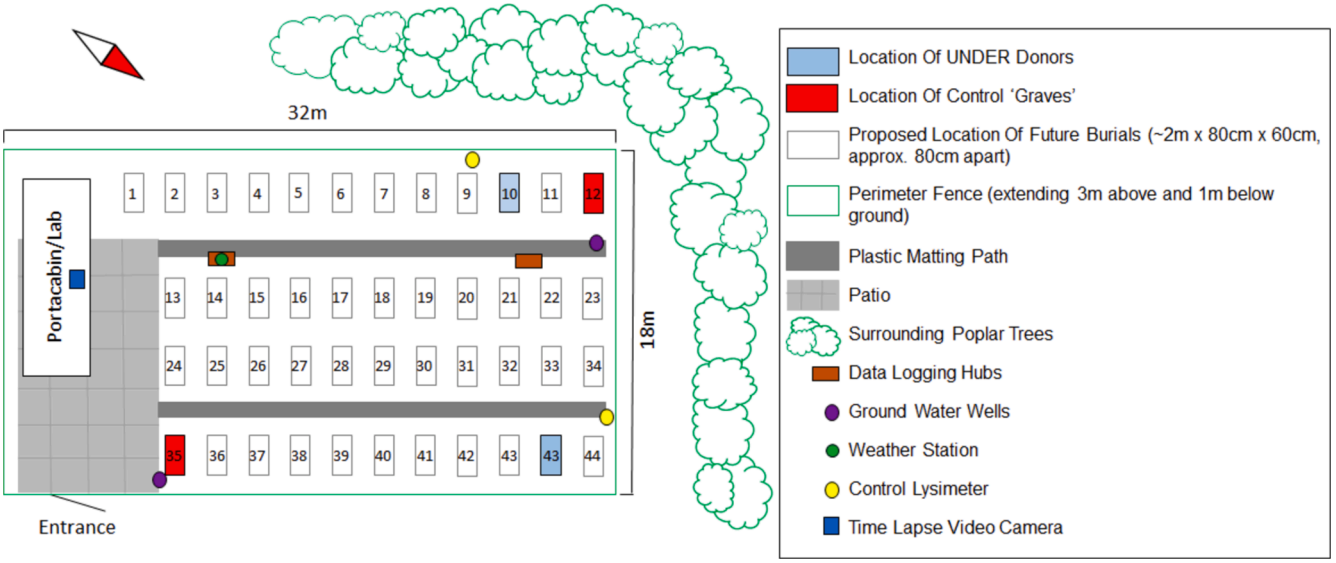

Fig. 2. Schematic of ARISTA site.

beneficial when restrictions on travel were made during the coronavirus pandemic, helping to ensure progress on research was still being conducted.

The management of such a large multi-faceted group was at the heart of the discussion. Apprehension among researchers in some areas to collaborate can result in feelings of encroachment on their autonomy [30]. Resolving this issue requires a significant cultural transition within the academic ethos, whereby research ownership, to some extent, sits with an institution. In this context, the 'institution' refers to the UNDER consortium, which aims not to impinge upon the disciplinary priorities of individual researchers but instead recognises the importance of collaborative work within this framework. The objective was to ensure that the outcomes, namely the data generated, became collective property (hence reflected in all joint research publications), with clearly defined priorities outlined by the 'Objectives set by the 'Gentlemen's agreement[1]'' (described below) at the inception of the UNDER project.

To achieve a vision of producing a baseline dataset and logistical, strategic, and ethical working practices, the following aims for the UNDER project were designed:

1) work collaboratively to design a multi-disciplinary, mutually beneficial series of experiments
2) maximise ethical, whole-body data collection opportunities throughout the mortuary, burial, and excavation process
3) disseminate findings in such a way that benefits all members of UNDER and associated parties, including operational personnel.

4. The research strategy

The universities and organisations that form the UNDER consortium can be seen in Table 1. There may be more than one individual from each organisation, however, due to considerations related to safe and efficient working practises, during experimentation a maximum of one stakeholder per institution was permitted on site. Experimental planning and data discussions, with all associated researchers, were hosted by videoconference.

Institutions and individuals were invited to contribute to the collaboration, with a small financial donation towards the administrative costs of running the UNDER project at the ARISTA facility. If this was not possible, then where reasonable, expertise input was valued just as highly and therefore seen as essential to the overall vision and achievement of UNDER objectives. Managing development of the collaborations was an initial challenge due to the number of stakeholders involved. A 'Memorandum of Understanding' between the different institution's legal teams proved impossible due to time and logistical issues related to institutional level bureaucracy rather than individual stakeholder reticence. Instead, it was collectively agreed that the UNDER working group would work under a "gentleman's agreement", to work towards a shared vision and goal.

Initial research data discussions, with the whole UNDER group, began by considering the two donors at the core of the planned work, specifically the features, examples of which include sex, age, weight, and cause of death. The UNDER group were limited to two donors due to financial constraints for the operational costings of ARISTA. It would have been ideal to have both (or even more) donors of similar sex, stature, and weight etc – however, the group chose not to further delay research and planned to initiate practical work in the summer of 2019. The reason for this haste in activity was to allow for entomological and microbial metabolic studies to be implemented in the summer rather than in the winter as research has shown a higher activity in higher temperatures [31]. Since it is known that pre-mortem medical interventions, such as chemotherapy, can affect post-mortem decomposition [32], the planned protocol was to use donors where this treatment had *not* been administered prior to death. However, due to the need to conduct human studies before the winter, it was not possible to stipulate this. Otherwise, knowing our donors' medical history would suffice for this baseline study, allowing data to be interpreted based upon this knowledge. It was also decided that although most bodies are buried in clandestine graves clothed [33–36] the donors in this baseline study would be unclothed, to minimise this additional variable effect of clothing such as chemical interaction from the garment's fabrics and dyes etc. As a result, the donors chosen were: Caucasian, male, and over 70 years old (76, 78 years old). The donors were refrigerated at the AMC after death for 7 and 12 days prior to burial to prevent pre-burial decomposition, and their medical history and cause of death (heart failure, metastatic carcinoma) were provided, indicating the latter had received chemotherapy. These donor limitations were accepted by the UNDER group for this study and should be discussed for any future work conducted at ARISTA, regarding the potential impact on data gathered. The facility and overarching body donation process itself has been approved by the ethical committee at the Amsterdam Medical Centre [1], with individual research processes being approved by institutional ethics committees.

The approach to the multi-disciplinary research was such that when opening discussions about individual ideal experiments, three factors were considered, which were refined into the aims previously stated:

1) Maximising the opportunity — obtaining as much research data from the donors as possible, not only for scientific purposes but to fulfil ethical and moral obligations to the donors and their family's generosity.
2) Having only two donors for this baseline experiment meant for minimal replication, and as such, invasive tests would occur on one body only. This was to ensure that an unexamined 'control' could be used to correlate any measurements/ observations. This therefore meant that both donors had to be exhumed simultaneously to allow complimentary comparisons.
3) As far as possible, all sample collection was designed to not interfere with or impact on other data collection / validity, to minimise cross-experimental interference and contamination.

Both graves were 12 m apart on either side of the ARISTA facility, with no recent graves filled between them, which follows the overall ARISTA plans for future donor spacing. One of the graves was within reach of the data logger probes for sub-surface, above body and internal body cavity temperature monitoring (as seen in Fig. 2). This data, along with that from the weather station (ambient temperature air temperature, humidity, wind speed and precipitation), lux metre and video surveillance cameras, was accessible at any given time and allowed for interpretation at any opportunity. An initial mind map recorded an array of ideas, attempting to cover as many research avenues as possible (see Fig. 3). This was narrowed down to focus upon the expertise of the researchers initially involved in the UNDER consortium, and what could be conducted on one donor without affecting other sampling protocols. Research plans were drafted by all UNDER group researchers and collaboratively assessed by the group for cross-experimental functionality and indeed interference. (See Fig. 4.Fig. 5.).

The research strategy (see Table 2) was implemented after careful consideration and discussion (in no order of priority).

For each of the various areas of analysis, a standard protocol was agreed upon. This was based on current best practice and mainly came from research published around the specific analysis. Many of these were based on journal articles that have published around the subject matter, as limited method development has been conducted to validate methods [37,38] – greater detail is discussed below.

[1] *A gentlemen's agreement is an informal and legally non-binding agreement between two or more parties. It is typically oral, but it may be written or simply understood as part of an unspoken agreement by convention or through mutually beneficial etiquette.*

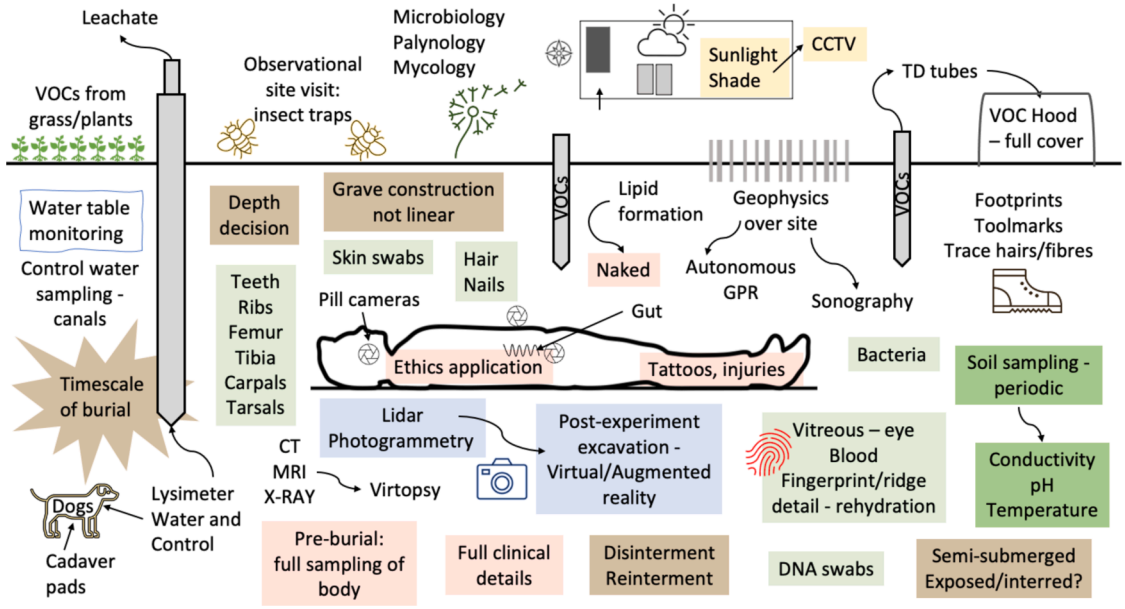

Fig. 3. Initial concepts for UNDER preliminary study, highlighting all considered research datasets to maximise donor use. VOC – volatile organic compounds; TD – thermal denaturation; CCTV – closed-circuit television (video surveillance). Brown shading indicates burial factors, red indicate pre-burial consideration, blue indicate imaging, green highlights cadaver-based sampling, yellow indicates site monitoring. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 4. Snapshot of Geo-imaging protocol (Netherlands Forensic Institute).

Fig. 5. Snapshot of Entomology protocol (University of Portsmouth).

Table 2
Planned sample analysis considered for UNDER preliminary study.

Experimentation	Control Site & graves	Donor 1	Donor 2
Ground water-table monitoring	Y		
Geophysical examinations	Y		
LIDAR	Y		
360 photography/photogrammetry (site and grave)	Y	Y	Y
Solar radiation and sun/shade passage	Y	Y	
Botany – plants/grasses	Y	Y	Y
Soil (lipids/adipocere)	Y	Y	Y
Soil conductivity, pH, and temperature data	Y	Y	Y
Grave construction marks (tools/ footwear)	Y	Y	
Pre-burial Imaging		Y	Y
Post-exhumation Imaging		Y	Y
Fingerprinting	Y	Y	
Body identification mark changes		Y	Y
Entomology	Y	Y	Y
Leachate	Y	Y	Y
VOCs	Y	Y	
Diagenesis and proteomics		Y	
Contact-lens degradation		Y	Y
Isotope analysis (soil and vegetation)	Y	Y	Y

5. Development of standard operating procedures (SOP), sample & data collection, storage and processing

The donors were initially examined in the mortuary at the AMC hospital located 300 m from the ARISTA facility. UNDER scientists and practitioners collected a variety of pre-burial samples from the donors with standard mortuary practice photography being taken by the staff of the AMC. This was based on the agreed analysis being conducted, as well as the potential for additional scientific exploratory research to be conducted in the future (for example, a range of DNA swabs were taken; buccal, ear, nose, genitalia, axilla, groin and foot swabs). These were stored in refrigeration at an institution with human tissue license until the costs / organisation was found to undertake this aspect.

Standard Operating Procedures (SOPs) were generated by all those

individuals leading on discipline specific aspects of the research themes, such that others could collect samples when visiting the site. Risk assessments were the responsibility of each individual researcher conducting their discipline-specific experiments/analysis. These SOPs and risk assessments were peer reviewed by other UNDER colleagues for quality control, thereby enabling prioritisation based on the multi-disciplinary approach to the larger scale of the study, and if possible, were accompanied by photos and short video guides produced on a mobile phone. This was done for the collection of materials such as entomological and leachate samples, which were sampled over 11 weeks. Once these SOPs and risk assessments were checked and edited, they were electronically stored in secure, restricted access Google Drive, and made available for sharing, for demonstration and training purposes, as one of the planned outcomes for this project. The methodologies used will be published in later, results-focussed articles.

All samples collected were itemised via a standard coding system, given individual sample numbers, and entered into a central Microsoft Excel database. The physical storage was specific to the sample type. For example, soil samples were stored in the facility refrigerator to ensure limited siloxane contamination (which can cause background contamination during chemical analysis). Sample storage information was included in the SOPs created by each researcher in their respective fields. The locations of the samples were indicated and updated in the database when samples were moved from the ARISTA site to individual institutions across Europe. It became the responsibility of individual researchers to log the locations and conditions of these samples in the Google Drive database once they were removed from the ARISTA site. Specific attention was paid to (UK) institutions which fell under the Human Tissue Act licensing requirements. However, it was agreed that every sample could be requested for examination or returned to ARISTA at any time, unless destructively tested. For this project, individual barcodes for samples were discussed, but despite this being the gold standard of sample continuity, this was determined to be prohibitively expensive since only limited funding was available. Of course, this would be an appropriate development in the logging of materials generated by the UNDER group in future projects.

6. Exhumation and subsequent internment

To support ethical processes including respect for the donors, sample integrity, and a strict forensic approach, exhumations were fully documented by video and photographic means (Nikon D3300, GoPro Hero Black, Garmin Virb 360). The examination was conducted according to best practices set by the European Network of Forensic Science Institutes (ENFSI) Forensic Archaeology subgroup. Forensic archaeologists employed by the Netherlands Forensic Institute were onsite to support and advise the wider group about 'best practice'. This included identifying new methodologies as part of their discipline-specific developments to establish the order in which bodies were exhumed, taking special consideration to not contaminate open graves. Pre- and *peri*-exhumation samples were taken to allow subsequent identification of any potential contamination, for example, unwanted insect colonisation not associated with the burial or exhumation processes. Personnel were present on a "need to be" basis (maximum one per institution), to prevent overcrowding in the ARISTA facility and to reduce any potential contamination between ongoing experiments, as well as any contamination of the overall ARISTA site. Any other requests were conducted remotely using videoconferencing, with detailed instructions for those on site. The issues of data protection were considered during all communications and no specific details or images were sent. Both bodies (125–2019 and 127–2019) were placed in September 2019, and then individually excavated on the following dates: 1st July 2020 (127–2019) and 8th July 2020 (125–2019). In both these instances the purpose was to CT scan and perform an autopsy to establish decomposition stages. They were then re-buried, where they remain.

7. Cloud data storage and sharing

Currently, data in all forms has been shared amongst almost 50 individuals across 18 different organisations, ranging from universities to police services. This was facilitated by a secure shared online repository, using Google Drive, giving editing permissions to others as they joined the UNDER group. Once all data collection had been completed, the data was collated and stored utilizing an external hard drive.

General Data Protection Regulation (GDPR) compliance, including anonymity of donors, was maintained throughout the project. Keeping such data secure (although no donor personal or identifiable data is known or stored), and allowing for regular additions, updates, and version control of documentations, is challenging. Hacking of cloud-based data is recognised by users of cloud-based storage systems, but considered to be sufficiently rare, and thus allows confidence in having sensitive data (numerical, medical, and photographic data) on the cloud.

Whilst Google Drive has allowed the UNDER project to develop, the amount of data generated (high-definition videos and photography) and the rapidity of updates as the experimental work continued, required consideration of alternatives as the longevity of the project was planned. One such system under consideration for future UNDER projects is Visionations 'Crimepad^{R}' [39]. This bespoke software system has been designed for law enforcement officers, detectives, crime scene investigators, and their supervisors to log information and photographs, generate field reports, and collaborate in 'real time' on all the information related to incidents and criminal cases. The current UNDER project may be considered analogous to a double homicide investigated by a pan-European, multi-disciplinary investigative team, and so in essence could sit well with the 'Crimepad^{R}' software and allow its fuller evaluation for use in such environments.

8. Project longevity

This multi-disciplinary approach provided excellent learning opportunities for all researchers and practitioners involved. It also facilitated access to some appropriate student cohorts (Saxion University, Netherlands), since one of the outcomes was to facilitate practical onsite work and teaching of standards and best practices in the policing/forensic/medical fields, which said students may be entering into. Beyond developing contacts throughout the world, those onsite were able to observe, discuss, and photograph & video (UNDER only) the research to use for dissemination/education at their home institutions, but maintaining anonymity of the donors. The key areas necessary to address for the UNDER group to develop further research projects are outlined below:

1. Research funding: While there were opportunities for securing funding, the analysis was largely dependent on goodwill due to the absence of funded, dedicated personnel for the research project. This reliance on goodwill limited the scope of analysis to specific areas, potentially meaning other broader research avenues were overlooked. The absence of funding for a full-time project member made it challenging to obtain resources promptly and precisely, leading to delays and compromises in the research process (Such as collection protocols and timely shipping of samples).
2. Biosecurity: A pressing concern was the need for a more robust system to ensure the security and traceability of samples. Without dedicated personnel to oversee sample management, there was a risk of mishandling or loss. Implementing a comprehensive tracking system would enhance accountability and safeguard sample integrity, but without funding for dedicated personnel, maintaining such a system proved challenging.
3. Publicity strategy: Managing a group seeking to raise its profile posed difficulties, particularly given the sensitivity of the information in the host country. Despite successful execution, there were concerns about whether this focus on publicity inadvertently

hindered efforts to attract additional collaborators. Balancing the need for visibility with the need for discretion was crucial in navigating this complex landscape.

4. Human vs. Animal strategy: The ability to fully compare inter-species variation hinged on access to facilities capable of replicating similar environmental and weather conditions for both humans and animals. Assessing the feasibility of this within the current facility's surroundings was essential, as it directly impacted the comprehensiveness and reliability of research findings in comparative taphonomy studies. Whilst this is not possible at ARISTA, it should be considered for any new facilities proposed.
5. Involving students: While offering the opportunity to observe the process to relevant undergraduate and postgraduate students presented an opportunity for hands-on learning in human taphonomy scenarios, the complex nature of method enhancement and sampling procedures necessitated guidance from experienced practitioners. Balancing the educational value of student involvement with the need for expertise, was a critical consideration in optimising the research process. Any additional support for students was offered by the AMC.

9. Conclusions and future prospects

The UNDER project had distinct goals focussed around the two donors, although no specific start-finish timelines were planned. The work was halted by the national and international lockdowns associated with the COVID-19 pandemic, with exhumations and reburials requiring alternative arrangements, so, often, strategies were formulated by means of online video calling. Fortunately, the timing was such that the pre-burial data collection, burial, and reinterment had been concluded, allowing for physical sampling and for medical imaging technologies, before the first lockdown. One key objective was to identify the paradigm structure in which many stakeholders, both academic and practitioner, interacted, that was conducive to a multi-disciplinary investigation. Such a process is developing in European forensic taphonomy and as such required a new philosophy and strategy for the interaction, discussion, and development of the experimental work and data interpretation.

Previous published reports [1,2] have focussed on offering examples of their facilities to assist in the establishment of future Human Taphonomy Facilities and in doing so, contributed to the expansion of global accessibility of human decomposition research and practitioner skills. However, we have shown the beginnings of a paradigm structure that sits within this, in terms of the interaction of various disciplines, and how stakeholders design, develop, mitigate, investigate, record, and decipher the complex levels of data sets generated in this rapidly evolving discipline of human forensic taphonomy.

The next stage following this journal article involves the deployment of dedicated personnel to distribute current samples, oversee the coordination of ongoing analyses and compiling the results obtained already into a comprehensive results paper. Following this, the intention is to repeat the original experiments in a second phase of the UNDER Project. The emphasis will be placed on ensuring project longevity and formulating next-stage plans informed by the insights gained from Project 1. Whilst geographical differences between the UK and The Netherlands undoubtedly exist, the UNDER group will continue to work at ARISTA to build a more robust, European human taphonomy dataset, for which comparison with UK animal decomposition and human casework can be attempted. Mitigation strategies will be developed to address any challenges identified, while continual advancements in standards for the study of human decomposition will be pursued to enhance the scientific understanding in this field.

10. Ethics Statement

We confirm that this research has favourable ethical opinion from Staffordshire University Research Ethics Committee, which was adopted by all institutions involved.

The principles embodied in the Declaration of Helsinki, regarding the use of donated human remains from the Amsterdam Medical Centre, have been followed. In particular, but not exclusively:

- Ensuring respect for all human (deceased) subjects, protecting their rights
- Generation of new knowledge, with respect and precedence over the donors rights and interests
- Maintaining dignity, right to self-determination and confidentiality of personal information
- All ethical, legal and regulatory norms and standards followed
- Conducted in a manner than minimizes possible harm to the environment
- Appropriate ethics, education, training and qualifications for the research and its investigators
- Based on a thorough knowledge of the scientific literature and grounded in generally accepted principles
- Experimental design is clearly described and justified
- Voluntary informed consent from the human donors, for forensic research at the designated site

CRediT authorship contribution statement

J. Brooks: Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Project administration. **A. Jantzi:** Investigation, Data curation, Funding acquisition. **K. Brown:** Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration, Funding acquisition. **W. Birch:** Conceptualization, Validation, Resources, Data curation, Writing – original draft, Funding acquisition. **L. Lijcklama a Nijeholt:** Investigation, Data curation. **C. Rogers :** Conceptualization, Validation. **H. Mickleburgh:** Investigation, Data curation, Visualization. **P. Randolph-Quinney:** Investigation, Data curation, Visualization. **L. Kootker:** Methodology, Validation, Investigation, Resources, Data curation. **M. Aalders:** Methodology, Validation, Investigation, Resources, Data curation, Visualization, Supervision. **R.J. Oostra:** Validation, Resources, Supervision. **A. Williams:** Conceptualization, Validation, Resources, Writing – original draft, Project administration, Funding acquisition. **C. Hiley:** Conceptualization, Validation, Resources, Project administration, Funding acquisition. **J. Everett:** Methodology, Validation, Investigation, Resources, Data curation. **J.P. Cassella:** Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Visualization, Project administration, Funding acquisition.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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