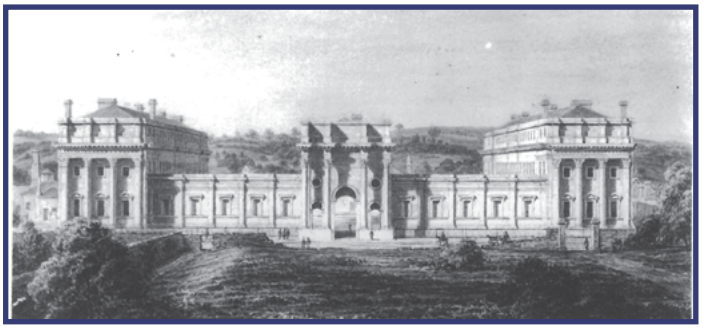
Post Excavation Assessment

Radcliffe Infirmary Burial Ground

Oxford



Post Excavation Assessment

oxfordarchaeology south

November 2014

NGR: 450900 207100

Radcliffe Infirmary Burial Ground, Oxford

Post-excavation assessment and project design

By Louise Loe, Mark Pollard, Mark Gibson and Andrew Simmonds

with contributions by John Cotter, Alice Parkin, Ian Scott, Ruth Shaffrey and Lena Strid

Edited by: Paul Booth

Illustrator: Lucy Gane

Report Date: November 2014

Report Number:	N/A
Site Name:	Radcliffe Infirmary Burial Ground
HER Event No:	
Date of Works:	June 2013 – August 2014
Client Name:	RB Development Ltd, on behalf of the Estates Department, University of Oxford
Client Ref:	OX/5575/13
Planning Ref:	
Grid Ref:	450900 207100
Site Code:	OXIB13
Finance Code:	OXIB EX/PXA/PUB
Receiving Body:	Oxfordshire Museums.
Accession No:	OXCMS : 2013.86
Prepared by:	Louise Loe
Position:	Head of Heritage Burial Services
Date:	November 2014
Checked by:	Paul Booth
Position:	Senior Project Manager
Date:	November 2014
Signed:	.....

Disclaimer

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Oxford Archaeology being obtained. Oxford Archaeology accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person/party using or relying on the document for such other purposes agrees and will by such use or reliance be taken to confirm their agreement to indemnify Oxford Archaeology for all loss or damage resulting therefrom. Oxford Archaeology accepts no responsibility or liability for this document to any party other than the person/party by whom it was commissioned.

Radcliffe Infirmary Burial Ground, Oxford

Post-excavation assessment and project design

By Louise Loe, Mark Pollard, Mark Gibson and Andrew Simmonds

with contributions by John Cotter, Alice Parkin, Ian Scott, Ruth Shaffrey and Lena Strid

Table of Contents

List of Figures

List of Plates

List of Tables

Summary

Between June 2013 and August 2014 Oxford Archaeology undertook an archaeological watching brief and excavation at the former Radcliffe Infirmary burial ground, Oxford. This was in addition to recording of the boundary wall on the south-west side of the site. The works were commissioned by RB Development Limited, on behalf of the Estates Department, University of Oxford, in advance of the development of the site as the Blavatnick School of Government. This document comprises a post-excavation assessment and updated project design for the site archive generated by the investigations.

Non-burial features revealed during the works include a probable former gateway, two possible prehistoric features and possible 18th century quarry pits. Features relating to the burial ground totalled 386. They included 358 graves, each containing a single inhumation; 23 shallow pits containing amputated (or probably amputated) limbs and five charnel pits containing two partially articulated skeletons and a quantity of disarticulated bone. The majority of the graves were aligned NE-SW and were divided into two groups, separated by a path. No grave markers were encountered and artefacts primarily comprised the remains of coffins. Assessment of the skeletons has identified a wealth of data pertaining to demography and pathology, including evidence for surgery. Virtually no evidence for anatomisation was seen and this is perhaps surprising considering contemporary examples. The articulated skeletons comprise the largest hospital assemblage recovered from outside London and the second largest from England.

1 INTRODUCTION

1.1 Project background

1.1.1 This document comprises a post-excavation assessment and project design for the site archive generated by a programme of archaeological fieldwork undertaken by Oxford Archaeology (OA) at the site of the former Radcliffe Infirmary burial ground, in advance of the construction of the Blavatnick School of Government (Fig. 1). This work forms part of a wider scheme of re-development by Oxford University of the Radcliffe Observatory Quarter (ROQ). This report outlines the requirements of the post-excavation project design with reference to Management of Research Projects in the Historic Environment guidelines (English Heritage 2006).

1.1.2 The work was undertaken in response to a Faculty issued by the Diocese of Oxford. An archaeological brief was set by the Diocesan Archaeological Advisor (Munby 2013), in consultation with the Oxford City Archaeologist, detailing the requirements for work necessary to fulfil the conditions of the Faculty, and the work was carried out in accordance with a Written Scheme of Investigation (OA 2013) that was agreed between OA and the DAA, and approved by the Consistory Court.

1.1.3 The main phase of fieldwork was undertaken between June and September 2013 with further watching briefs during March and July/August 2014. In addition, the photographic recording of boundary walls and a watching brief during demolition of the boundary walls was undertaken, in accordance with the requirements of the planning consent.

1.2 Location, geology and topography

1.2.1 The ROQ redevelopment site is centred at NGR 450900 207100. The site, encompassing the former Radcliffe Infirmary burial ground, is bounded to the west by Walton Street, to the south by Somerville College, to the north by the former St Paul's church and to the east by the remainder of the ROQ development (MoLA 2010a, 4).

1.2.2 The underlying natural geology of the area is floodplain terrace gravel (Geological Survey of Great Britain, sheet no 236).

1.3 Archaeological and historical background

1.3.1 The archaeological and historical background to the site are detailed elsewhere (MoLAS 2007; MoLA 2009a; 2009b; 2010a; 2010b; Munby 2013; Purcell Miller Tritton 2010) A summary is provided here.

1.3.2 The Radcliffe Infirmary was a teaching hospital that was established, with its own burial ground, in 1770 within the Parish of St Giles. In 1834-5 part of the burial ground – the northern and southern ends – was conveyed to the Commissioners for Building New Churches for the construction of St Paul's chapel. Following the closure of the burial ground in 1855, when burial activity is assumed to have ceased, the land became a convalescent garden for the adjacent hospital fever wards that lay to the east. In the early 20th century, the burial ground was partly built over by an extension to the eye hospital (1921-1939), formerly the fever ward, and a laboratory to the south,

constructed between 1939 and 1957. The Radcliffe Infirmary site was sold to the University of Oxford in 2003, who have since demolished the hospital in preparation for the proposed re-development.

1.3.3 Several archaeological investigations have taken place at the ROQ development site, including at the former burial ground, prior to and following the demolition of the former hospital. An archaeological evaluation was carried out by Museum of London Archaeology in 2007 and revealed two burials from the Infirmary burial ground, an east-west aligned boundary ditch containing no datable artefacts, and part of a late post-medieval gravel quarry (MoLAS 2007). The latter features are thought to have pre-dated the burial ground (MoLA 2010a). MoLA's investigations also revealed evidence for a middle Neolithic-early Bronze Age monumental landscape in the form of three large ring ditches, Saxon settlement, and structural and horticultural evidence associated with the grounds of both the 18th/early 19th century Infirmary and the adjoining Radcliffe Observatory (MoLA 2010a).

1.3.4 In 2009-2010 MoLA carried out an evaluation within the former burial ground in order to assess its spatial extent and depth, and the density and state of preservation of the burials within it. Comprising two trial trenches, the works revealed a total of 36 individual burials and a pit containing several skeletons, as well as local concentrations of disarticulated human bone (MoLA 2010a). The individual burials were well organised, and aligned at right angles to the main axis of the cemetery (SW-NE), rather than east-west (ibid.). Some burials included evidence for coffins, in the form of wood stains, nails and coffin furniture, such as grips and grip plates. Burial depths varied but were generally between 1.0m and 2.5m below ground level (ibid.).

1.3.5 The human remains revealed during the 2009-2010 evaluation were found to be in a good state of preservation. The majority of the skeletons were male, but the disarticulated assemblage was more varied, including females and juveniles (MoLA 2010a). There was also evidence for medical intervention, in the form of a craniotomy and limb bones exhibiting saw marks (ibid.).

1.3.6 The evaluation also revealed the eastern limit to the cemetery, which comprised a wall foundation to the south and a robbed out continuation to the north. This corresponded well to the position marked on historic maps (ibid.).

1.3.7 Further archaeological investigation by MoLA (2010b), a watching brief during the installation of a new foul water drain in the vicinity of the Radcliffe Infirmary burial ground, recovered a small amount of disarticulated human remains. In addition, articulated human remains were observed in section at approximately 0.5m below the tarmac road surface, although it was not possible to conclude whether the bones had been disturbed. The remains were left *in situ.*

1.3.8 A transcript of the surviving burial register for the Radcliffe Infirmary burial ground was made in 1992 by the Oxfordshire Family History Society. This indicates that a total of 95 burials took place at the burial ground and, in keeping with the osteological findings from the MoLA evaluation, a greater number of male burials is recorded. Aside from a single burial in 1771, all burials took place between 1815 and 1855, and the maximum in any one year was 11, in 1830. The burial records also suggest that many of those

interred were not from Oxford city, but were from elsewhere in the county and further afield (David Clark pers. com).

1.3.9 The transcript of the burial register is part of an extensive collection of historic archive material relating to the Radcliffe Infirmary, held by Oxfordshire Health Archives and hosted by Oxford Health NHS Foundation Trust and Oxfordshire County Council. A comprehensive review of this material is beyond the scope of the present report, although documents that are particularly relevant and are worth mentioning are:

- A return of burials covering the period 1830-1836 inclusive giving the patient's name, parish of residence, date of burial and age at burial.
- A register of operations 1838-74 giving information on the patient's name, the surgeon's name, the procedure (e.g. hernia/ amputation) and the outcome.
- The minutes of the board of governors

1.1.4 Other primary and secondary sources, relevant to the Radcliffe Infirmary Burial Ground, are held at the Bodleian library. A by no means comprehensive list of these is provided in Appendix A.

1.4 Original Research Aims and Objectives

1.4.1 The aim of the programme of archaeological investigation, as stated in the WSI (OA 2013), was to recover the human remains present in that area of the former burial ground within the limits of the Faculty application and the proposed works for the construction of the Blavatnik School of Government by the university of Oxford. The investigation also sought to appropriately record any other significant archaeological features that survived within the site, noting the nearby presence of a middle Neolithic-early Bronze Age monumental landscape and dispersed early Saxon settlement remains.

1.4.2 The objectives of the archaeological investigation were:

(i) to identify the character and extent of any surviving archaeology within the impact area;

(ii) to recover the full extent of remaining burials within and around the land required for the proposed development and establish the layout of the burial ground, including sequences of paths, plots, walls and entrances;

(iii) to carry out a general assessment of the archaeological significance of all archaeological deposits;

(iv) to determine which of those human remains are of such significance that they require further study of their anatomical, pathological and biological interest;

(v) to carry out such further studies and investigations allowed by the Consistory Court and agreed to be necessary, and any other approved studies which may be supported by the University that are allowed by the Consistory Court;

(vi) to signal, before work proceeds, the discovery of an archaeological find for which further action is required;

(vii) to return for re-burial those remains not requiring further investigation beyond initial assessment;

(viii) to retain for the duration of time stipulated by the Consistory Court those remains requiring further investigation, and then to return these for reburial;

(ix) to provide and report an ordered archive on the investigation.

(x) to advance understanding of the significance of the burial ground and to make the generated archive publicly accessible.

2 Summary of Excavation Results

2.1 Stratigraphic summary

Freud's party wall watching brief

2.1.1 In May 2013, OA carried out a watching brief on five engineering test pits excavated by Laing O'Rourke to investigate the foundations of the party wall between the Radcliffe Infirmary site and the adjacent Freud's cafe (TP1-5, Fig. 2). The base of the rough concrete footing for the wall was at *c* 0.8m below ground level, and was overlain by a single course of brick which was offset from the overlying brick wall by approximately 0.06m.

2.1.2 A fairly homogeneous dark reddish brown clayey silt layer was recorded in TP1 that was not dissimilar in composition to the post-glacial loessic subsoil that overlies the gravel terrace in Oxford, although characterisation of the deposit was problematic given the confines of the test pit. The construction cut for the wall was cut into the layer.

2.1.3 Test Pits TP2, TP3 and TP4 were excavated entirely within the construction cut for the wall and exposed no earlier deposits.

2.1.4 In Test Pit TP5 the construction cut for the wall was cut into a loamy soil layer that was interpreted as a cemetery soil.

2.1.5 Human bone and possible coffin fittings were recovered from the fill of the construction cut in Test Pit TP4, and human bone was recovered from the same feature in Test Pit TP5. The remains were re-buried in the base of the test pits

Walton Street wall

2.1.6 As part of the programme of archaeological investigations Oxford Archaeology also undertook recording of the boundary wall on the south-west side of the site along the Walton Street frontage. The recording included a general photographic survey (black and white prints and digital camera) as well as a photographic montage of the south-west face of the wall. Descriptive and interpretative notes were also made on site to provide an understanding of the character of the wall and to highlight features of interest.

2.1.7 The main wall is constructed from regular squared, coursed stonework with the larger stones generally towards the base. These stones are *c* 0.20m tall while towards the upper part of the primary wall the stone courses are generally *c* 0.14m tall. The stones are of varied lengths. The uppermost section of the wall has been rebuilt; towards the northern end this rebuilt section is four courses tall (0.42m) but towards the southern end it steps down slightly.

2.1.8 Towards the centre of the wall there is a distinct section that is likely to have been a former gateway into the site. There are no clear vertical straight joints on either side of the gateway but there are stepped structural breaks and the stonework in this section has a different character to elsewhere. The stonework here is a lighter colour than elsewhere and the coursing does not follow that of the primary stonework. This section also bulges significantly.

Main excavation

2.1.9 As is appropriate at the assessment stage, the following treatment of the stratigraphy seeks to provide an overview rather than a full account. Specific features are only mentioned where they provide example of patterns or where they illustrate key events. Provisionally, three broad chronological phases of activity were recognised amongst the excavated data:

- Phase 1: Natural features and pre-burial ground activity (up to 1770)
- Phase 2: Burial ground activity (1770-1855)
- Phase 3: Post-burial ground activity (after 1855)

2.1.10 The definition of these phases was determined primarily by the nature and date of the archaeological remains themselves with limited reference to documentary sources. Thus, features have been attributed to a phase on the basis of their equation with documented features, through the presence of datable artefacts and through stratigraphic relationships.

Phase 1

2.1.11 The earliest identified stratum was the natural gravel deposit (3035), a flint gravel in a mid brownish-yellow course sand matrix. This deposit was encountered across the entire site. This gravel was overlain by a variety of dark greyish brown sandy silt deposits across the site, which are likely to represent buried soils.

2.1.12 Pit 4203, located adjacent to the Walton Street wall towards the southern end of the site, appeared to be the earliest evidence of pre-burial ground activity on the site. Pottery indicates a middle Iron Age date for this feature, though as an isolated feature its purpose is unclear.

2.1.13 Ditch 3496, which extended NE-SW across the northern half of the burial ground, may also have been prehistoric in origin. No finds were recovered from this feature, but it had a very distinctive sterile gravel fill and was cut by pit 4367, which in turn pre-dated the burials.

2.1.14 A group of large sub-rectangular pits (6372, 4367, 4464 and 4572) were located in the north-western part of site and a further such pit (3542) was situated further south-east. The features may have been quarry pits. Pottery recovered from pits 3542 and 3672 indicates that they were dug during the 18th century and were still silting when the burial ground came into use. Pit 4367 appears to have become a particular focus for the earliest phase of grave digging.

Phase 2

2.1.15 Features relating to the burial ground were uncovered across the majority of the site except on the south-eastern side, which had been heavily truncated by a modern access road and by modern services. A total of 358 earth-cut graves were uncovered across the site along with 23 shallow pits containing amputated (or probably amputated) limbs and five charnel pits (3227, 3735, 4221, 4309 and 4512) containing disarticulated human bone, one of which also contained two partial articulated skeletons. Table 1 summarises the number and type of burial features (referred to as burial units), including the quantity of skeletons, limbs and disarticulated bones (referred to as osteological units) recovered from each.

Table 1: Summary of the human remains recovered

Number of burial Units	***Number of osteological units***
358 Graves	358 discrete articulated skeletons 6 amputated limbs (from grave backfills) Approximately 16 large bags* and 4 boxes of (bone in concrete) disarticulated bone
23 Shallow pits	17 amputated limbs 11 isolated limbs (?amputations)
5 Charnel pits	27 large bags disarticulated bone 2 discrete articulated skeletons
Total burial units = 386	Total articulated remains = 394 Total disarticulated remains = minimum 40 individuals (see human osteology assessment report, Section 2.2) **Total osteological units = 434**

*Large bags are 450mm x 600mm

2.1.16 The graves were divided into two groups by a wide path bounded by bedding trenches (3441 and 3445). The path was represented by a strip of undisturbed natural gravel between 2.2m and 4.4m wide running on a NE-SW alignment approximately one third of the way along the site from the north-western boundary. It is shown in the engraving

'The University Printing House, from the Infirmary' by J Le Keux, published by J H Parker of Oxford in 1833 (Fig. 3).

2.1.17 The majority of the graves were aligned NE-SW, roughly perpendicular to Walton Street and parallel with the path, although a small number lay perpendicular to this principal alignment. The north-east boundary of the burial ground may have been defined by wall 3402, only a small part of which had survived truncation by the foundations of the later Eye Hospital. Certainly no burials were identified beyond the line of the wall.

2.1.18 The graves on the north-western side of the path appeared to comprise two phases. The earlier group consisted of 14 graves that were dug while the large 18th century quarry pits were still at least partly open. One of the pits (4464) was cut by a group of graves, all of which respected its orientation and two of which were located very near the base of the feature. Another ten graves were located within the confines of pit 4367 - six on a NW-SE alignment along the south-east side, and the remaining four on a NW-SE alignment along the south-west side.

2.1.19 The majority of the graves on this side of the path formed six fairly regularly spaced rows that truncated the Phase 1 pits 4464 and 4367, along with the earlier Phase 2 graves (although they did not truncate the skeletons). The graves of the main phase of burial were all discrete from one another, although some were truncated by later features.

2.1.20 The graves on the south-eastern side of the path formed by far the larger of the two groups. All but two of the graves were aligned SW-NE, the remaining two being aligned NW-SE. The latter burials were both located alongside the Walton Street boundary wall, possibly because space elsewhere in the southern half of the cemetery was restricted. The rows that were present to the north-west of the path were also visible to the south-east, although they were less distinct due to repeated re-use of the area for burial. There were numerous instances of inter-cutting graves in this area.

2.1.21 Each of the graves contained a single inhumation, almost all of which were interred inside a coffin (represented by iron fittings and a stain left by the wood). The one exception to this was grave 4245, which contained a young adult female who had been buried with a neonate. The location of associated coffin fittings suggests that both individuals had been buried within the same coffin.

2.1.22 Evidence for coffins was uncovered in the majority of the graves, generally in the form of a stain left by the decayed wood and a number of iron grips and coffin nails. The coffin fittings in two graves (3303 and 3899) included the remains of breastplates, which originally bore the name, age and date of death of the deceased. Further analysis of these may identify some of this information.

2.1.23 All the graves were cut though the buried soil layers and into the underlying gravel except where they truncated earlier features or graves. However, the pits containing amputated (or probably amputated) limbs were generally restricted to the buried soil and did not cut into the gravel. Due to the similarity of the backfills to the buried soils, the edges of the pits could not be defined and their presence was indicated only by the

concentrations of bones that they contained. They were found in both the northern and southern groups.

2.1.24 The five charnel pits (3227, 3735, 4221, 4309 and 4512) were distributed across both the northern and southern burial groups. The exact stratigraphic phasing of these features is unclear; they may date from Phase 2b, and have been used as a way of disposing of groups of bones from early graves that had been disturbed by the digging of subsequent burials. However, they may equally have resulted from the excavation during Phase 3 of features that truncated the Phase 2 burials. The charnel pits in the northern group were cut into the backfill of large pit 4367 while those in the southern group truncated a number of earlier graves. Charnel pit 4309 (in the northern area) differs from the other four in that it contained two partial articulated skeletons (abdomen and leg 4305 and foot 4306) in addition to the disarticulated bone. No indication of anatomisation was present on either of the two partial skeletons so it is likely that they were from graves that had been truncated while some connective tissue was still present.

2.1.25 Three other pits (3212, 3240, 3242) were contemporary with the use of the burial ground, as indicated by pottery found within their fills. Pit 3240 contained a mixture of domestic refuse and may have been a rubbish pit but the purpose of the others is unclear. Pit 3212, which contained a mortar-rich fill, cut grave 3226 and was in turn cut by grave 3207.

Phase 3

2.1.26 The most significant element of Phase 3 was the construction of the Eye Hospital, the concrete foundations for which had been excavated through the underlying burials (Plate 6).

2.1.27 Several other features also truncated burials. Pit 4375, which was situated at the south-eastern end of the footprint of the Eye Hospital and was presumably associated with it, measured 4.8 x 1.8m and had removed all evidence for burials in this area. The location of pit 4223, in the north-western part of the burial ground, suggested that it had completely removed a grave, and it was in turn cut by a brick-lined well (3476) that contained pottery dating from between 1890 and 1930. A square brick-lined feature that may have been a manhole (3585) was also located in this part of the site.

2.2 Human osteology assessment

Introduction

2.2.1 Human skeletal remains from a total of 345 graves, 21 shallow pits and four charnel pits were assessed in accordance with standard national guidelines (Mays *et al*. 2004).

2.2.2 The aim of the assessment was to characterise the human skeletal assemblage in sufficient detail to determine the desirability of carrying out any further and more detailed investigations of individuals with apparent aspects of interest. In accordance with a Faculty issued by the Diocese of Oxford, the results would be employed to identify a suitable sample of human remains for further, detailed investigation. Sample selection would be undertaken with reference to local, regional and national

archaeological research agendas and relevant guidelines (Oxford City Council 2011; Hind 2010; Mays 1999; English Heritage 2011; The Church of England and English Heritage). More specifically, consideration would be given to the potential of skeletons to contribute towards Oxford city's draft archaeological plan to further present understanding of patterns of health, wealth and lifestyle within the local population of Oxford. Other research areas that are relevant here are anatomisation and medical treatment; diet and dental health; health and disease; population mobility / ancestry and osteological methods for estimating age, sex and parity. These are detailed in the WSI (OA 2013).

Methodology

2.2.3 Osteological assessment was undertaken with reference to published guidelines for recording human remains from archaeological sites (Brickley and McKinley 2004). Skeletons were rapidly scanned to note preservation, determine age, sex and stature (where possible) and to note any pathology, evidence for anatomisation or other bony abnormality. In addition, the potential for other metrical data (e.g. femoral/tibial indices), and whether or not skulls were complete and intact for the assessment of ancestry, was also recorded. Any non-metrical traits and pathological lesions observed during the course of the assessment were also noted.

2.2.4 All data were entered into a spreadsheet specifically tailored to capture key demographic and palaeopathological data. Given that the present stage of work is an assessment, a full inventory of bones was not completed for each skeleton, nor were non-metric traits or pathological conditions systematically scored. For this reason, true prevalence rates (TPR, i.e. the number of particular bones with a particular trait or condition out of the total number observed) are not presented in this report.

2.2.5 The number of disarticulated bones recovered from the charnel pits was approximated, and a comment was made on whether the material comprised adults and/or juveniles. On site, any disarticulated bone fragments (from graves or charnel pits) that were noted to have been modified (i.e. exhibiting cut or saw marks) were bagged separately. These were rapidly examined to provide basic information on the bone affected, type of modification and evidence for pathology.

Results

Quantification

2.2.6 The excavated assemblage comprised 360 discrete, articulated skeletons, 23 amputated limbs and a further 11 isolated limbs (without direct evidence for having been amputated, i.e. no cut/saw marks); see Table 1. This was in addition to a large quantity of disarticulated bone, recovered from the backfills of disturbed graves and charnel pits and comprising a minimum of 40 individuals. The assessed assemblage totalled 347 articulated skeletons, disarticulated bones that represent at least 35 individuals and 31 amputated or possible amputated isolated limbs. The following results relate to the assessed assemblage only.

Preservation and completeness
Articulated skeletons

2.2.7 Bone condition and completeness has considerable influence on the amount of information that may be retrieved from skeletons. The vast majority of the articulated skeletons (78.1%) exhibited high levels of completeness (76-100%) (Table 2, Fig. 4).

Table 2: Completeness of articulated skeletons

Completeness	*No. of skeletons*	*%*
0-25%	26	7.49
26-50%	21	6.05
51-75%	29	8.36
76-100%	271	78.1
TOTAL	347	100

2.2.8 The level of post-mortem fragmentation was scored (Table 3, Fig. 5) as low (<25% of present bone fragmented), medium (25-75% of present bone fragmented) or high (>75% of present bone fragmented). Two thirds of the articulated skeletons exhibited a low level of fragmentation. Less than 9% of the assemblage was highly fragmented.

Table 3: Fragmentation of the articulated skeletons

Fragmentation	No. of skeletons	%
Low	231	66.57
Medium	85	24.5
High	31	8.93
TOTAL	347	100

2.2.9 The condition of bone surfaces of the articulated skeletons was scored in accordance with McKinley (2004, 16) (Table 4, Fig. 6). Whilst only 10.06% of skeletons had no post-mortem surface erosion (Grade 0), the vast majority of the assemblage (80.4%) were assigned to condition Grade 1, meaning that the bone surfaces displayed only slight, patchy surface erosion (ibid, 16). Far fewer skeletons (8.36%) exhibited more extensive surface erosion, with slightly deeper surface penetration (Grade 2) (ibid, 16), and only around 1% of skeletons had a surface condition of Grade 3 (most bone surfaces affected by some degree of erosion; ibid, 16). No skeletons were assigned to the poorer condition grades (4 - 5+).

Table 4: Bone surface condition in the articulated skeletons

Condition (after McKinley 2004)	*No. of skeletons*	*%*
Grade 0	35	10.09
Grade 1	279	80.4
Grade 2	29	8.36
Grade 3	4	1.15
Grade 4	0	0
Grade 5	0	0
Grade 5 +	0	0
TOTAL	347	100

2.2.10 In order to calculate an overall preservation grade for each skeleton ('Excellent', 'Good', 'Fair', 'Poor' or 'Destroyed'), a method was devised which combined the fragmentation and surface condition scores (see Appendix E). The majority of skeletons (79.54%) were scored as having 'Good' preservation. No cases of 'Poor' or 'Destroyed' preservation were observed (Table 5, Fig. 7).

Table 5: Overall preservation of the articulated skeletons

Overall preservation	*No. of skeletons*	*%*
Excellent	29	8.36
Good	276	79.54
Fair	42	12.1
Poor	0	0
Destroyed	0	0
TOTAL	347	100

Amputated and isolated limbs

2.2.11 Levels of fragmentation, surface condition and overall preservation were also calculated for the 31 amputated and isolated limbs. Just under half of the limbs (45.16%,14/31) exhibited medium fragmentation. Ten limbs (32.23%) exhibited low fragmentation and seven (22.58%) were highly fragmented. As with the articulated skeletons, levels of surface erosion were generally low, with none assigned to the higher grades (Grades 4 to 5+, McKinley 2004, 16). Most limbs (64.52%, 19/31)

exhibited just slight, patchy surface erosion (Grade 1, ibid, 16). Just under one quarter (22.58%, 7/31) of the limbs were assigned to Grade 2, and fewer (12.9%, 4/31) were assigned to Grade 3 (ibid, 16). Overall, the majority of limbs were in good condition (61.29%, 19/31). A total of ten limbs (32.26%) were assigned to the 'Fair' preservation grade, and only two (6.45%) were placed in the 'Poor' preservation category.

Ancestry

2.2.12 Ancestry may be estimated using skeletal remains by visually assessing the morphology of the skull, in particular the facial region (Gill 1986; Gill and Rhine 1990), and by metrical analysis applied to the formula and associated software programme CRANID (Wright 2008). CRANID allows the user to carry out a linear discriminant analysis (LDA) and a nearest neighbour discriminant analysis (NNDA) with 29 measurements on an individual cranium. The cranium is classified after automated comparison, using multivariate size and shape, with 74 samples that include 3,163 crania from around the world (Wright 2008). Whilst full exploration of ancestry was beyond the scope of the assessment, it was noted that six articulated skeletons (adult males 3136, 3312, 3376 and 3485, adult female 3755 and adolescent 3434) exhibited morphological features that were probably not typical of Caucasoid ancestry. Over one quarter of the articulated skeletons (27.59%, 96/348), including the four with non-Caucasoid features, had complete, intact skulls that could be assessed using CRANID.

Demography

Articulated skeletons

2.2.13 Articulated skeletons were assigned to one of the age categories presented in Table 6. Of the 347 skeletons assessed, 300 were adults (86.46%) and 47 were juveniles (13.54%). Most adult deaths (34.0%, 102/300) occurred during prime adulthood (26-35 years) and most juvenile deaths (61.70%, 29/47) occurred in the adolescent category (12-17 years). Younger juveniles (preterms, neonates, infants and young children) were notably under-represented, with only three skeletons falling within these age categories. Adults over 60 years of age were equally under-represented.

Table 6: Age categories employed

Age category	*Age range*
Juvenile	
Pre-term	<37 weeks gestation
Neonate	Birth-1 month
Infant	1 month-1 year
Young child	1-5 years
Older child	6-12 years
Adolescent	13-17 years
Adult	

Young adult	18-25 years
Prime adult	26-35 years
Middle adult	36-45 years
Mature adult	>45 years
Mature adult +	>60 years
Adult (unspecified)	>18 years

2.2.14 Estimation of sex could be carried out for the vast majority of adult skeletons (92.33%, 277/300). There was a much higher proportion of males (68.23%, 189/277) than females (31.77%, 88/277). Table 7 gives the age and sex distribution of the total assessed sample, and the mortality profile is depicted in Fig. 8. The mortality profile highlights the peak in death during prime adulthood (26-35 years), as noted above. However, when the data for males and females are presented separately, it is clear that this peak is due to the higher proportion of male deaths. Female deaths actually peak during young adulthood (18-25 years). The single neonate, the youngest individual within the assemblage (4247) was recovered from the same coffin as young adult female 4246. This may represent an obstetric death although the only way to confirm a potential familial link between the two individuals could be by reference to the burial ground records (should the information exist) or by DNA analysis (Roberts and Cox 2003, 253).

Table 7: Age and sex distribution of the articulated skeletons

Age category	*Male (inc. ?/??)*	*Female (inc. ?/??)*	*Unknown sex*	*Total (inc. unknown sex)*
Preterm	0	0	0	0
Neonate	0	0	1	1
Infant	0	0	0	0
Young child	0	0	2	2
Older child	0	0	15	15
Adolescent	0	0	29	29
Young adult	28	31	1	60
Prime adult	78	22	2	102
Middle adult	52	22	1	75

Mature adult	22	11	0	33
Mature adult +	2	0	1	3
Adult (unspec.)	7	2	18	27
TOTAL	189	88	70	347

Amputated and isolated limbs

2.2.15 Of the 31 amputated and isolated limbs, 25 were adult (80.65%) and six were juvenile (19.35%). Only one of the adult limbs, right leg 3190, could be aged more specifically. In this case, the distal femoral epiphysis had completely fused, but the fusion line was still visible, indicating that this was probably a young adult (18-25 years). The same limb was the only one for which sex could be estimated, and the femoral bicondylar width indicated a male individual. Of the juvenile limbs, one was from a young child, three from older children and two from adolescents.

Stature and other metrical analyses

2.2.16 Where possible, measurements of long bones were taken and used for the estimation of stature by applying them to the appropriate regression formula, set out by Trotter and Gleser (1952; 1958) and revised by Trotter (1970). Bones used for stature, in order of preference (i.e. starting with the bone with lowest error margin) were femur, fibula, humerus/radius (humerus over radius in males, vice versa for females), and ulna, with the left side used in preference over the right.

2.2.17 Stature could be estimated for a total of 269 adults, or 89.37% (269/301) of the adult sample. The stature averages and ranges for males and females are presented in Table 7. It should be noted here that male skeleton 4445 was remarkably short, with a stature of 143.45cm, equating to approximately 4ft 8½ in. To provide some perspective, clinically a stature of 147cm (4ft 10in), would be defined as dwarfism (Medline Plus 2013). In the present case, the stature was calculated by employing the maximum length of the humerus, which has a fairly high error margin (4.05cm). In addition, no other skeletal indicators of dwarfism (proportionate or disproportionate) were observed on the skeleton. Further analysis may aid or disprove this as a diagnosis.

Table 8: Stature estimates

	Average stature	*Stature range*
Males (N=185)	170.43 (*c* 5 ft 7in)	143.45 – 187.31 (*c* 4 ft 8½ in-6 ft 2 in)
Females (N=84)	161.00 (*c* 5 ft 3½ in)	147.68 – 174.39 (*c* 4 ft 10 in-5 ft 8½ in)

2.2.18 Stature could be estimated for only one of the amputated/isolated limbs. The right fibula of amputated limb 3190, estimated to have been male based on the bicondylar width of the femur, gave a stature of 175.5 cm (*c* 5 ft 9 in).

2.2.19 Aside from stature estimation, metrical analysis was beyond the scope of this assessment. However, in order to assess the potential of the remains for metrical data, it was noted whether the femora and/or tibiae were intact for calculation of the platymeric and platycnemic indices. Skeletal indices allow variation in the physical attributes of a population to be explored. A total of 262 skeletons (170 males, 82 females and 10 skeletons of unknown sex) had measurable femora and/or tibiae. Of the amputated/isolated limbs, only three (3037, 3253 and 4426) had potential for platymeric/platycnemic indices to be calculated. The assessment of skulls for measurement for CRANID assessment is also relevant here and has been discussed above (see 'Ancestry')

Non-metric traits

2.2.20 Non-metric traits are minor anomalies of skeletal anatomy that are normally of no pathological significance. Environment, geography, diet and genetics are all thought to be factors in the occurrence of these traits (Mays 1998). Cranial traits in particular have been employed to explore relatedness between individuals and groups, while those that involve joints may refer to activity patterns (ibid.).

2.2.21 Whilst systematic scoring of cranial and post-cranial non-metric traits was not carried out for the assessment, all traits that were observed, based on those described by Berry and Berry (1967) and Finnegan (1978), were noted. Cranial non-metric traits were noted in almost a quarter (24.78%, 86/347) of articulated skeletons and post-cranial traits were noted in over a third (36.89%; 128/347), indicating that there is high potential for non-metrical analysis in the assemblage. In addition, amputated limb 3190 exhibited non-metric traits. Parietal foramen and sutural ossicles appeared to be the most common cranial traits observed, whilst double calcaneal facets were the most frequently recorded post-cranial trait. Systematic recording of non-metric traits would be required to explore whether these patterns hold true.

Dental health status

2.2.22 Dental pathology was noted in a total of 276 skeletons, giving a crude prevalence rate (CPR) of 79.54% (276/347). Over 80% (243/300) of adults and almost three quarters of the juveniles (70.21%, 33/47) exhibited some form of dental pathology. The pathological conditions observed include dental enamel hypoplasia (DEH), calculus, periodontal disease, caries, periapical cavities and ante-mortem tooth loss.

2.2.23 Table 9 summarises the crude prevalence rates of the main dental pathologies for adults, juveniles and the total assemblage. Calculus was the most frequently observed dental pathology, having been noted in 69.67% of adults and 55.32% of juveniles. Caries was the next most frequent condition in both the adult (58.67%) and juvenile (34.04%) samples. Dental enamel hypoplasia was the next most commonly observed condition in the juvenile sample (25.53%), but in the adult assemblage, ante-mortem tooth loss was more frequently observed, having been noted in over half (55.67%) of the skeletons. It is atypical for ante-mortem tooth loss to be prevalent among a predominantly young (less than 40 years) group of individuals. More detailed analysis is required to explore this further.

Table 9: Crude prevalence rates of dental disease

Dental pathology	*Adults CPR (n/N)*	*Juveniles CPR (n/N)*	*Total CPR (n/N)*
Dental enamel hypoplasia	15.33% (46/300)	25.53% (12/47)	16.71% (58/347)
Calculus	69.67% (209/300)	55.32% (26/47)	67.53% (235/347)
Periodontal disease	22.33% (67/300)	4.26% (2/47)	19.88% (69/347)
Caries	58.67% (176/300)	34.04% (16/47)	55.33% (192/347)
Periapical cavities	20.33% (61/300)	2.13% (1/47)	17.87% (62/347)
Ante-mortem tooth loss	55.67% (167/300)	6.38% (3/47)	48.99% (170/347)

2.2.24 A variety of dental anomalies were also observed, including cases of impaction, possible agenesis, retention of deciduous teeth, abnormal wear patterns, supernumerary teeth and overcrowding/malalignment. These are summarised in Table 10. Cases of probable third molar agenesis were noted. These have been classified as 'probable' because without radiographic analysis it is not possible to say for certain that the teeth are not present within the jaws (i.e. unerupted). That said, in the cases included here, the lack of space within the dental arcade for the missing teeth, makes agenesis most likely. Of the three cases of abnormal wear, two individuals (3851 and 3874) had pipe facets, from the habitual use of a smoking pipe.

Table 10: Dental anomalies

Dental anomaly	*Adults CPR (n/N)*	*Juveniles CPR (n/N)*	*Total CPR (n/N)*
?Agenesis of M3s	0.33% (1/300)	2.13% (1/47)	0.58% (2/347)
Unerupted/impacted teeth (not M3s)	2.67% (8/300)	2.13% (1/47)	2.59% (9/347)
Overcrowding/rotation/malalignment	0.67%	2.13%	0.86%

	(2/300)	(1/47)	(3/347)
Supernumerary teeth	0.33% (1/300)	2.13% (1/47)	0.58% (2/347)
Retention of deciduous teeth	0.67% (2/300)	/ (0/47)	0.58% (2/347)
Abnormal wear/pipe facets	1.00% (3/300)	/ (0/47)	0.86% (3/347)

2.2.25 One skeleton, middle adult female 3628, had a dental prosthesis for the anterior portion of the maxilla. The plate was made from a probable gold alloy. A real human tooth, in the position of the right central incisor, was attached to the plate by a metal peg. A metal peg in the position of the left lateral incisor indicated that a second tooth had originally been attached to the plate, but this was not present at the time of assessment.

Skeletal pathology – Articulated skeletons

2.2.26 Although not systematically examined for pathology, a wide range of conditions was observed among the articulated skeletons. In total, 53.19% (25/47) of juveniles, 87.67% (263/300) of adults and 83.00% (288/347) of the total number of articulated skeletons, exhibited lesions of pathology. Pathological conditions were divided into 10 broad categories: congenital/developmental disease, inflammation/infection, metabolic disease, spinal joint disease, extra-spinal joint disease, trauma, circulatory disorders, neoplastic disease, miscellaneous conditions (i.e. those that do not fit within any of the aforementioned categories) and undiagnosed conditions (i.e. lesions of pathology for which the diagnosis was unclear). Table 11 summarises the crude prevalence rates for each of the pathology categories. Figure 9 shows the crude prevalence rates for each of the pathology categories as a proportion of the total number of cases of disease (N=720). It should be noted that this figure does not account for each skeleton having multiple cases of the same category of disease. That is, if a skeleton has lesions of trauma, these will be counted as a single case, regardless of how many traumatic lesions are present in that skeleton.

Table 11: Crude prevalence rates of skeletal pathology by category (articulated skeletons)

Pathology category	*Adults CPR (n/N)*	*Juveniles CPR (n/N)*	*Total CPR (n/N)*
Congenital/developmental	14.33% (43/300)	2.13% (1/47)	12.68% (44/347)
Inflammation/infection	55.33% (166/300)	23.40% (11/47)	51.01% (177/347)

Metabolic	26.00% (78/300)	36.17% (17/47)	27.38% (95/347)
Spinal joint disease	68.33% (205/300)	4.26% (2/47)	59.65% (207/347)
Extra-spinal joint disease	38.00% (114/300)	2.13% (1/47)	33.14% (115/347)
Trauma	18.00% (54/300)	2.13% (1/47)	15.85% (55/347)
Circulatory	2.67% (8/300)	/ (0/47)	2.31% (8/347)
Neoplastic	0.33% (1/300)	/ (0/47)	0.29% (1/347)
Miscellaneous	0.67% (2/300)	/ (0/47)	0.58% (2/347)
Undiagnosed	4.67% (14/300)	4.26% (2/47)	4.61% (16/347)

Spinal and extra-spinal joint disease

2.2.27 Spinal joint disease (including spondylosis deformans, osteoarthritis (OA), Schmorl's nodes and vertebral body osteophytes) was the most frequently observed condition overall, seen in 59.65% of the total assemblage, 68.33% of adults, but just 4.26% of juveniles. Table 12 presents the summary data for this category of disease.

2.2.28 Schmorl's nodes were the most frequently noted condition, observed in over half of the adult skeletons (53.00%). These are identified on dry bone as indentations on the vertebral end plates and are essentially 'pressure defects' arising from herniation of the intervertebral disc (Rogers and Waldron 1995, 27). Disc herniation is usually a gradual, age-related occurrence in adults, associated with weakening of the posterior longitudinal ligaments of the spine, but it may also occur in younger individuals as a result of activity or an injury, such as a jump or fall from height (Lovell 1997, 159; Jurmain 1999, 165). Only two juvenile skeletons (adolescents 3457 and 4461) exhibited Schmorl's nodes.

2.2.29 The next most frequently observed spinal joint disease was vertebral body osteophytes, recorded in 49.00% of adults. Osteophytes, growths of new bone which arise around the margins of a joint, are extremely common in any skeletal population and their prevalence increases with age (Rogers and Waldron 1995, 20). Marginal

osteophytes on the vertebral bodies are almost invariably seen alongside spondylosis deformans (degenerative disc disease) (ibid; 27), although they frequently appear in the absence of any other changes relating to degeneration of the intervertebral disc.

2.2.30 Spinal OA was observed in only eight adults. Osteoarthritis, which was recorded using the criteria given by Rogers and Waldron (1995, 44), is the most common joint disease in both modern and archaeological populations (Rogers and Waldron 1995). It is a chronic, progressive and non-inflammatory disease that can affect any synovial joint of the skeleton (Rogers and Waldron 1995, 32; Aufderheide and Rodríguez-Martín 1998, 93; Ortner 2003, 545). At 2.67%, the CPR of spinal OA is likely to be an under-representation of the true prevalence within the assemblage, probably resulting from the non-systematic recording of the disease and the fact that the skeletons were not washed prior to assessment.

Table 12: Crude prevalence rates for spinal joint disease (articulated skeletons)

Spinal joint disease	*Adults CPR (n/N)*	*Juveniles CPR (n/N)*	*Total CPR (n/N)*
Schmorl's nodes	53.00% (159/300)	4.26% (2/47)	46.40% (161/347)
Spondylosis deformans	6.33% (19/300)	/ (0/47)	5.48% (19/347)
Spinal osteoarthritis	2.67% (8/300)	/ (0/47)	2.31% (8/347)
Vertebral body osteophytes	49.00% (147/300)	/ (0/70)	42.36% (147/347)

2.2.31 Extra-spinal joint disease (including OA, osteophytosis, rotator cuff disease and diffuse idiopathic skeletal hyperostosis (DISH)) was the third most commonly observed category of disease in the adult sample, affecting 38.00% of adult skeletons. Table 13 summarises the extra-spinal joint diseases observed. Note that skeletons exhibiting single joint changes (for example, osteophytes only) are included in the overall rate of extra-spinal joint disease given in Table 11, but these cases are not included in Table 13 as they are so commonly observed in skeletal assemblages (Rogers and Waldron 1995, 20). As noted above, it is likely that the CPR of OA (4.33%) is an under-estimate. Of the cases of OA observed, the acromio-clavicular, sterno-clavicular, gleno-humeral, elbow, wrist, hip, knee, ankle and foot joints were all involved.

Table 13: Crude prevalence rates for extra-spinal joint disease (articulated skeletons)

Extra-spinal joint disease	*Adults CPR*	*Total CPR*

	(n/N)	*(n/N)*
Osteoarthritis	4.33% (13/300)	3.75% (13/347)
Rotator cuff disease	0.33% (1/300)	0.29% (1/347)
DISH/?Early DISH	3.67% (11/300)	3.17% (11/347)

NB No juvenile skeletons exhibited extra-spinal joint disease

2.2.32 Rotator cuff disease, a fairly common joint disease of the shoulder region (Rogers and Waldron 1995, 40), was observed in just one adult skeleton (3773). The rotator cuff is a group of muscles and tendons which help to stabilise the shoulder joint. The disease is diagnosed in dry bone by the presence of new bone formation on the proximal humerus and scapula, specifically at the insertion sites of these muscles and tendons (ibid, 42).

2.2.33 A total of 11 adults (nine males and two females), exhibited bony changes in the spine and in the extra-spinal skeleton, indicative of DISH. In four cases (3344, 3348, 3438, 3751), a firm diagnosis of DISH was made based on the presence of four fused adjacent vertebrae via ossification of the anterior longitudinal spinal ligament down the right side of the vertebral bodies (Rogers and Waldron 1995, 48-49). This calculates as a 1.15% CPR (4/347). In the other seven cases (3025, 3098, 3678, 4005, 4065, 4085, 4479), fewer than four adjacent vertebrae were fused. That said, skeletons which obviously have DISH, but in which fewer than four vertebrae are fused, are not uncommon in archaeological assemblages (ibid; 51). Further analysis of these cases would allow for assessment of other skeletal indicators of the condition, such as extra-spinal enthesophytes, which may aid in the diagnosis. If the less certain cases are included, the CPR is 3.17%, with a CPR of 4.76% (9/189) for males and 2.27% (2/88) for females.

Inflammation/infection

2.2.34 Inflammation/infection was prevalent in both the adult (55.33%) and juvenile samples (23.40%). In most cases, the lesions could not be assigned to a specific infection and are classified as 'non-specific'. Non-specific inflammation, or periostitis, was by far the most commonly observed condition in this category, having been observed in 52.33% (157/300) of adults and 17.02% (8/47) of juveniles (all adolescents). Whilst true prevalence rates have not yet been calculated, the long bones of the leg appear to be the most commonly affected elements, with the tibia by far the most frequently affected bone. Of the 165 skeletons exhibiting periostitis, at least 122 (73.94%) had lesions on one or both tibiae.

2.2.35 A total of 13 skeletons (3052, 3103, 3136, 3221, 3281, 3368, 3588, 3608b, 3675, 3831, 4230, 4329, 4332) exhibiting periostitis, also had bones that were swollen in appearance and/or exhibited cloacae, indicative of bone infection (osteitis/osteitis or osteomyelitis). Again, the lower limb bones, in particular the tibia, were most commonly

affected. For skeletons 3136, 3221 and 3608b, infection of the bones appeared to be secondary to trauma, although further analysis once the bones have been cleaned is required.

2.2.36 Maxillary sinusitis (inflammation in the paranasal sinuses) was observed in eight skeletons (3052, 3234, 3288, 3828, 3851, 3862, 3870, 3882), giving a CPR of 2.31% (8/347), or 2.67% (8/300) of adults. The CPR in females (4.55%, 4/88) was double the rate observed in males (2.12%, 4/189). This finding is interesting, although calculation of the TPR is necessary to confirm whether females really suffered a higher rate of this condition.

2.2.37 Many of the skeletons exhibiting periostitis were affected in multiple skeletal regions. Of these, nine (3568, 4031, 4075, 4106, 4140, 4155, 4192, 4281, 4321) had notably diffuse periostitis, indicative of systemic infection. In female skeletons 3568 and 4321 and male skeletons 4031, 4106 and 4281, the ectocranial surfaces exhibited inflammatory and erosive lesions possibly indicative of caries sicca, a pathognomonic lesion of tertiary syphilis. Further analysis of these cases once the remains have been fully cleaned, along with the other skeletons exhibiting diffuse inflammatory lesions, is required to confirm diagnosis.

2.2.38 Another skeleton, adult male 3312, exhibited possible rhino-maxillary resorption. Such changes may be seen in syphilis, or leprosy (Aufderheide and Rodríguez-Martín 1998, 150-151, 163). Whilst this skeleton also had periostitis on the mandible and maxilla, probably resulting from dental disease, no other evidence for infection/inflammation was observed on the skeleton. Again, careful cleaning and more thorough examination of this skeleton is required to explore this diagnosis further.

2.2.39 Another possible case of specific infection was observed in adult female skeleton 3234. Aside from periostitis in bones of the legs, this skeleton exhibited erosive lesions in two lumbar vertebrae, possibly indicative of tuberculosis or, given that the lumbar spine is involved, brucellosis (Aufderheide and Rodríguez-Martín 1998, 135, 192). In adolescent skeleton 3991, infection of the hip joint may have been the result of tuberculosis, although the hip is also one of the most common joints to be affected by septic arthritis in young individuals. These cases also warrant further investigation.

Metabolic disease

2.2.40 Metabolic disease was the most frequent type of pathology observed in the juvenile assemblage, affecting 36.17% of juvenile skeletons. Over a quarter (26.00%) of adult skeletons exhibited lesions attributed to metabolic disease. By far the most frequently observed metabolic condition observed was cribra orbitalia, affecting a total of 25.65% of all assessed skeletons (89/347), 36.17% (17/47) of juveniles and 24.00% (72/300) of adults. Males and females were fairly equally affected, with CPRs of 26.46% (50/189) and 23.86% (21/88) respectively. Cribra orbitalia is identified on dry bone as surface pitting on the orbital roof (the eye socket), accompanied by thinning of the compact bone (Ponec and Resnick 1984). These lesions have traditionally been attributed to iron deficiency anaemia, which may occur due to a diet deficient in iron, excessive blood loss through injury, chronic disease such as cancer, or malabsorption (for example, due to intestinal parasites) (Mays 2012; Stuart-Macadam 1991). That said, vitamin B12

and/or folic acid deficiency (megaloblastic anaemia) have more recently been suggested as the cause of cribra orbitalia (Walker *et al.* 2009), and Mays (2012, 293) highlights that porosity on the orbital roofs may also occur in a variety of other conditions, such as rickets or scurvy. Regardless of aetiology, cribra orbitalia is often considered as a skeletal indicator of non-specific health stress, and can be used to evaluate the overall burden of disease in archaeological populations (e.g. Steckel *et al.* 2009).

2.2.41 Possible cases of rickets were also observed in the assemblage. A total of eight skeletons (3209, 3246, 3722, 3847, 3886, 3967, 4343, 4440), all adult males, exhibited bowing of long bones, which may represent residual rickets deformity (Brickley and Ives 2008; Aufderheide and Rodríguez-Martín 1998, 307). In all but one case, the bones of the legs were affected. In skeleton 4343 the left radius and ulna (bones of the forearm) were bowed. In order to more confidently diagnose these cases, the skeletons must be examined in more detail, but if all are confirmed, the CPR for this condition is 2.30% (8/347). This is lower than the average rate calculated for the period (3.65%), but in keeping with the range of rates observed at other sites (Roberts and Cox 2003, 310).

Trauma

2.2.42 Multiple lesions of trauma, mostly healed, were observed in the assessed sample, including ossified haematomas, fractures, myositis ossificans traumatica and subluxation. In the adult assemblage, 18.00% of skeletons exhibited trauma, whilst only one juvenile skeleton had a traumatic lesion.

2.2.43 Ossified haematomas were noted on the shafts of two tibiae (adult male skeletons 3305 and 3722; one on each). Probable cases of myositis ossificans traumatica were observed in five adults (3209, 3563, 3758, 4051 and 4483), giving a CPR of 1.44% (5/347), or 1.67% (5/300) of adults. In all but one case, a femur was involved. In skeleton 3563, the right tibia exhibited the lesion. The lesion presents as an ossified mass of woven bone and results from crushing or avulsion of tendinous and/or muscle attachment to bone, and subsequent calcification and ossification of the resultant haematoma and periosteum (Aufderheide and Rodríguez-Martín 1998, 26-7).

2.2.44 Two skeletons exhibited evidence for subluxation (partial dislocation). In adult 3608b (indeterminate sex), the right femur and tibia were fixed at an approximately 90º angle, having ankylosed at the knee joint. The femur was positioned antero-medially from its normal position and both bones exhibited evidence for bone infection, probably having occurred secondary to the trauma. In adult male 3767, the left glenoid fossa was abnormally shaped with the anterior portion missing, probably resulting from anterior subluxation of the humeral head. The humerus also exhibited a possible well healed fracture at the head/neck region, possibly having occurred as part of the same traumatic event. Secondary osteoarthritis was present in the gleno-humeral joint. In adult female skeleton 3321, the right elbow joint was ankylosed at an approximately 90º angle. This may represent a third possible case of subluxation, although this could not be confirmed during the assessment. Further analysis is required.

2.2.45 Fractures were by far the most commonly observed traumatic lesion. Definite fractures were observed in a single juvenile skeleton and 35 adult skeletons, giving CPRs of

2.13% (1/47) and 11.67% (35/300) respectively, or 10.37% (36/347) of the total assemblage. An additional nine adults exhibited probable fractures, increasing the adult rate to 14.67% (44/300) and the overall rate to 12.97% (45/347). Table 14 summarises the CPRs of definite and probable fractures by element, observed during the assessment. Whilst most skeletal regions were affected, initial observations indicate that tarsals were the most commonly fractured element (nine adult skeletons). Interestingly, the skull was the next most commonly fractured region (1 juvenile skeleton, seven adult skeletons). Also noteworthy is the fact that of the eight cases of skull fracture, most (5/8) involved the facial region (nasal bones and maxilla). Ribs were the next most commonly fractured skeletal element (seven adults).

Table 14: Crude prevalence rates of fractures by element (articulated skeletons)

Element	*Adult CPR (n/N)*	*Juvenile CPR (n/N)*	*Total CPR (n/N)*
Skull	2.33% (7/300)	2.13% (1/47)	2.31% (8/347)
Clavicle	0.33% (1/300)	/ (0/47)	0.23% (1/347)
Humerus	1.33 (4/300)	/ (0/47)	1.15% (4/347)
Radius	1.67 (5/300)	/ (0/47)	1.44% (5/347)
MC	0.33% (1/300)	/ (0/47)	0.23% (1/347)
Vertebra	1.00% (3/300)	/ (0/47)	0.86% (3/347)
Rib	2.00% (6/300)	2.13% (1/47)	2.02% (7/347)
Innominate	1.00% (3/300)	/ (0/47)	0.86% (3/347)
Femur	1.67% (5/300)	/ (0/47)	1.44% (5/347)
Tibia	1.33% (4/300)	/ (0/47)	1.15% (4/347)

Fibula	2.00% (6/300)	/ (0/47)	1.73% (6/347)
Tarsal	3.00% (9/300)	/ (0/47)	2.59% (9/347)

NB Rates given are for the number of skeletons with fractures affecting each element, with the data for left, right and multiple elements (eg ribs, vertebrae, MC, MT, phalanges) pooled

2.2.46 The majority of fractures observed were healed, although in two of these cases (all adult males), the fracture surfaces were ununited. These include a femoral neck fracture in skeleton 3426, with subsequent atrophy of the femur, tibia and fibula, probably resulting from limited use of the limb. In skeleton 3449, a healed fracture of the distal humerus was ununited.

2.2.47 Nine skeletons exhibited fractures that were healing or, in some cases, completely unhealed, having been sustained peri-mortem (around the time of death). These cases are summarised in Table 15.

Table 15: Summary of fractures that were unhealed, or still healing at time of death (articulated skeletons)

Skeleton no.	*Age*	*Sex*	*Fracture details*
3025	Middle adult	?F	Comminuted spiral fracture to distal right femoral shaft. Macroscopic signs of early healing, but clearly recent injury before death (individual also exhibits vertebral body fractures but these are healed)
3078	Prime adult	?M	Peri-mortem spiral fracture to left proximal femur shaft
3122	Prime adult	?M	Probable peri-mortem fractures to left ilium (individual also has a healed fracture of the right distal radius)
3272	Middle adult	M	Peri-mortem oblique fractures to the left tibia and fibula shafts
3465	Adolescent	?	Fractures of the left first and second ribs (still healing at time of death), peri-mortem fracture to right parietal (individual has undergone a trepanation in the region of the trauma, and a full craniotomy – see below for full discussion of medical intervention/post-mortem evidence)
3554	Prime adult	?M	Fracture of right radius midshaft (thick callus on both fragments but ununited and probably still healing at time of death)
3678	Mature adult	M	Unsided rib shaft fracture (healing at time of death)
3940	Prime adult	?M	Peri-mortem helical/oblique fracture of left femur shaft
4065	Middle adult	?M	Comminuted (?spiral) fracture to left distal tibia and fibula

			(some healing and union of fragments but incompletely healed at time of death. Secondary inflammation noted)

2.2.48 Of particular interest was a possible case of peri-mortem sharp-force trauma, involving prime adult male skeleton 4031. Probable chop marks were present on the left and right femur and tibia, as well as the frontal bone. The lumbar vertebrae also exhibited possible sharp-force trauma lesions. It may be relevant that the same individual may have suffered from some kind of systemic infection, possibly syphilis.

Congenital/developmental disease

2.2.49 Lesions pertaining to congenital/developmental disease were observed in 12.68% (43/347) of articulated skeletons, 14.33% (43/301) of adults and 2.13% (1/47) of juveniles. Conditions included in this category are:

- spina bifida occulta
- bifid neural arch of vertebra (CV2, SV1)
- spondylolysis
- vertebral border shifting (sacralisation)
- additional vertebral segments (six lumbar vertebrae)
- butterfly vertebra
- os acromiale

2.2.50 Most of the examples of abnormal bone morphology observed were relatively minor, and in the majority of cases, were probably of no consequence in life. The most commonly observed condition in this category was spina bifida occulta, in which there is incomplete fusion of the sacrum, involving one or more of the sacral segments. A total of 14 skeletons, including one adolescent, had this condition, giving a CPR of 4.03% (14/347). Systematic scoring of this condition would allow for a TPR to be calculated and comparison to be made with other archaeological populations.

2.2.51 Aside from the conditions listed above, one skeleton, prime adult male 3317, exhibited a bilateral abnormality in the joint surface of the femoral heads, which was probably a developmental anomaly, and skeleton 3637, a prime adult female, had an abnormally shaped left nasal bone. This did not appear to have been fractured, thus it was suggested that this was a developmental anomaly. In middle adult female 4036, the distal articular surface of the left humerus was cleft, appearing as though it had formed in two distinct parts.

Circulatory disorders

2.2.52 The only condition observed in this category was osteochondritis dissecans (OD). OD presents as a focal area of bone necrosis on the convex surface of a joint. It results from trauma to the blood supply and partial or complete detachment of the subchondral

bone and articular cartilage (Aufderheide and Rodríguez-Martín 1998, 81). In total, eight adult male skeletons (total CPR 2.31%, 8/347, adult CPR 2.67%, 8/300) exhibited OD lesions on one or more joints. In all but one of the skeletons the elbow joints were affected. In skeleton 3305 the ankle joint (talus) was involved.

Neoplastic disease

2.2.53 Only a single case of neoplastic disease was observed amongst the articulated skeletons. Mature adult female 4168 had a small, benign tumour, known as a button osteoma, on the frontal bone of the skull.

Miscellaneous

2.2.54 Small pits of unknown aetiology were observed on the distal tibia joint surfaces of adult male skeleton 3166 and and on the right glenoid fossa of adult male skeleton 3909. These lesions have been termed osteochondritis non-dissecans (Rogers and Waldron 1995, 30) and are frequently observed in archaeological skeletal assemblages.

Undiagnosed conditions

2.2.55 A total of 16 articulated skeletons (4.61%, 16/347) exhibited lesions of pathology, which could not be diagnosed. All of these cases require cleaning and further analysis. Further investigation, with the application of radiography, may also be required to aid diagnosis. The undiagnosed cases are summarised in Table 16 under the headings of possible aetiologies. Of particular note was adult female skeleton 3052, in which the carpals and metacarpals of the left hand were ankylosed. The bones also exhibited erosions and inflammatory new bone. This may represent a case of rheumatoid arthritis, although ankylosis due to trauma and/or infection are differential diagnoses which require further investigation. Radiographic analysis may aid diagnosis of many of these undiagnosed cases.

Table 16: Undiagnosed bony abnormalities (articulated skeletons)

Sk no.	*Age*	*Sex*	*Undiagnosed pathology*
?Trauma			
3087	Young adult	??F	Large bony exostosis projecting posteriorally from the distal R tibia - ?trauma
3767	Prime adult	M	Large bony spur/bridge extending from L fibula proximal shaft to L tibia shaft - ?trauma - ?healed fracture, ?ossified soft tissue
?Trauma / ?Developmental			
3139	Prime adult	?M	L femoral head wide and flattened, no joint disease observed - ?developmental, ?perthes, ?trauma
3162	Middle adult	M	Severe scoliosis of the TV with associated ankylosis - ?trauma, ?developmental

Sk no.	*Age*	*Sex*	*Undiagnosed pathology*
3221	Prime adult	M	Lateral wedging of L side of LV2 - ?developmental, ?trauma
4036	Middle adult	F	R radius is reduced in size (not long enough to reach the distal ulna) and the head is more spherical, no obvious signs of trauma – ?developmental, ?trauma during development
?Trauma / ?Inflammation/infection			
3843	Prime adult	M	Swelling of L fibula - ?trauma, ?infection
4325	Adolescent	/	Bony nodules on proximal tibia shafts (L + R) - ?trauma, ?infection/inflammation
?Trauma / ?Inflammation/infection / ?Developmental			
3052	Middle adult	??F	L carpals + metacarpals ankylosed with new bone + lytic lesions observed ?rheumatoid arthritis, ?infection, ?trauma
4234	Prime adult	M	Possible pathological changes to both pubic symphyses – abnormal joint surfaces - ?trauma, ?infection, ?age related joint change
4440	Middle adult	?M	?Possible pathological lesion on L pubic symphysis (no new bone growth) - ?trauma, ?infection, ?age related joint change
?Inflammation/infection			
3773	Mature adult	M	Possible inflammatory new bone deposits in non-articular regions of acetabulae - ?infection
?Inflammation/infection / ?Joint disease			
3173	Young adult	F	2 small erosive lesions on the inferior surface of the CV6 body - ? infection, ?joint disease
3714	Young adult	F	Large lytic lesion on LV5 body - ?Schmorl's node, ?infection
3718	Middle adult	M	Lytic lesion in L sacroiliac joint - ?infection, ?joint change
?Inflammation/infection / ?Neoplastic disease			
4471	Adolescent	/	Large lytic lesion on medial aspect of the distal metaphysis of R femur – ?neoplasm, ?infection

Skeletal pathology – Amputated/isolated limbs

2.2.56 Of the 31 amputated and isolated limbs, 21 (67.74%) had one or more lesions of pathology. Those affected include 18 of the 22 (81.82%) amputated limbs and three of

the nine (33.33%) isolated limbs. Table 17 summarises the categories of pathology observed.

Table 17: Crude prevalence rates of skeletal pathology by category (amputated/isolated limbs)

Pathology category	*Adults CPR (n/N)*	*Juveniles CPR (n/N)*	*Total CPR (n/N)*
Congenital/developmental	/ (0/25)	16.67% (1/6)	3.23% (1/31)
Inflammation/infection	64.00% (16/25)	33.33% (2/6)	58.06% (18/31)
Joint disease	36.00% (9/25)	/ (0/6)	29.03% (9/31)
Trauma	12.00% (3/25)	/ (0/6)	9.68% (3/31)

Inflammation/infection

2.2.57 Lesions of non-specific bone inflammation and/or infection were the most frequently observed type of pathology, having been observed on the amputated/isolated limbs of two juveniles and 16 adults (involving 15 amputated limbs and three isolated limbs). In all cases, periostitis was observed on one or more bones. The periostitis was noted to be severe, long-standing and/or active in 11 of the limbs. In amputated upper limb 3063 and lower limbs 3233, 3237, 3253, 3414, and 3766, the periostitis observed was related to more severe infection of the joints (septic arthritis, see Joint disease section below). Cloacae, indicative of osteomyelitis, were observed in lower limbs 3233, 3237 (both adult) and 3789b (juvenile). The inflammation observed in right lower limb 3446 may have been secondary to trauma, given the severe contour change observed in the ankle joint.

Joint disease

2.2.58 Over one third (36.00%) of the adult amputated/isolated limbs exhibited joint disease. All observed cases affected amputated limbs. In left lower limb 4400, marginal osteophytes were present around the ankle joint, and in left lower limb 4473, the knee joint exhibited marginal osteophytes. Right lower limb 3446 exhibited severe joint contour change at the ankle, possibly secondary to trauma.

2.2.59 Left upper limb 3063 (elbow), left lower limbs 3233, 3237, 3253 and 3766, and right lower limb 3414, (all involving knee joints) exhibited more severe joint changes including erosive and inflammatory lesions, as well as periostitis on the shafts/metaphyses of the affected bones, probably indicative of septic arthritis. Septic

arthritis may result from Mycobacterium tuberculosis (tuberculous arthritis), or from a non-specific infection (usually Streptococcus or Staphylococcus) (Roberts and Manchester 1995, 115; Aufderheide and Rodríguez-Martín 1998, 106). Non-specific septic arthritis may occur through spread of the infection via the blood to the joint cavity, contiguous infection from an infected source (for example, from an infected bone), or through direct inoculation, such as a penetrating wound, as is the most common cause in modern adults (Aufderheide and Rodríguez-Martín 1998, 106). In limbs 3233 and 3237 infection of the joint may have been secondary to bone infection (osteomyelitis), evidenced by the presence of cloacae. Eburnation (polishing), indicative of osteoarthritis, was also observed in the knee joint of 3237, probably a secondary complication of the septic arthritis.

Trauma

2.2.60 A total of three adult amputated limbs exhibited definite evidence for trauma, in the form of fractures. In all three cases, the fractures were unhealed, having been sustained either peri-mortem, or around the time of amputation. In right lower limb 3037 the right tibia exhibited a crush-type fracture of the proximal metaphysis, also involving the proximal articular surface (part of the knee joint). Right lower limb 3190, estimated to be that of a male, had an unhealed butterfly fracture of the tibia shaft, and in left lower limb 4400, the distal tibia shaft exhibited an unhealed fracture.

2.2.61 As noted above (see Joint disease section), severe joint contour change was noted in the ankle joint of right lower limb 3446. This may have resulted from some kind of trauma, but this could not be confirmed, thus it has not been included in the rate given in Table 17. Cleaning and further analysis of this case is required.

Congenital/developmental disease

2.2.62 A minor congenital condition, known as symphalangism, was observed in one of the distal interphalangeal joints of the foot of amputated limb 3415, the right leg and foot of an older child. Symphalangism is an inherited condition (Austin 1951; Aufderheide and Rodríguez-Martín 1998, 76) that leads to fusion of the interphalangeal joints.

Evidence for medical intervention, post-mortem investigation and anatomisation

Amputation of limbs

2.2.63 A total of 22 isolated limbs had direct evidence for having been amputated (classified as 'amputated limbs' above). Of these, four were juvenile and 18 were adult. Details of the amputated limbs are summarised in Table 18.

2.2.64 All but one of the amputated limbs was a lower limb (12 right and nine left). Of these 14 had undergone amputation above the knee, and seven had undergone below-knee amputation. However, two of the lower limbs differed from the rest. Left lower limb 3237, whilst having been sawn through the femur above the knee joint, also exhibited a cut through the distal tibia and fibula shafts (the distal elements were also present). In right lower limb 3415, only one cut was present, the tibia and fibula having been sawn through at the midshaft region. However, the proximal parts were present, as well as the distal part of the fibula, and the foot, indicating that the limb had probably been

amputated from higher up (possibly through the femur, although this bone was not present). These two cases may represent limbs that were initially amputated lower than was necessary to successfully treat the patient, with a higher amputation carried out subsequently as a matter of necessity (e.g. to remove all infected tissue).

2.2.65 In 16 of the amputated limbs, pathological bony changes that may represent the medical reasons for the limbs having been amputated, were noted. These included cases of infection, probable septic arthritis and fractures. This said, whilst it seems most likely that the limbs were amputated as a medical treatment, this must not be assumed. It is of course possible that limbs were removed after a patient had died, for post-mortem investigation or medical training. This should be investigated through further, detailed analysis of the remains, which may reveal discrete evidence (for example, fine cut marks) for post-mortem investigation.

Table 18: Summary of the amputated limbs

Amputated limb no.	*Age*	*Bones present*	*Amputation evidence*	*Reason for amputation evident?*
3036	Adult unspecified	R tibia, fibula, foot bones	Proximal tibia + fibula shafts sawn through (below knee amputation)	?Infection – severe periostitis on tibia + fibula shafts
3037	Adult unspecified	R femur, tibia, fibula, foot bones	Distal femur shaft sawn through (above knee amputation)	?Trauma – probable unhealed crush fracture to proximal tibia metaphysis + articular surface
3059	Adult unspecified	R femur, tibia, fibula, foot bones	Distal femur shaft sawn through (above knee amputation)	?Infection – severe, active periostitis on tibia shaft
3061a	Older child	R femur, tibia, fibula, foot bones	Distal femur shaft sawn through (above knee amputation)	
3061b	Young child	L tibia, fibula, foot bones	Distal tibia + fibula shafts sawn through (below knee/above ankle amputation)	?Infection – severe periostitis on tibia + fibula
3063	Adult unspecified	L humerus, radius, ulna, hand bones	Distal humerus sawn through (below elbow amputation)	?Septic arthritis – elbow joint
3090	Adult unspecified	R tibia, fibula, foot bones	Proximal tibia + fibula shafts sawn through (below knee amputation)	
3190	Young adult	R femur, tibia, fibula, foot bones	Femur midshaft sawn through (above knee amputation)	?Trauma – unhealed butterfly fracture of tibia shaft
3233	Adult	L femur,	Distal femur shaft sawn	?Septic arthritis – knee

Amputated limb no.	*Age*	*Bones present*	*Amputation evidence*	*Reason for amputation evident?*
	unspecified	tibia, fibula	through (above knee amputation)	joint
3237	Adult unspecified	L femur, patella, tibia, fibula, foot bones	Distal femur shaft sawn through (above knee amputation). Distal tibia/fibula also sawn through (but distal parts + foot present)	?Septic arthritis + osteomyelitis – knee joint
3253	Adult unspecified	L femur, tibia, fibula	Distal femur shaft sawn through (above knee amputation)	?Septic arthritis – knee joint
3414	Adult unspecified	R femur, patella	Distal femur shaft sawn through (above knee amputation)	?Septic arthritis – knee joint
3415	Older child	R tibia, fibula, foot bones	Tibia + fibula midshafts sawn through (below knee amputation) but both the proximal + distal parts of the fibula + the proximal tibia are present (distal tibia missing)	
3446	Adult unspecified	R tibia, fibula	Proximal tibia + fibula shafts sawn through (below knee amputation)	?Infection, ?trauma – active periostitis on tibia + fibula, severe contour change at right ankle joint
3565	Adult unspecified	R femur, tibia, fibula	Femur midshaft sawn through (above knee amputation)	
3647a	Adult unspecified	L femur, patella	Distal femur shaft sawn through (above knee amputation)	
3647b	Adult unspecified	R tibia, fibula, foot bones	Proximal tibia + fibula shafts sawn through (below knee amputation)	
3766	Adult unspecified	L femur, patella, tibia, fibula, foot bones	Distal tibia shaft sawn through (above knee amputation)	?Septic arthritis – knee joint
3789b	Adolescent	L femur, tibia	Femur midshaft sawn through (above knee amputation)	?Infection – osteomyelitis in tibia
4400	Adult	L tibia, fibula,	Proximal tibia + fibula	?Trauma – unhealed

Amputated limb no.	*Age*	*Bones present*	*Amputation evidence*	*Reason for amputation evident?*
	unspecified	foot bones	shafts sawn through (below knee amputation)	fracture to distal tibia shaft
4426	Adult unspecified	R femur, tibia, fibula	Distal femur shaft sawn through (above knee amputation)	?Infection – periostitis on femur, tibia + fibula
4473	Adult unspecified	L femur, patella	Distal femur shaft sawn through (above knee amputation)	?Infection – active periostitis on femur + patella

2.2.66 Evidence for the amputation of limbs was also observed in 13 of the articulated adult skeletons (one adolescent, three adult females and nine adult males), giving a CPR of 3.75% (13/347). These cases are summarised in Table 19. Only one case (3453) involved an upper limb, in which the amputation had been carried out above the right elbow joint. The lower limb amputations involved four right limbs and eight left limbs. In six cases, amputation had been carried out below the knee joint, with six lower limbs having been amputated above the knee.

2.2.67 Only in skeleton 3960 did the end of the amputated limb (at the proximal tibia and fibula shafts) exhibit healing. In this case, the bones exhibited active periostitis. This may indicate that the leg had been infected, either before amputation (possibly the reason for the amputation), or that the leg had become infected following, possibly as a complication of, the amputation procedure.

2.2.68 In two cases (3963 and 4329), the limbs that had been amputated were present within the grave. In adult male 4329, the left proximal tibia shaft had been sawn through (below knee amputation). However, the tibia below this point was still present. In addition, the distal tibia shaft had also been sawn through, removing the ankle and foot (these elements were not present). In adolescent 3963, the left femur had been sawn through the proximal and distal shaft. Whilst the central femur shaft portion was missing, the distal part of the limb was present. As noted above for isolated, amputated limbs 3237 and 3415, these cases may represent limbs that were initially not amputated as fully as was necessary, thus a second, higher cut was required. Alternatively, they may represent some form of post-mortem investigation. Indeed, the absence of a section of femur shaft in adolescent 3963 is interesting. Also, perhaps relevant to this, is the fact that the vast majority of amputated limbs in the articulated skeletons showed no obvious evidence for healing despite the fact that, with the exception of 3963 and 4329, the limbs had not been buried with the rest of the body. It is possible that, following amputation, the limbs were used for post-mortem investigation or medical training, and were either retained or buried/disposed of at a later date, in a different location.

Table 19: Articulated skeletons exhibiting amputated limbs

Skeleton no.	*Age*	*Sex*	*Amputation evidence*	*Reason for amputation evident?*
3453	Middle adult	F	R humerus sawn through at midshaft (above elbow amputation, unhealed)	
3498	Prime adult	M	R proximal tibia and fibula sawn through (below knee amputation, unhealed)	
3668	Middle adult	M	L distal femur sawn through (above knee amputation, ? unhealed)	
3801	Middle adult	F	R femur cut through mid-distal shaft (above knee amputation, unhealed)	
3927	Prime adult	?M	L distal tibia and fibula sawn through (below knee/above ankle amputation, unhealed)	?Infection – periostitis on L tibia + fibula (but also observed on R lower limb bones)
3960	Mature adult	?M	L lower limb missing from proximal tibia/fibula shaft region (below knee amputation, healed)	?Infection – active periostitis on L tibia + fibula, could be secondary to the amputation
3963	Adolescent	?	L distal femur shaft sawn through (above knee amputation) + prox femur shaft also sawn through. L lower leg present, but 110mm length of midshaft (between the two cuts) is missing	
4082	Young adult	M	R distal femur shaft sawn through (above knee amputation, unhealed)	?Infection – periostitis on R femur
4183	Prime adult	?M	L distal femur sawn through (above knee amputation, unhealed)	?Infection – periostitis on R femur (but also observed on L lower limb bones)
4329	Mature adult	?M	L distal tibia shaft sawn through + foot not present (above ankle amputation, unhealed) + proximal tibia shaft also sawn through (below knee amputation but tibia below this point is present, unhealed)	?Infection – osteitis in L tibia

Skeleton no.	*Age*	*Sex*	*Amputation evidence*	*Reason for amputation evident?*
4369	Mature adult	?M	L proximal tibia shaft sawn though (below knee amputation, unhealed)	
4440	Middle adult	?M	L distal femur shaft sawn through (above knee amputation, unhealed)	
4479	Middle adult	??F	R tibia and fibula mid-shafts sawn through (below knee amputation, unhealed)	?Infection – periostitis on R femur, tibia + fibula

2.2.69 Aside from the cases of amputations described above, there were nine other isolated limbs, without direct evidence for amputation (i.e. in the form of cut/saw marks). These also probably represent amputated limbs, either additional cases, or cases already accounted for in the 'Amputated limbs' assemblage (i.e. it may be possible to re-associate some of the partial 'Isolated limbs' with partial 'Amputated limbs). These require further osteological analysis.

2.2.70 The disarticulated bone assemblage also revealed evidence for probable amputations. A total of 13 contexts (3006, 3009, 3199, 3238, 3480, 3515, 3560, 3591, 3706, 3783, 3880, 4063 and 4222, graves and charnel pits) contained one or more disarticulated long bones with saw marks. These included arm and leg bones, predominantly adult, with at least one juvenile bone.

Trepanation

2.2.71 One skeleton, adolescent 3465, exhibited a trepanation. The circular hole had been cut through the right parietal bone, in the region of a peri-mortem fracture. It seems likely that the trepanation had been carried out in order to treat the individual following the trauma to the head, perhaps in an attempt to relieve pressure on the brain caused by bleeding into the cranial cavity. A small area of bone was missing, having been removed via an additional cut running from the trepanned hole to the peri-mortem fracture line. This may have been a fragment of bone that had been forced inwards by the trauma, which was surgically removed in an attempt to save the individual's life. The absence of evidence for healing indicates that the individual died during, or very shortly after the surgery.

Craniotomy

2.2.72 Craniotomies were observed in a total of 10 articulated skeletons (2.88%, 10/347), two juveniles (4.26%, 2/47) and eight adults (2.67%, 8/300). These are summarised in Table 20. In all cases, the superior part of the cranium had been horizontally separated from the rest of the skull.

2.2.73 In adolescent skeleton 3465 there was strong evidence that the craniotomy had been carried out to further investigate the peri-mortem trauma (described above in the

Trepanation section). Whilst the cranium had been sawn through horizontally, the inferior portion of the right side of the skull had also been cut/sawn through vertically, just anterior to the temporo-mandibular joint. This cut had also cut through the right mandibular ramus and the atlas. The left side of the skull had not been cut vertically.

2.2.74 Pathological lesions were noted in only two of the other skulls. Adult male 3686 exhibited non-specific inflammatory lesions on the ectocranial surface, whilst adult male 3975 had endocranial lesions on the occipital bone. It is not possible to ascertain whether the craniotomies were carried out in order to further investigate pathological conditions relating to these lesions, or whether these lesions are unrelated to the post-mortem investigation.

Table 20: Articulated skeletons with craniotomies

Skeleton no.	*Age*	*Sex*
3078	Prime adult	?M
3098	Mature adult	?M
3465	Adolescent	/
3624	Prime adult	M
3675	Older child	/
3686	Young adult	M
3927	Prime adult	?M
3975	Prime adult	M
4150	Young adult	F
4251	Prime adult	??F

2.2.75 A number of disarticulated skull fragments, recovered from graves and charnel pits, also exhibited evidence for craniotomies. These were present in contexts 3009, 3783 and 4222.

Removal of body parts for post-mortem investigation, medical training or anatomisation

2.2.76 Whilst it has already been suggested above that limbs which had been amputated may subsequently have been used for post-mortem investigation or medical training, only one convincing case of a body part having been specifically taken for this purpose was noted in the assemblage. Young adult female skeleton 3173 was complete, with the exception of the skull. The grave had not been truncated, and the tips of the sixth cervical vertebrae superior articular processes had been removed by a sharp, bladed instrument, indicating that the head had been severed at the neck. The absence of the skull suggests that the head may have been retained for post-mortem investigation and/or anatomisation/medical training purposes.

2.2.77 It is of course possible that further evidence for anatomisation is present within the disarticulated bone assemblage, thus it is important that this material is examined in detail.

Intestinal parasites

2.2.78 Soil samples were collected from the abdomen/pelvic region of around 100 skeletons by members of the University of Oxford Research Laboratory for Archaeology and the History of Art during the course of the excavation. Of these, 50 were inspected under the microscope for evidence of intestinal parasite eggs. Intestinal parasites can contribute to the overall picture of health, disease and sanitation in the past, but on this occasion no eggs were found (see Appendix D).

Summary and conclusions

2.2.79 The Radcliffe Infirmary assemblage comprises 360 discrete individuals (including the assessed and non assessed material), all relatively complete and well preserved. This is in addition to limbs and disarticulated bones from grave backfills, charnel pits and shallow pits and resulting from surgical intervention and/or disturbance from grave digging and other activity (for example, the building of the 1920s eye hospital). Further analysis of these burial units is required to more accurately determine the total number of individuals present.

2.2.80 Assessments of sex and age indicate a predominantly adult group, with twice as many males than females. The very young and the very old are distinctly absent, with most individuals aged between 26-35 years (males) and 18-25 years (females). It is possible that young adult female 4246 was related to the youngest individual within the assemblage (neonate 4247), which had been buried within the same coffin. This possibly represents an obstetric death, but DNA analysis would be required in order to confirm this potential familial link (Roberts and Cox 2003, 253). Overall, the extent to which these patterns in demography are a reflection of the admissions policy of the hospital, the types of diseases and trauma that were being treated, the socio-economic status of the individuals being treated and preservational bias requires further research.

2.2.81 At the outset of the project it was anticipated that the preservation of biographical information would afford the opportunity to test methods of age and sex estimation. However, this opportunity is precluded by the fact that only two individuals were found in direct association with a coffin plate giving this information (see Section 2).

2.2.82 Of the population's physical attributes, the morphology of several skulls were notable for posessing atypical Caucasoid features. The identification of potentially non-Caucasoid individuals within this assemblage is very interesting and will greatly add to the overall picture of the composition of the population in terms of biological and ethnic diversity in Oxford at this time. Further work, specifically, visual assessment after Gill (1986) and Gill and Rhine (1990) and cranio-metric analysis of all complete, intact skulls, is required to explore this further. This could be combined with DNA and Strontium and Oxygen isotope analyses.

2.2.83 More generally, a good proportion of the assemblage preserves the landmarks required for a suite of metrical and non-metrical assessments, which will provide further

information on the physical attributes of the inidividuals. Estimated adult statures showed a particularly wide range, which may suggest a genetically diverse population and/or include individuals who were physiologically compromised during childhood. These findings are highly significant in terms of understanding the ethnic composition of the population.

2.2.84 High rates of dental disease were observed, with over three quarters of both adults and juveniles exhibiting at least one type of dental pathology. These rates currently do not take account of those skeletons for which the dentitions were not observed, and therefore they represent a minimum number. Rates for calculus and caries were especially high, possibly indicating diets that were highly cariogenic. In addition, a high prevalence of enamel hypoplasia (growth arrest) may suggest high levels of health stress in childhood.

2.2.85 A range of skeletal pathology was present, classified as metabolic, developmental, circulatory, neoplastic, infection and joint disease. Joint disease was generally infrequent (as might be expected for a group of predominantly young individuals), while non-specific bone inflammation and cribra orbitalia, both indicative of generalised poor health, were common. Interestingly, several skeletons had DISH, a bone forming disease which is associated with obesity and late onset diabetes and which, in the archaeological record, is common among the middle classes in the post-medieval period. In addition, septic arthritis, probable cases of syphilis, and possible tuberculosis, brucellocis, leprosy and rickets were all noted, but could not be confidently diagnosed without more detailed examination and radiography.

2.2.86 Trauma and medical interventions were particularly frequent, the latter evidenced by craniotomies, amputations and a trepanation. The assemblage of isolated amputated limbs provides perhaps the most compelling evidence for medical treatment, because the bones had probably been removed in order to save lives, as suggested by associated, severe pathology (for example, multiple cases of severe infection, septic arthritis and fractures). A significant number of articulated skeletons also exhibited limb amputation, but only in one case had the bones of the remaining part of the limb healed. In the unhealed examples, if it is assumed that these also represent cases of medical intervention (i.e. surgical removal of the limb in order to save the life of the patient), it is clear that the individuals had died during, or shortly after the procedure had taken place. It would be interesting to integrate this information with existing documentary evidence for limb amputations at the hospital, to further explore the success rate of such operations.

2.2.87 In most of the unhealed amputations the separated limbs were not found (i.e. they had not been buried with the rest of the body). This is interesting and requires further investigation. Possible reasons could be:

1. The amputated limb was immediately disposed of following the amputation, before the individual died and was buried (even though the interval between the surgery and death must have been short, given the absence of healing);

2. Whilst the rest of the body was buried, the amputated limb was kept for further post-mortem examination and/or medical training;

3. The amputation was actually carried out post-mortem, for further examination and/or medical training.

2.2.88 If the reason that the limbs were not buried with the rest of the bodies is because they were subsequently used for post-mortem investigation or medical training, then it seems likely that the bones should exhibit evidence for further dissection (e.g. longitudinal cuts, fine cut marks associated with soft tissue removal etc; Mitchell 2011). Whilst no clear evidence of this was observed on the amputated limbs during the assessment, further, detailed analysis of these remains, as well as of the disarticulated long bones exhibiting saw marks, is essential. This information will be key to the investigation of medical treatment and training at the Radcliffe Infirmary.

2.2.89 It should also be noted here that there may be potential to re-associate amputated limbs with articulated skeletons. This could be done by positively matching the unhealed, sawn ends of the bones, as well as through positive identification of associated left and right skeletal elements. Not only would this refine the count of individuals and allow for more detailed information on disease/medical treatment in individual cases, but it may also provide information on the burial/amputated limb disposal practices of the infirmary. For example, do any of the amputated limbs recovered from grave backfills relate to the individuals within the graves?

2.2.90 The pattern, timing and distribution of all interventions, coupled with the appearance of tool marks require further examination to determine whether any could refer to post-mortem training opportunities (and hence the practice of anatomisation). At least one example of anatomisation was seen on skeleton 3173. Here, the head had been severed at the neck and was missing, having not been buried with the rest of the body. In addition, the patterns of tool marks should be examined to explore the techniques and implements employed by the surgeons.

2.2.91 Trauma included healed and unhealed wounds. Interestingly, fractures commonly involved the skull, most often the facial region where inter-personal violence is a likely cause. Of particular interest is skeleton 4031 which had sharp force peri-mortem trauma, almost certainly arising from inter-personal violence. This case is all the more interesting given the fact that the individual appears to have suffered from a systemic and potentially disfiguring infectious disease. Further examination of the individual, to explore the diagnosis of the infection and the timing of the peri-mortem insults, coupled with a search for comparable examples, would be informative.

2.2.92 These patterns of dental disease, skeletal pathology, trauma and medical intervention may be explored further by determining true prevalence rates, which take into account missing bones/parts of bones and therefore provide a more accurate reflection of the health status of the population. While beyond the scope of the present assessment, this will allow differences in rates of disease between particular age groups, males and females and populations to be explored fully, providing a more in-depth perspective on the assemblage.

2.2.93 In conclusion, this assessment has identified a number of patterns and trends in the Radcliffe human skeletal remains which, through further detailed analysis, would make an important contribution to current knowledge of health, wealth and lifestyle within the

local population of Oxford. More broadly, it would make a significant contribution to current research on anatomisation and medical treatment, diet and dental health; health and disease; and population mobility and ancestry at local and national levels.

3 Updated Project Design

3.1 Statement of potential

Osteology

3.1.1 This sizeable and well preserved assemblage has enormous potential to add to exisiting knowledge at national and local levels. Hospital burial ground assemblages provide a unique window on post-medieval populations in terms of health status, demography, health care and medical history. In particular, they present the opportunity to explore medical interventions at a time when considerable advances were being made in medical science and practice, such as the introduction of anesthesia (the advances made in surgical practice were contingent on the development of anaesthesia and Oxford played a key role; see http://www.rcoa.ac.uk/about-the-college/history-of-anaesthesia) and the passing of the 1832 Anatomy Act.

3.1.2 The number of post-medieval human skeletal assemblages to have been archaeologically investigated from Britain is relatively small and, as such, there are significant gaps in current knowledge of these populations, particularly when compared with other time periods. Of the post-medieval assemblages that have been investigated, those from hospital burial grounds are relatively uncommon and tend to comprise small assemblages. The Radcliffe Infirmary would seem to be unique in comprising the largest number of discrete individuals excavated from a hospital burial ground outside London. It also comprises the second largest assemblage of discrete skeletons from England after The Royal London Hospital (Fowler and Powers 2013). Comparative hospital assemblages which have been archaeologically investigated are given in Table 21. Added to these are examples of medical intervention that have been identified from non-hospital post-medieval assemblages, for example the dissected human remains from Benjamin Franklin House, Craven Street, London (Kausmally 2010) and the Old Anatomy School, Trinity School, Dublin (Murphy 2011).

3.1.3 Hospital assemblages are of particular interest for the information they provide on practices relating to anatomisation before and after the introduction of the Anatomy Act in 1832. However, unlike the comparative hospital sites listed in Table 21, the Radcliffe Infirmary seems to lack evidence for dissection / removal of body parts. Thus, the value of the Radcliffe assemblage is increased by being unusual in this respect.

Table 21 Archaeologically excavated post-medieval hospital assemblages

Name	Date of burials	Number of skeletons	Reference
Royal London	1825-1841/2	636 articulated skeletons and disarticulated from 175 contexts	Fowler and Powers 2013
St Bartholomew's	1726-94	Disarticulated from a MNI of 2 individuals	West 1980

London			
Bristol Royal Infirmary	1757-1854	106 articulated skeletons and disarticulated from a MNI of 544 individuals	Witkin 2011
Worcester Royal Infirmary	18th-19th century	Disarticulated bone from a MNI of 18 individuals	Western 2010
13 Infirmary Street, Edinburgh	1749-1821	6 articulated skeletons and disarticulated bone	Henderson *et al.* 1996
Surgeon's Square, London	18th and 19th centuries	55 disarticulated bones	Henderson *et al*. 1996
Newcastle Infirmary	1753-1845	210 articulated skeletons plus disarticulated bone from a MNI of 400 individuals	Boulter *et al.* 1998
Royal Naval hospital, Greenwich	1749-1857	101 skeletons	Boston *et al*. 2008

3.1.4 Locally, some relatively scattered osteological examples of medical intervention have been found around Oxford (see Boston and Webb 2012), but none that match the scale of the Radcliffe Infirmary burial ground, which is the first of its kind to be excavated in the region. Not only does the assemblage present a rare opportunity to significantly add to a growing corpus of data on hospital assemblages from around the country, but it is also presents the unique opportunity to study the physical evidence of one of the earliest and longest lived public hospitals to be established outside London, in a city that is home to one of the earliest medical schools in Britain.

3.1.5 The Radcliffe assemblage is also highly significant because it is rare in posessing a wealth of documentary source material (see above) that exceeds contemporary assemblages (for example, The Royal London Hospital; see Fowler and Powers 2013) in completeness and extent. It therefore presents the opportunity to compare the physical evidence with the written record, which will provide an insightful and fascinating perspective on Oxford between 1770 and 1855. In addition, the Radcliffe Infirmary was the principal health care provider to individuals who were too poor to afford private treatment at home. Those interred within the burial ground probably had no surviving relatives and/or had families who could not afford to transport them to their home parish for burial. Archaeological studies of post-medieval populations have tended to focus on the middle and upper classes and therefore the Radcliffe Infirmary assemblage is a rare opportunity to learn about the lives of the poorer members of post-medieval society.

3.1.6 Finally, the assemblage holds significant potential for isotope analysis, to explore the origins and diet of the individuals buried at the hospital. In particular, the associated documentary evidence, which shows that the individuals had relatively local origins, presents the unique opportunity to test some of the assumptions frequently made when determining the ratio of 'locals' to 'incomers' in skeletal populations.

Coffin fittings

3.1.7 The Radcliffe Infirmary assemblage is important because there is currently very little in the published and grey literature on coffin remains from post-medieval hospital burial grounds. Any biographical details that have survived on the breastplates will be valuable for exploring biographical histories of the individuals they are associated with. They may also provide some help to refine dates of burial and knowledge of burial organisation through further stratigraphic analysis. No other coffin fittings were identified that give biographical details and therefore this precludes any opportunity to test osteological methods for ageing and sexing skeletons.

Artefacts

3.1.8 Excluding coffin fittings, the finds assemblage is quite small and is likely to result from casual disposal of refuse. The material recovered from the Phase 1 quarry pits was clearly deposited before the burial ground came into use, and some of the finds from grave backfills may represent redeposited material that also ultimately derived from this episode of dumping. Small rubbish pits 3212, 3240 and 3242, however, were certainly contemporary with the use of the burial ground. The only artefact that may have been functionally associated with the Infirmary was part of a very large Creamware vessel, possibly part of a washbasin, that was recovered from the backfill (3791) of grave 3788. Other washbasin fragments came from later contexts and therefore are more likely to have been associated with the Eye Hospital. The finds assemblage has some potential to provide information regarding the use of these materials during the post-medieval period on the northern outskirts of Oxford. The pottery and some of the clay pipe will additionally contribute towards refining the date-range of some of the graves and rubbish pits on the site.

3.1.9 Pit 4204 and the small group of middle Iron Age pottery recovered from it, although ostensibly unprepossessing, may be evidence for the encroachment of settlement onto the peripheries of the Neolithic/early Bronze Age funerary complex that occupied the gravel spur between the River Thames and River Cherwell and which had formerly inhibited domestic occupation in this area (Lambrick 2013, 44).

3.2 Updated research aims

3.2.1 The original aims and objectives (Section 1.4) are still largely pertinent and can be addressed by the data recovered during the excavations. In addition, some of the these have been refined by the addition of the following aims, presented as a series of research questions.

Osteology

(i) Can the material be further quantified to determine how many individuals are represented by the buried human remains ?

(ii) Is the ratio of males to females significantly different to that of contemporary sites?

(iii) To what extent is the mortality profile reflective of the admissions regulations of the hospital?

(iv) Is there any evidence of epidemics (smallpox, influenza, typhus, cholera)?

(v) Can the lower female average age at death be attributed to the risks of childbirth?

(vi) How does the mortality profile of the osteological sample compare with the documentary record?

(vii) Can any osteological data be correlated (either directly or indirectly) with biographic information particularly with regards to injuries, cause of death and health problems which were unresolved at the time of death?

(viii) How do numbers of burials compare with the burial register and what does this tell us about death rates at the hospital between 1770 and 1855?

(ix) What is the full range and extent of pathology on the skeletons and what does this tell us about the former inhabitants of Oxford in terms of their health status, lifestyle, sanitary conditions and access to medical treatment ?

(x) Are there any patterns in the spatial distribution of individuals with different pathologies/medical interventions and what do they tell us about the organisation and management of the burial ground?

(xi) How do rates for dental disease and skeletal pathology compare with other, contemporary assemblages (hospital and non-hospital)?

(xii) How do the dentures compare with contemporary examples from the rest of the country?

(xiii) What do the skeletal remains tell us about the origins of the individuals in relation to the information given in the burial registers ?

(xiv) What is the full range, character and extent of medical interventions ?

(xv) What can be determined about the success rate of ante-mortem surgical procedures performed at the hospital ?

(xvi) What was the motivation behind the different medical interventions apparent on the skeletons and to what extent was anatomisation practised at the hospital ?

(xvii) Can a specific surgeon be identified in relation to the types of medical interventions observed?

(xviii) Is there any evidence for crutch use?

(xix) What types of tools were used to perform the various medical interventions?

(xx) What understanding can be gained of the diet of those buried at the Radcliffe Infirmary?

Coffin fittings

3.2.2 How unique are the coffin fittings from The Radcliffe Infirmary and how can they be used to expand and refine the growing body of data on these artefacts and so contribute to an important resource for future archaeologists ?

3.2.3 What do the coffin fittings tell us about the the individuals they are associated with?

Artefacts

3.2.4 Can any of the artefacts recovered from graves be directly associated with the burial or was the material all residual within the backfill?

3.3 Project scope

3.3.1 The proposed programme of analysis will seek to address the research aims as comprehensively as possible, in order to gain the best possible understanding of the results and to place them within a wider chronological and thematic context, at local, regional and national levels. The analysis will be undertaken in accordance with the guidelines issued by EH as MAP2 (EH 1991) and MoRPHE (EH 2006) and will comprise three main objectives:

- The preparation of a research archive report detaining the results of the analysis, including appendices and specialist information and data;
- The preparation of a draft publication text detailing the salient results of the programme of analysis, with appropriate background, contextualisation, discussion and conclusions;
- The completion and submission of the project archive of orginal records, and of artefacts to the appropriate repository.

3.4 Interfaces

3.4.1 As part of the current project OA will work closely with the Research Laboratory for Archaeology and the History of Art, University of Oxford. Close liaison will be maintained with the Diocesan Archaeololgist for Oxford, Julian Munby, the City Archaeologist, David Radford and with Oxfordshire Museum Service, who will be the recipients of any significant artefactual and documentary material and Botley cemetery, where the human skeletons will be re-buried. Furthermore, it will be important to develop consultational interfaces with a range of specialists. Where appropriate, provisional results can be disseminated to the public through outreach.

3.5 Communications and project review

3.5.1 The project team will communicate by email and through face-to-face discussions. Regular progress reports will be made to Colin McAuley of RB Development Management Ltd (acting on behalf of University Estates), principally by email and telephone.

3.5.2 Project progress will be assessed by the project manager, Louise Loe, and the project officer, Andrew Simmonds, in face to face meetings on a weekly basis. The project will be monitored at least on a monthly basis by project manager Dan Poore and by the post-excavation manager, Anne Dodd.

4 Resources and Programming

4.1 Methods statement

Documentary research

4.1.1 The main contribution of the documentary research will be to provide information about the individuals recovered from the burial ground that may be compared with osteological information obtained through further detailed examination of the skeletons. This includes population composition, health and social status, and the practices of the infirmary in terms of surgical prodecures and governance. This will primarily be at the assemblage level, although it may be possible to research the biography of the only surviving named skeleton (associated with a coffin plate, see above) and of other skeletons should a particular pathology and/or surgical procedure, coupled with biological profile, provide a compelling link with individuals described in records (for example, the register of operations).

4.1.2 Documentary records at the Oxfordshire Health Archives and the Bodleian library will be accessed to confirm their potential. A report will be produced for the publication incorporating the data which can then be used to integrate with and inform the general conclusions and discussion of the publication.

Stratigraphic analysis

4.1.3 Stratigraphic analysis will concentrate on establishing the spatial development of the burial ground. Particular attention will be paid to the areas of intercutting graves in the south-eastern part of the burial ground and within pit 4367. The former area in particular will be significant for establishing whether the dense, intercutting graves represent the imposition of ordered rows on an area of burials that were initially less formally arranged or whether, conversely, an initially ordered structure broke down as a result of the number of burials.

4.1.4 The pottery and clay pipes recovered from grave backfills will be used to refine the dates ranges for individual graves and to inform the dating of intercutting sequences.

4.1.5 A stratigraphic narrative that describes the burial ground and its development will be prepared for publication, illustrated with plans and photographs.

4.1.6 The final publication on the archaeological works at the Radcliffe Infirmary site will also include a detailed analysis of the Walton Street wall, comprising:

- A description of the wall;
- An interpretation of the wall and a discussion of evidence of alteration or phasing;

- A complete photographic montage image of the wall with interpretative annotations added to help understand how it has evolved.

Osteological analysis

4.1.7 Condition 8 of the Faculty issued by the Diocese of Oxford currently states that no more than 50% of the excavated assemblage can be selected for further detailed investigation. However, a 50% sample is not sufficient for addressing the research aims and therefore realising the potential of the assemblage. This is because questions about health, demography and medicine require the analysis of patterns across the entire sample; to select 50% would obscure these. Therefore, all skeletal material – discrete articulated skeletons, amputated limbs, isolated limbs and disarticulated bones – should be analysed. The following methodology assumes full analysis of the entire assemblage, subject to approval from the Consistory Court.

4.1.8 All skeletons will be cleaned following standard IFA guidelines (McKinley and Roberts 1993). Detailed osteological analysis will be undertaken by employing nationally accepted standards (Brickley and McKinley 2004). The minimum number of individuals will be estimated by employing counts of the most frequently occurring skeletal landmark, combined with age, sex and overall size (Buikstra and Ubelaker 1994). Co-mingled/disassociated bones will be re-united with skeletons (where possible), by reference to site plans, the sex and age of the remains, visual and metrical matching and by undertaking re-fitting exercises (Adams and Byrd 2008; White 1992; Wright 2008). Records will be updated accordingly.

4.1.9 Ancestry will be explored both macroscopically and metrically, where relevant. Macroscopic analysis will employ the observations of Gill and Rhine (1990), which refer to features of the cranio-facial skeleton. Metrical assessment will involve, for each skeleton, taking measurements of the crania and applying these to CRANID (Wright 2008), the formula and associated software programme described above (Section 2).

4.1.10 Further manipulation of the data will be undertaken to explore the mortality profile, including comparisons with the morbidity profile and comparisons with contemporary assemblages. The sex and age of skeletons will not be routinely analysed, as this has already been undertaken. However, they may be revised (as appropriate) with reference to the nationally accepted standards described in Brickley and McKinley (2004).

4.1.11 Analysis of non-metrical cranial traits will be undertaken. Hundreds of non-metric cranial traits have been described in the anthropological literature (for example, Berry and Berry 1967). The present analysis will select traits with reference to nationally accepted standards (Brickley and McKinley 2004) including those that are believed to be more greatly influenced by inheritance and activity (Hauser and De Stefano 1989).

4.1.12 A suite of measurements will be taken (as recommened in Brickley and McKinley 2004). In particular, these will provide further information on physical attributes, to add to the height data that has already been obtained.

4.1.13 Pathology will be described and, backed up by radiography, differential diagnoses explored with reference to relevant journals (for example, the *International Journal of*

Osteoarchaeology; the *International Journal of Palaeopathology*; the *Journal of the History of Dentistry* and the *American Journal of Physical Anthropology*, and specialist texts (for example, Resnick's *Diagnosis of Bone and Joint Disorders* (1995)), by consultation with senior specialists, with whom OA has previously worked, and by consulting the online museum and archive collections catalogue of The Royal College of Surgeons (http://www.rcseng.ac.uk/museums/surgicat.html).

4.1.14 Evidence for medical intervention will be examined macroscopically using a hand lens of up to x20 magnification. Modifications will be fully described with reference to anatomical locations employing standard terminology (Ortner 2003). Selected modifications may be examined microscopically, where this will help with interpretation. For example, high powered microscopy could be undertaken to explore the timing of surgical interventions.

4.1.15 Data will be entered directly onto Oxford Archaeology's bespoke osteology database and will be analysed by calculating true prevalence rates and by performing appropriate statistical tests. Comparisons will be made with the British hospital assemblages listed in Table 21, as well as other non-hospital post-medieval assemblages from Oxford, for example, St Peter Le Bailey Churchyard, Bonn Square (Norton and Webb, 2009) and Littlemore Baptist Chapel (2012), and the rest of England, for example, St George's, Bloomsbury, London (Boston *et al.* 2009), St Martin's, Birmingham (Brickley *et al.* 2006), St Marylebone, London (Miles *et al.* 2008) St Pancras, London (Emery *et al*. 2011) and the Anabaptist cemetery, Norwich (Caffell 2007).

Isotopes

4.1.16 In order to explore aspects relating to diet and origins a programme of isotope analysis is proposed. This would be undertaken by the University of Oxford's Research Laboratory for Archaeology and the History of Art (RLAHA) and would involve destructive sampling of bones from 56 skeletons. The Faculty currently does not allow for destructive sampling and therefore the proposed work will require representations to the Court for further directions. Details of the proposed work, including a methods statement are presented in Appendix D.

Intestinal Parasites

4.1.17 Considering that no parasite eggs were found in the samples recovered during excavation, no further work will be undertaken. A short report on this work will be prepared for inclusion in the publication.

Finds analyses

Pottery

4.1.18 A report will be produced for publication, containing more detail than the current assessment report. No further detailed cataloguing will be necessary for the post-Roman pottery but the contexts of some individual pieces and groups of vessels will be investigated in more detail, particularly those with a suspected connection to the Infirmary. A quantified breakdown of the assemblage by phase will be provided along with a more considered comment on site distribution. Around 6-10 unusual post-

medieval items will be illustrated by line drawings or photographs. The group of 12 Iron Age sherds will be analysed and reported by a suitable specialist in this period and 2-3 additional drawings may be required.

Coffin fittings

4.1.19 Where necessary (ie to facilitate observation of detail) coffin fittings will be radiographed. They will be recorded and entered into a digital catalogue. Inscribed breast plates and any fittings that are determined to be unique to the Radcliffe Infirmary will be hand-drawn to scale, scanned, and digitised for inclusion within the national coffin fitting database. Comparative analysis using trade catalogues and contemporary assemblages and stylistic dating of fittings will be undertaken, as appropriate, and the results of this analysis will be presented within a brief report (incorporating a discussion and bibliography) for inclusion in the publication report.

Other metal artefacts

4.1.20 The rapid scan of selected metalwork suggests that there are very few pieces that are not coffin fittings or coffin nails. All the metalwork will be identified and recorded during the post excavation process. If any objects are considered worthy of publication a text will be prepared, including a catalogue and, if appropriate, illustrations.

4.1.21 The non-ferrous metal finds are limited and will require a basic record and brief catalogue. A very small number of finds (*c* 7-10) will require slightly more detailed publication. Selected items will be illustrated.

Worked stone

4.1.22 A brief report describing the roofstone fragments and stone disc will be written, including a review of the occurrence of stone discs.

Ceramic building material

4.1.23 No further recording or analysis are required for the CBM assemblage. The assessment report will be edited to form a text for publication.

4.1.24 The ceramic gaming counter will be photographed and described in more detail and a few tile samples will be added to the Oxford tile fabric reference collection. Apart from any minor editing to the report here, no further work on the CBM is recommended.

Clay pipe

4.1.25 A reasonably detailed summary report accompanied by a few illustrations, including one or two line drawings and a few photographs, will be produced for publication. Items of moderate interest (incomplete/damaged makers' stamps etc.) will be reported on without illustration. Seven items of particular interest have been identified, which will be illustrated and/or reported on in more detail.

Pipeclay wig curler

4.1.26 The assessment report will be edited to form a text for publication, accompanied by a photograph of the object.

Other non-metal artefacts

4.1.27 The non-metallic finds which comprise buttons will require a basic record for the archive and brief catalogue and illustration of a selected sample. The glass finds will require a basic archive record and brief publication text. This should comprise a statement characterising the glass assemblage and a basic catalogue with illustration of selected vessels.

Animal bone

4.1.28 The assemblage will be recorded and a text prepared for inclusion in the published report. The material also needs be scanned for disarticulated human bones.

4.2 Publication

4.2.1 One of the primary aims of the project is to make the results of the investigation available to the wider public. This may be achieved through deposition of the site archive with Oxfordshire County Council Museums Service, Standlake and the compilation and production of a technical report and/or the production of a publication. The deposition of a properly ordered and indexed project archive is considered by the IFA to be an essential and integral element of all archaeological projects and is a key component of that organisation's Code of Conduct (IFA 2013). The collated results of each stage of the project will form the basis of a full archive compiled to professional standards in accordance with EH and other guidelines (EH 1991; EH 2006; UKIC 1990; Walker 1990).

4.2.2 The assessment has indicated that, following the completion of the project, the results, including those arising from work undertaken by the RLAHA, would be worthy of publication. An appropriate text, which meets the guidelines set out in by English Heritage (1991; 2006) and is suitable for publication will be compiled. It will be clearly referenced and will place the site in its local archaeological, topographical and historical context, supported by a number of illustrations, comprising plans and photographs, tables to summarise data and, where appropriate, interpretative phase drawings. The proposed contents would be:

1. *Introduction*

1.1 Site location

1.2 Circumstances of project and nature of the investigation

2. *Background*

2.1 Brief historical background

2.2 Summary history of the Radcliffe Infirmary

2.3 Documentary evidence for the Radcliffe Infirmary burials

3. *Results of the Archaeological Project*

3.1 Phased description and interpretation of the features encountered during the archaeological investigations

3.2 Results of the osteological analysis

3.3 Results of isotope analyses by the RLAHA

3.4 Overviews of the results of the analysis of the material remains, including finds and coffin remains

4. *Discussion*

4.1 Chronological, economic and social discussion

4.2 Thematic context and wider examples

Bibliography

Acknowledgements

4.2.3 The complete, illustrated, text would be edited by the project manager and quality-assured by the publications manager to check and ensure that it is complete, appropriate for the purpose intended, and academically legitimate. Any corrections arising from the QA will be addressed by the project manager. The text and illustrations will be sent out to two academic referees and any corrections arising from this will be addressed by the project manager before the document is signed-off by the publications manager. Following sign-off, the project manager will submit all components of the draft for publication. It is envisaged that the draft will be published in a journal, such as *Oxoniensia* (or an equivalent publication). A stand alone Oxford Archaeology monograph (approximately 150 pages in length) is another option. This Updated Project Design has provided timings and costs for a journal publication.

4.2.4 A bound offprint of the final publication, a digital copy of the text in PDF format and any specialist papers relating to the site will be supplied to the Diocesan Advisory Committee, the Court, the Oxford City Council Archaeologist and the Oxford Urban Archaeological Database. A further offprint of the publication will accompany the archive and another will be supplied to the County Historic Environment Record.

4.2.5 A summary report (including illustrations where appropriate) will be sent to the editors of *South Midlands Archaeology* no later than three months after the end of the calendar year in which work is undertaken.

4.2.6 Provision will be made for the production of a popular four page colour handout bringing together the results of the excavation of the 18th-19th century Radcliffe Infirmary buildings and grounds and information from the contemporary burial ground. The print run will be in the region of 400 with provision for an on-line version.

4.3 Archive

4.3.1 The site archive will be deposited with Oxfordshire County Museum Service following completion of the project.

4.3.2 The site archive will consist of the following material: correspondence relating to fieldwork, context sheets, site drawings, finds and sampling records, photographic records, assessment reports, historical data and copies of specialist reports. Records will be microfiched and deposited, together with digital data, with the museum. The archive will be prepared and deposited in accordance with the guidelines set out in 'Archaeological Archives: A guide to best practice in creation, compilation, transfer and curation' (Brown 2007).

4.3.3 Considering the national importance of the archive, OA will liaise with the Diocesan Archaeological Adviser, the Oxford City Council Archaeologist and the museum curator to agree any requirements for long term digital storage.

4.3.4 An OASIS fieldwork summary form will be completed and submitted to the Archaeology Data Service.

4.3.5 The Faculty conditions state that retained human remains will be kept at Oxford Archaeology, Janus House and/or the University's Archaeological Research laboratory on Keble Road for a period of up to 10 years (or such extended period as the Court may in writing allow), at which point they will be re-buried in Botley cemetery. Considering the national importance of the assemblage it is of considerable academic interest and, given the opportunity, it holds the potential to make important contributions to research that lie beyond the scope of the work described here. It is anticipated that there will be a lot of academic interest in the assemblage following the completion of the present project (OA has already been approached by researchers from universities about the assemblage). In recognition of this, it may be more appropriate to deposit the assemblage with a local museum, such as Oxfordshire County Museum Service, Standlake (provided a local museum agrees to take the assemblage; this is currently being investigated) This would be subject to a petition to the Consistory Court to change the Faculty conditions.

Appendix A. Documentary Source Material Relating to the Radcliffe Infirmary Burial Ground

Oxfordshire Health Archives:

- RI/I/31 1848 Contents: Rules of the Radcliffe Infirmary (Manuscript).

- Deaths RI 9 B [n.d.]Registers of deaths RI 9 B1 [n.d.] Register of deaths RI 9 B1/1 Jan 1845-Mar 1858 1 vol
- [no title] RI/II/100(15) 22 April 1837 Contents: A Return of Burials at the Radcliffe Infirmary: for the period 1830-1836 inclusive.This return quotes the patient's name, his parish of residence, the date of burial and his age at burial. A total of 45 patients is recorded and this is certified as being a correct list of all interments which have taken place by Joseph West, chaplain to the Radcliffe Infirmary.
- Records of Treatment RI 10 [n.d.] Clinical records RI 10 A [n.d.]
- [no title] RI/II/100(17) 25th april 1838 petition by church wardens
- [no title] RI/I/23 1838-74 Contents: Register of all operations of a higher order performed at the Radcliffe Infirmary.

Bodleian Library:

- A short history of the Radcliffe Infirmary Robb-Smith, A. H. T. (Alastair Hamish Tearloch) | John Radcliffe Hospital ; United Oxford Hospitals 1970 | Oxford : Church Army Press for the United Oxford Hospitals | 223 p. : ill., plans ; 22 cm. | book
- The Radcliffe Infirmary Moss, Andrew. 2007 | Stroud : Tempus | 128 p. : ill. ; 24 cm. | book
- Annual report John Radcliffe Hospital. 1771- | Oxford : [Hall & Son's machine printing works, etc.] | v. : ill. ; 21 cm. | journal
- Rules of the Radcliffe Infirmary at Oxford, founded by Dr. Radcliffe's trustees, and supported by voluntary subscription.John Radcliffe Hospital. 1848 | Oxford : Printed by I. Shrimpton | 34 p. ; 23 cm. | book
- Rules of the Radcliffe infirmary. Oxford city, Radcl. infirmary. 1848 | Oxf. | cm.21. | book
- Relief of the sick and lame : two hundred years of nursing at the Radcliffe Infirmary Bone, Mary 1970 | [Oxford s.n.] | 90p. : ill. ; 22cm. | book
- To the governors of the Radcliffe Infirmary : [letter, dated] June 30, 1855 Hussey, E. L. (Edward Law) 1855 | Oxford : [s.n.] | [1] p. ; 31 cm. | book
- Analysis of cases of amputation of the limbs in the Radcliffe Infirmary, Oxford. Hussey, E. L. (Edward Law) 1856 | Lond. | book
- On the epidemic small-pox in Oxford in 1854-5. Hussey, Edward Law. 1860 | Lond. | cm.17. | book |
- Inquests at the Radcliffe infirmary [letters &c. by E.L. Hussey]. Hussey, Edward Law. | Oxford city, Radcl. Infirmary 1893) | (Oxf. | cm.21. | book
- The study of anatomy in Britain, 1700-1900 Hutton, Fiona, 1969- 2013 | London : Pickering & Chatto | ix, 203 pages ; 24 cm. | book

APPENDIX B. RISK LOG

B.1.1 This table lists risks identified during the planning of a project at the initiation stage or execution of a project.

No.	Description	Probability	Impact	Countermeasures	Estimated time / cost	Owner
1	Unavailability of specialist staff at required point in programme	20%	Medium	Source alternative internal or external expertise. Programme has flexibility built in	Should be none within overall project timescale. Some knock-on effects to submission of project possible	SPM
2	Hardware or software failure	5%	High	OA IT team to ensure repair or replacement within 24 hours	None. Will be initially be covered by warranty or replaced by OA under existing IT protocols	SPM
3	Specialist reports late	30%	Medium	Project 'pauses' to wait for reports/carry on with other aspects of project until reports received. Programme has flexibility built in	Slight delay in submission of final project report possible	SPM

Appendix C. Assessment of Finds

C.1 Pottery

By John Cotter with Alice Parkin

Introduction

C.1.1 A total of 800 sherds of pottery weighing 17.459kg was recovered from 112 contexts. Nearly all of this is of post-medieval date (*c* 1500+). A modest amount of medieval pottery, probably all residual, is also present. There are also 12 sherds of middle Iron Age pottery from a pit of this date and a single small residual sherd of Roman pottery. The pottery is in a fairly mixed and fragmentary condition but some fairly large fresh sherds occur, as is typical of pit assemblages. Most, however, are fairly small and worn. The vessel forms present are entirely domestic in character. Excluding the few very early sherds, a range of post-Roman pottery fabrics from the late 11th century through to the 19th century is present, although material from the 18th and early 19th centuries predominates. The majority of the assemblage comprises types which are well-known in the Oxfordshire region and beyond.

Methodology

C.1.2 The whole pottery assemblage was catalogued in some detail, partly as a training exercise with the assistance of a graduate intern from Oxford University (Alice Parkin). The pottery catalogue (on Excel spreadsheet) includes a breakdown of all pottery fabrics (coded) in every context, quantified by sherd count and weight per fabric. As the assemblage is mostly of later post-medieval date, and mostly from grave backfills and a few pits, the detailed and routine recording of vessel forms and other attributes was not considered worthwhile. However, comments on the range of vessel forms, decoration, condition, evidence of use, cross-joins and anything unusual were recorded in a comments field. A small number of items suitable for illustration have also been highlighted. Very few predominantly late post-medieval assemblages from Oxford have been catalogued in detail and the assemblage here is a useful addition to these. Full catalogue details may be consulted in the site archive.

Pottery Fabrics

C.1.3 Medieval pottery fabrics were recorded using the system of codes developed for the Oxfordshire County type series (Mellor 1994). Post-medieval pottery fabrics were recorded using the codes of the Museum of London (LAARC 2007), which can be applied to most post-medieval types in southern England. The types and quantities occurring here are listed below in roughly chronological order (Table 1).

Table 1: Quantification of pottery by fabric

Fabric	Common Name	Date	Sherds	Weight (g)
AV3	Middle Iron Age pottery	400-100BC	12	176
ROM	Roman pottery	43-410AD	1	10

Fabric	Common Name	Date	Sherds	Weight (g)
OXAC	Cotswold-type ware	1050-1225	2	38
OXY	Medieval Oxford ware	1075-1300	6	60
OXAQ	East Wilts ware (Newbury B)	1150-1350	1	7
OXAW	Early Brill ware (Bucks)	1175-1400	1	8
OXAM	Brill/Boarstall ware (Bucks)	1225-1625	20	200
KING	Kingston-type ware (Surrey)	1230-1400	2	9
CHEA	Cheam whiteware (Surrey/Hants)	1350-1500	1	5
TUDG	Tudor Green ware (Surrey/Hants)	1375-1550	2	2
OXBX	Late med Brill ware (Bucks)	1400-1625	45	576
FREC	Frechen stoneware (Germany)	1525-1750	17	264
BORD	Border ware (Surrey/Hants)	1550-1700	32	409
OLIV	Spanish olive jar	1550-1750	2	132
PMR	Post-medieval red earthenwares	1550-1900	189	8125
NDGT	North Devon gravel-tempered ware	1550-1900	1	6
TGW	English tin-glazed earthenware	1575-1825	29	477
PMBL	Post-med black-glazed redware	1580-1750	15	145
WEST	Westerwald stoneware (Germany)	1590-1750	9	39
BLACK	Blackware	1600-1900	2	14
VERW	Verwood-type ware (Dorset/Hants)	1600-1900	1	47
CHPO	Chinese porcelain	1600-1900+	6	29
BRSL	Brill post-med slipware	1650-1800	30	1219
STCO	Staffs-type coarse earthenware	1650-1800	2	48
ENGS	English stonewares (misc)	1670-1900	9	801
LONS	London stoneware	1670-1900	21	781
STMO	Staffs-type mottled brown glazed	1680-1800	5	54
STSL	Staffs-type combed slipware	1680-1900	4	43
NOTS	Nottingham stoneware	1700-1800	4	47
SWSG	Staffs white salt-glazed stoneware	1720-1780	32	415
CREA TORT	Creamware with tortoiseshell glaze	1740-1770	1	3

Fabric	Common Name	Date	Sherds	Weight (g)
SWSG SCRB	Staffs white stoneware with scratch-blue dec	1740-1780	2	32
STBL	Staffs fine blackware (Jackfield)	1740-1780	4	41
ENPO	English porcelain	1745-1925	17	277
CREA DEV	Creamware (Staffs/Yorks)	1760-1830	159	1654
CREA GRN	Creamware with green glaze	1760-1830	3	37
REST ENG	Red stoneware with engine-turned dec	1765-1780	1	4
CREA SLIP	Creamware with industrial slip dec	1775-1830	1	16
PEAR	Pearlware (Staffs/Midlands)	1780-1830	27	243
PEAR TR	Transfer-printed Pearlware	1780-1830	55	616
TPW	Transfer-printed wares (Staffs etc)	1780-1900+	6	65
YELL	Yellow ware (Staffs/Midlands)	1790-1900	5	118
BONE	Bone china	1794-1900	1	3
CREA BAND	Creamware with slip trailed banded dec	1797-1830	7	52
REFW	Refined whitewares (Staffs etc)	1805-1900+	7	105
REFW SPON	Refined whiteware with sponged dec	1805-1900	1	7
Total			**800**	**17459**

Chronological overview

Prehistoric and Roman

C.1.4 The ceramic sequence begins in the middle Iron Age with a group of 12 fairly fresh sherds (176g) from the backfill (4204) of pit 4203. Due to the coarseness and simplicity of the sherds there was some initial confusion that these might be early Anglo-Saxon but closer inspection suggests they are much more likely to date to the middle Iron Age (*c* 400-100BC). This is an isolated but reasonably well-preserved group pointing to activity of this date on or near the site and possibly linked to the evidence of prehistoric settlement (including barrows) found on the Radcliffe Infirmary site during earlier excavations by MoLA. The group is comprised of grey reduced handmade pottery with a sandy fabric with some organic content (AV3). It includes two crude everted jar rims, one plain upright bowl rim and one jar shoulder sherd with a band of incised decoration. Several sherds are crudely burnished externally. A single residual worn sherd of Roman grey sandy ware was recovered from context (3621), the backfill of grave (3619) which also produced late post-medieval pottery.

Medieval

C.1.5 The medieval assemblage comprises 80 sherds (905g) of pottery, mostly as fairly small/worn sherds and all commonly known types from the city. Although the context of every sherd has yet to be considered in detail these mostly seem to occur as residual material in post-medieval grave and pit backfills. The earliest sherds (OXAC, OXY) may date from the late 11th or 12th century. Products of the Brill/Boarstall industry (OXAM, OXBX), including glazed jugs, dominate here, as they do on most Oxford sites of the high and late medieval periods. The only piece of note is a complete spout from a tubular-spouted OXAM jug with a pair of grasping anthropomorphic hands, which dates to the 14th or 15th century (grave fill 3459). Late Brill/Boarstall ware (OXBX, *c* 1400-1625) is the single commonest medieval fabric type (45 sherds) but probably includes some early post-medieval vessels, as the fabric remained in production into the early 17th century. Although mostly (or all?) residual, the quantity of pottery might suggest a phase of sporadic medieval activity on the site before the digging of graves in the post-medieval period.

Post-medieval

C.1.6 By far the largest single period component of the pottery assemblage comprising 707 sherds (16.368kg) or 88% (by sherds) of the site total. The largest assemblage from a single context is 143 sherds (3354g) of pottery from context (3241), the fill of Phase 3 pit (3240) which produced pottery of *c* 1830-1840 as well as residual 18th-century pottery. Most of the pottery comes from grave and pit backfills. The pottery dating agrees fairly well with the documented digging of the first graves associated with the infirmary in 1770 and the closure of the cemetery in 1855. The second commonest ware from the site is developed Creaware (CREA DEV, *c* 1760-1830: 189 sherds) and the third commonest is transfer-printed Pearlware (PEAR TR, *c* 1780-1830: 55 sherds) the latter mostly comprising dishes and plates with Chinese-style 'Willow Pattern' designs suggesting a dating closer to *c* 1800-1830. These and several other related creamwares and refined whitewares represent mass-produced tablewares from the Staffordshire and Midlands potteries. The commonest single fabric from the site, however, is glazed post-medieval red earthenware (PMR, *c* 1550-1900), probably from local potteries including Brill (Bucks). While PMR is not generally closely datable, the character of most of the vessels here (mainly jars and some bowls) fits better with an 18th to 19th century date. English brown salt-glazed stonewares (ENGS, LONS) are fairly common, mostly in the form of spirits flagons, a few tankards and cylindrical ink/blacking bottles. One of the latter, from fill 3241 of pit 3240, has a maker's stamp dating to the 1830s. The complete absence of English stonewares with glassy Bristol-style glazes (invented in 1835) and the very low presence of transfer-printed (TPW) and related wares dating after *c* 1830 also points to a cut-off point of *c* 1840/50 for the main period of pottery deposition. Obviously some of these late 18th and 19th century tablewares and kitchenwares, which are quite robust, may have remained in use for some decades before breakage and subsequent disposal. It is unlikely (but not unheard of) that any were deposited as grave goods, but they may well be derived from the refectory and kitchens of the Infirmary. Although no obviously late 19th/20th century pottery was identified, a few pieces of ceramic building material (CBM) appear to be of this date (CBM, below). These include a very late-looking ceramic wall tile from grave

backfill (3391) of perhaps *c* 1880-1920+ and an assemblage of sanitary CBM wares (including water closets and washbasins) datable to *c* 1890-1930 from the backfill (3474) of a Phase 3 well (3476).

C.1.7 A range of earlier post-medieval wares of the later 16th and 17th centuries (and clay pipes) testify to some activity (or rubbish deposition) before the foundation of the infirmary. These might be associated with gravel or brickearth quarrying in the vicinity. None of this material is of particular significance. There is quite a strong presence of 18th century pottery, including Brill slipware (BRSL, 30 sherds) and Staffordshire white salt-glazed stoneware (SWSG, 32 sherds). The latter, datable to *c* 1720-1780, includes decorated dishes with borders suggesting a dating of *c* 1750-1780 and therefore possibly overlapping with the early years of the Infirmary. Several quite interesting vessels came from the fill (3403) of Phase 1 pit 3542, with other pottery of *c* 1790-1830. These include SWSG dishes and a pair of unusual moulded spouts/pouring lips probably from two separate SWSG 'gravy boats' with acanthus leaf and other types of moulded decoration. It also includes a flat base (or lid) from a very fine cylindrical SWSG ?tankard or container with a very unusual 'scratch blue' copperplate-style inscription including part of a name ('Saml/ ---ff---') - possibly an owner's mark? Two body sherds from this pit come from an unusual and very large Woolwich-style PMR storage jar with cross-joins with several other contexts including the fill of Phase 1 rubbish pit 3212 and a couple of grave backfills (3086, 3223). The jar (or deep bowl) has a flanged rim (dia. 460mm) designed to take a lid and is decorated on the body with large applied clay rosettes and combed wavy band decoration. It may have had a specialised function (eg. a pickling or salting jar) and may be an import from one of the London Thames-side potteries of this date. It is quite unlike any other jar of this period published from Oxford.

C.1.8 Other inscribed vessels (from other contexts) include a few Creamware (CREA DEV) dishes or plates of *c* 1800 with black transfer-printed inscriptions on the rim flange naming 'Balliol College' and with a distinctive brown rim edging or border (contexts 3241, 3440, 3791). How these ended up on the site is something of a puzzle, although college plates do occasionally turn up on Oxford sites far from the colleges they came from. Another inscribed vessel is represented by the base of a Creamware tankard with the name 'Hick' or 'Hicky' crudely scratched on the underside (3241). Parts of a very large Creamware vessel, possibly part of a washbasin, were also noted in a couple of contexts and may have derived from the infirmary (3791, 3199). Rarer coarseware fabrics (probably 18th century) include single sherds of North Devon gravel-tempered ware (NDGT) (3211) and Verwood-type ware from Dorset/east Hants (3008) - both the first examples identified from Oxford. Two sherds from the same Spanish olive jar (OLIV) represent another rare type (3007, 3791) known only from three or four sites in the city. A fairly large number of red earthenware flowerpots were also noted from later contexts, including several early examples with white slip banding on the rims typical of Brill products (PMR, BRSL). The small assemblage of English tin-glazed wares (TGW) includes a number of ointment pots including two from context 3403 with late-style blue-painted decoration of *c* 1750-70. Again these might be connected with the early infirmary.

Recommendations

C.1.9 It is recommended that a slightly more detailed report should be produced for publication. No further detailed cataloguing will be necessary for the post-Roman pottery but the contexts of some individual pieces and groups of vessels should be investigated in more detail, particularly those with a suspected connection to the Radcliffe Infirmary. A quantified breakdown of the assemblage by phase should be provided along with a more considered comment on site distribution. Around 6-10 unusual post-medieval items should be illustrated by line drawings or photographs. The group of 12 Iron Age sherds should be analysed and reported by a suitable specialist in this period and 2-3 additional drawings may be required.

C.2 Metal and glass

By Ian Scott

Summary and quantification

C.2.1 The finds from the Radcliffe Infirmary burial ground comprise a large quantity of iron finds, some few small copper alloy finds, a small number of non-metallic finds and small glass assemblage (Table C2.1).

Table C2.1: Summary of small finds

Material	*Count*	*Weight (g)*
Iron	3935	57736
Copper alloy	172	-
Silver	1	-
Glass	111 sherds	6853
Ceramic buttons	7	-
Nacre buttons	6	-
Tortoise shell	1	-

Assemblage composition and provenance

C.2.2 The finds assemblages have been rapidly scanned. No detail record has been made of the finds at this stage.

Ironwork

C.2.3 The ironwork forms the overwhelming bulk of the finds assemblage by both weight and count. The finds are mainly from burials and most of the ironwork comes from coffin

contexts (n = 3079, 44613g) or was associated with skeletons (n = 42, 783g). The fills of graves produced a further 721 pieces of ironwork (9887g), other fills 27 iron objects (907g) and soil layers 11 pieces of iron (167g). Only some 55 objects (1397g) came from contexts that predated the cemetery or were significantly later than the cemetery. Much of the ironwork and in particular that associated with the coffins comprises nails and coffin handles and handle plates. In addition, two breastplates were found and are the only evidence recovered from the burial ground that may give biographical details and therefore identify the individuals they were associated with. The ironwork is not particularly well-preserved.

Non-ferrous metals

C.2.4 Copper alloy finds comprise for the most part pins, presumably used to fasten shrouds. The other finds of interest include a small number of lace tags, small wire rings associated with coffin 3513, a small plain ring (grave fill 4558), a book clasp (grave fill 3153), a very worn and eroded jeton (grave fill 3099), a plain flat circular shank button (grave fill 3631), and a decorative cast fitting of uncertain purpose (grave fill 3815). The sole silver item is sixpenny piece of George III dated 1816 from soil 3008.

Non-metallic finds

C.2.5 There are seven ceramic buttons from grave fill 4105. These buttons were made using the process patented by Richard Prosser of Birmingham and date from after *c* 1840. There are also six nacre (mother of pearl) buttons, five from grave fills (3397, 3500, 3631) and one button from a coffin (3513). Finally there is a small but complete tortoise shell comb from coffin 4044.

Glass

C.2.6 The glass comprises for the most part vessel glass, much recovered from grave fills. Of the 110 pieces of glass, 38 are from contexts that either pre-date or post-date the cemetery. There are numerous sherds from wine bottles, including complete bases and necks. The bottles range from the early 18th to late 18th and early 19th century in date, with most dating to the mid-late 18th century or early 19th century. There are 18 sherds from grave fill 3631. These include the complete neck and shoulders of a large cylindrical jar or wide necked bottle with tooled rim in green metal together with a number of body sherds, most of which undoubtedly belong to the vessel. Very little of the base of the jar survives. The vessel is probably early 19th-century in date. There is surprisingly little window glass. With the possible exception of one or two pieces of window glass none of the glass need date later than the early 19th century.

Assessment

C.2.7 It clear that most of the metal finds are either coffin fittings (iron nails, handle plates, etc) or are from the shrouds (pins) or clothing (buttons) of the deceased. There appear to be very few objects accompanying the burials, which given the circumstances of the burials is hardly a surprise. The glass recovered from grave fills and elsewhere is by and large contemporary with the burials. There is little evidence for the redistribution or redeposition of earlier material. Much of the glass comprises sherds from wine bottles, and amongst the material are large pieces of the bases of bottles and a number

complete bottle necks. It is unlikely that the bottles were redeposited rubbish. The sherds from the cylindrical jar or wide necked bottle from grave fill 3631 are interesting and may have been rubbish thrown into a convenient hole in the ground.

Further work

Ironwork

C.2.8 The main task will be to identify and record the iron coffin handles and handle plates, using an existing corpus of designs and adding any new designs or design variants to the corpus. The two coffin plates will also be recorded in this way, including identification of any surviving inscriptions which may give the name and age of the individuals they were associated with. Any piece of ironwork that is not either a coffin fitting or nail will be identified and recorded during the post excavation process. The rapid scan of selected metalwork suggests that there will be very few such pieces. If any objects are considered worthy of publication they will be included in the published report.

Non-ferrous metalwork

C.2.9 The non-ferrous metal finds are limited and will require a basic record and brief catalogue. A very small number of finds (*c* 7-10) may require slightly more detailed publication. Selected items should be illustrated.

Non-metallic finds

C.2.10 The non-metallic finds which comprise buttons will require a basic record for the archive and brief catalogue and illustration of selected sample of buttons.

Glass

C.2.11 The glass finds will require a basic archive record and brief publication. This should comprise a statement characterising the glass assemblage and a basic catalogue with illustration of selected vessels.

C.3 Ceramic building material

By John Cotter with Alice Parkin

Introduction and methodology

C.3.1 A total of 114 fragments of ceramic building material (CBM) weighing 12.451kg was recovered from 36 contexts. This appears to range in date from the 13th or 14th century until the late 19th or 20th century. Post-medieval material predominates and it seem likely that all the medieval material is residual and redeposited. Much of the post-medieval material is probably residual too. In general, the condition of the assemblage is very worn and fragmentary, although a few pieces are fairly fresh and a couple of very late bricks are fresh and complete. The largest context assemblage is the 36 pieces from context 3474, the backfill of well 3476. The rest of the assemblage mostly comes from grave and pit backfills dating from the 18th-19th centuries.

C.3.2 The CBM was catalogued at an 'intermediate' level of detail, somewhere between a basic catalogue (ie. recording just sherd counts and weight per context) and a detailed catalogue. By this system broad functional categories of CBM were recorded by sherd count per context (ie. roof tile, brick etc) but categories were not individually weighed. Overall weight per context was noted, however. This gives a reasonably detailed snapshot of the composition of the assemblage. Other details were recorded in the catalogue in a comments field. Full details may be consulted in the catalogue but are summarised in the report here. The material was catalogued with the assistance of Alice Parkin, a graduate intern from Oxford University, and all identifications and data were checked by the author.

Flat roof tile (48 pieces)

C.3.3 As usual the bulk of the CBM comprises plain or flat rectangular roof tile with a pair of circular nailholes near the upper end (peg tiles). The assemblage is mostly very fragmentary and worn, although some post-medieval pieces are fairly large and fresh - but no complete lengths of widths survive. Most tiles are in a range of sandy orange-red fabrics which include several very worn medieval pieces dating from the 13th or 14th centuries. A single medieval piece in an off-cream fabric (Fabric VIIA) was also noted. Other tiles are in a sandy late medieval fabric that was first noted at the Classics Centre site in St Giles and probably dates from the 15th-17th century (Cotter 2008). These normally have an oxidised orange-brown fabric with swirls and pellets of white clay and coarse iron-rich inclusions. The Radcliffe Infirmary examples of the latter mostly occur in an unusually pale orange-buff fabric which may be from a different source. A small number of dense, smoother and generally neater orange-red tiles were also noted from contexts associated with later post-medieval pottery types or clay tobacco pipes. These smoother red tiles (possibly from several sources) appear to have been the main type of ceramic roof tile in Oxford until at least the 19th century.

Ridge tile (4 pieces)

C.3.4 These are in a similar range of fabrics to the flat roof tiles (see above). A couple of small and very worn pieces come from the curved sides of orange sandy medieval ridge tiles (13th-16th century), including a glazed piece. A fairly large but worn fragment comes from the apex of an unglazed crested ridge tile in an unusually pale orange-buff St Giles-type fabric with broken knife-cut triangular crests (context 3211). This probably dates to the 15th-17th century but was residual in post-medieval rubbish pit 3212, along with pottery of *c* 1750-1780. A large end fragment from fill 3403 of pit 3542 comprises almost the whole vertical profile of an orange-red post-medieval ridge tile of simple curved or slightly V-shaped cross-section. This was associated with pottery of *c* 1790-1830 and is probably of broadly contemporary date. Finds of datable post-medieval ridge tiles in Oxford are generally much rarer than medieval examples.

Brick (19 pieces)

C.3.5 Mostly a very scrappy/worn collection, possibly including one or two examples of soft red handmade Tudor-style bricks. Most pieces are of indeterminate post-medieval date. No examples are frogged. A couple of very late bricks, however, are complete and unworn. One of these is in an orange fabric and probably of 18th to early 19th century

date (3440). It was associated with pottery of *c* 1820-1850 in a bedding trench flanking path 3441. The other complete example (3475) is in a very hard orange-brown fabric and appears to have been machine-made, which suggests a late 19th or 20th century date. It came from the lining of well 3476, which contained pottery and other CBM of similar date (see below).

Floor tile (1 piece)

C.3.6 A single corner fragment from a very worn 'quarry' tile in a fine sandy red fabric (3007), is possibly of early post-medieval date but residual in later pit 3542.

Other CBM (42 pieces)

C.3.7 Most of these (34 pieces) are from context (3474), the backfill of modern well 3476. These include fragments of sanitary whiteware and yellow ware, probably including washbasins, a washbasin stand and water closets. One piece bears moulded decoration in the Art Deco style dating it to *c* 1890-1930. Another piece of yellow ware drainage pipe (from a WC?) bears part of a late-looking maker's stamp. The same context produced pieces of brown salt-glazed stoneware drainpipe and the rim of a chimney pot. Other contexts produced pieces of three separate tin-glazed ('delftware') wall tiles with painted decoration in blue or blue and purple. These date from the mid 18th century but are residual in contexts containing early 19th century pottery (3403 and 4236). Another sub-category includes a piece of grey 19th or 20th century cement with a thick layer of bitumen or tar (3104). The most unusual item is a worn gaming counter (dia. 40mm) made either from a filed-down green-glazed roof tile or from a thick pot base (Fabric OXBX?) and probably dating to the 16th or early 17th century but residual in a later context (3007).

Recommendations

C.3.8 The main interest of the assemblage lies in the fact that very little medieval or post-medieval CBM has been studied or reported on from this suburb of Oxford. The ceramic gaming counter should be photographed and described in more detail and a few tile samples should be added to the Oxford tile fabric reference collection. Apart from any minor editing to the report here, no further work on the CBM is recommended.

C.4 Clay pipe

By John Cotter with Alice Parkin

Introduction and methodology

C.4.1 A total of 356 pieces of clay pipe weighing 1677g was recovered from 94 contexts. These have been catalogued and recorded on an Excel spreadsheet. The catalogue records, for each context, the spot-date, the quantity of stem, bowl and mouth fragments, the overall sherd count, weight, and comments on condition and any makers' marks or decoration present. It also records the minimum number of bowls per context. Most of the pipe bowls and possibly some of the stamps can be paralleled with those published from excavations in St Ebbe's, Oxford (Oswald 1984) and to a slightly lesser extent with those published in Oswald's simplified national typology (Oswald 1975). The

St Ebbe's pipe dates have been used in preference to more general national dating. Other (mainly later) bowls are identified in the catalogue according to a series of codes based on Atkinson and Oswald's (1969) London pipes typology with bowl types assigned to an abbreviated code (eg. AO22). The material was catalogued with the assistance of Alice Parkin, a graduate intern from Oxford University, and all identifications and data were checked by the author.

Summary of the assemblage

C.4.2 The pipes are mostly in a poor to fairly good condition with a reasonably high proportion of complete bowls present and a few fairly long pieces of stem - up to 105mm long - although most are much smaller. A fairly high degree of residuality was noted, particularly from grave backfills. In total there are 65 pieces of pipe bowl from a minimum of 61 bowls (20 complete), 6 pieces of mouth and 285 fragments of stem. The highest number of pieces from a single context is the 27 pieces from context 3403, the fill of Phase 1 Pit 3542. This context produced 10 pipe bowls, including three of *c* 1820-1860 (and pottery of *c* 1790-1830). Another fill of the same pit (3007) produced 23 pieces of pipe including four bowls and pottery of *c* 1820-1840. Fill 3211 of Phase 1 pit 3212 produced 18 pieces of pipe broadly datable *c* 1740-1800 and pottery of *c* 1750-1780. Although the fills of rubbish pits produced the highest number of pipes per context (and some of the largest pieces), the highest proportion of pipe fragments came from the numerous Phase 2 grave backfills (with a documentary dating of 1770-1855). Most of these produced just a few pieces of pipe stem (often just one) but two graves (3283 and 3315) produced 14 pieces each. Many graves produced residual 17th-century bowls and stems. The distribution of pipes by broad context type is shown in Table C4.1 below.

Table C4.1: Quantification of clay pipe assemblage by context type

Context type	**No. ctxs**	**No. pieces**
Graves	76	225
Pits and layers	18	131
TOTAL	**94**	**356**

Date-range and emphasis

C.4.3 The earliest pipes comprise three bowls of St Ebbe's Type A of *c* 1630-1655 with circular or heart-shaped heels (ctxs 3211, 3241, 3172). Bowls of Type B (*c* 1650-1690/1700) are also common as are bowls of Type C (*c* 1690-1720). Presumably all these early types are residual in their contexts. There are also a fair number of Type D bowls (*c* 1750-1790), a few London-type AO26 bowls (*c* 1740-1800) and a single bowl of AO27 (*c* 1780-1820 with 'WN' mark) from grave 3780. By contrast, 19th century bowls are relatively scarce; there are four examples of AO28 (*c* 1820-1860), including one from fill 3241 of pit 3240 and three from fill 3403 of pit 3542 with 'CP' marks. Other contexts are dated only by 19th century stem fragments.

Potential for further study

C.4.4 The assemblage, which is quite large, is fairly typical of Oxford sites except that it includes two pipe stems of mid 18th century date with square makers' marks containing the names of two Broseley pipemakers (see below). These are fairly rare from Oxford sites and the marks here do not appear to have reported from the city previously. Broseley (Shropshire) was one of the major pipe-producing centres in England from the 17th to the 19th century. Other marked pieces have the potential to contribute towards our knowledge of clay pipes in Oxford. Some late 18th and 19th century pipe bowls can contribute towards refining the date-range of some of the graves and rubbish pits on the site.

Recommendations

C.4.5 The basic catalogue with its extensive comments field and some parallels should be detailed enough to form the basis of a report without any more detailed cataloguing being required. It should be possible from the existing catalogue to construct a rough quantified table of the main types and dates of pipe bowl from the site. Most of the assemblage is plain/unmarked and comprises a limited range of bowl types typical of Oxford pipe assemblages (Oswald 1984); these should not require much more attention apart from quantification by type and some discussion of context. Only a dozen or so pieces are marked or otherwise of special note and therefore require further investigation and possibly illustration. A reasonably detailed summary report accompanied by a few illustrations, including one or two line drawings and a few photographs, should be sufficient for publication. Items of moderate interest (incomplete/damaged makers' stamps etc.) can be reported on without illustration but items of particular interest which should be illustrated and/or reported on in more detail are briefly described and listed below:

1. Context 3211, Grave 3212. Burnished stem with square maker's mark: 'WILL/HARPER/BOSS' for William Harper of Broseley *c* 1730-1740 (SCPR 11, 1986, 7). Illustrate.

2. Context 3086, Grave 3089. Fresh stem with very faint square maker's mark - probably an 18th century Broseley product. The first few letters are possibly 'BES---'. To be identified.

3. Context 3403, Pit 3542. Three bowls (2 complete) of London-type AO28 (*c* 1820-1860) with squared heels. All three with relief heel mark 'CP'. Probably an unidentified local maker (less likely Charles Pickman of Henley, *c* 1752). To be identified and possibly illustrated.

4. Context 3783, Grave 3780. Broken bowl base of London-type AO27 (*c* 1780-1820) with squared heel. Relief heel mark 'WN'. Probably an unidentified local maker or possibly a London maker? To be identified and possibly illustrated.

5. Context 3318, Grave 3315. Short stem fragment with band of complex rouletted decoration, probably a running scroll of flowers/leaves and 3-4 bands of milling as a border. Probably 18th century. Similar to Chester pipes of this date and possibly an import from there? To be identified and illustrated.

6. Context 3579, Grave 3576. Broken bowl base of London-type AO23 (*c* 1690-1720) with spur. Spur marked 'EG'. Probably an unidentified local maker or possibly a London maker? To be identified and possibly illustrated.

7. Context 3631, Grave 3634. Broken bowl base of uncertain late 18th/early 19th century type with squared spur. Relief spur mark 'IP'. Possibly the Oxford maker J Pottinger (*c* 1849-1860) or an unidentified local maker? To be identified and possibly illustrated.

C.5 Pipeclay wig curler

By John Cotter

C.5.1 A complete pipeclay wig curler (weight 22g) was recovered from a grave context containing no other datable ceramic finds (context 3263, backfill of grave 3260). The piece is in quite fresh condition with only slight wear visible on the bulbous terminals. It is of fairly well defined 'dumbell' shape with poorly defined and slightly flattened or concave terminals suggesting a late 17th- or 18th-century dating. No maker's mark is present on the circular terminals but they appear to bear finger-tip impressions. Except for the ends the whole item is covered with lateral burnishing. It has the following dimensions:

Max length: 66mm

Max diam of bulbous terminals: 18mm

Min diam of tapered shaft: 12mm

Diam of circular terminals: 9-10mm

C.5.2 Wig curlers became popular during the second half of the 17th century (Mellor 1984, 262-3). They fell out of fashion, along with wigs, during the late 18th and early 19th centuries.

Recommendations

C.5.3 The note here plus a photograph of the object should be published

C.6 Worked stone

By Ruth Shaffrey

Summary and quantification

C.6.1 A total of 16 pieces of stone were retained during the excavation, of which six are worked.

Methodology

C.6.2 The stone was rapidly examined and briefly recorded. All the information was entered into an Access database.

Description

C.6.3 Six items are of interest. These comprise five roof stone fragments from the fill of Phase 2 pit 3212. Each is perforated and therefore represents a different stone, but none are complete. All the fragments are made from a sandy limestone typical in Oxford. A few fragments of slate were also recovered but none complete enough to ascertain that they were certainly from roofing. A sixth fragment of the same sandy limestone may also have originated as a roof stone as it has an appropriately sized perforation. However, by the time it was deposited in a grave backfill (3223 filling 3226), it had been fashioned into a small disc of which half survives.

Table C6.1: Catalogue of worked stone

Ctx	*Type*	*Phase*	*No*	*Function*	*Notes*	*Size*	*Lithology*
3223	Grave backfill	2	1	Disc/reused roof stone	Small roughly semi circular fragment that is rather thin for a roof stone but might well be formed from one 8mm perforation	52mm diameter x 7mm thick	Sandy limestone
3211	Fill of pit 3212	2	5	Roof stone fragments	Five separate stones, each with a perforation, circular and 7-9mm diameter. One has two measurements, rest are 12-22mm thick	115 x >110mm x 18mm thick	Sandy limestone

Statement of Potential

C.6.4 The stone has very little potential to add to our understanding of the site.

Recommendations for further work

C.6.5 A brief description of the roofstone fragments and stone disc should be included in the publication. A review should be prepared of the occurrence of stone discs. This can be expected to take half a day.

C.7 Animal bone

By Lena Strid

The assemblage

C.7.1 The animal bone from the Radcliffe Infirmary site (OXIB13) comprises 757 fragments (8802g) deriving from a number of different features, including graves, pits, foundation cut backfills and layers. The assemblage was briefly scanned, but no recording has taken place at this stage.

C.7.2 Bones from cattle, sheep/goat, pig, horse, dog, rabbit, ?hare, domestic fowl, duck and a single bone from an unidentified wild bird were found in the assemblage and were generally in good condition. Judging by skeletal element representation and presence of butchery marks, the assemblage consists of both butchery and kitchen waste. There is no indication that any parts of the assemblage were used as a teaching collection, something that has been evidenced for some London hospitals (Morris *et al*. 2011).

Discussion and recommendations for further work

C.7.3 Post-medieval animal bones, particularly for the later part of this period, have often been neglected in archaeological reports (Thomas 2009). However, for the Radcliffe assemblage it is also important to consider the contexts from which these bones derive. Faunal remains from pits probably represent disposal of local waste, whereas the provenance of material in graves and cultivated soils is more problematic, since these deposits may include material spread onto the fields as fertiliser, some of which may have become redeposited into graves as backfill. However, at the Radcliffe Infirmary site the well-preserved nature of the assemblage suggests that the animal bones found in the grave fills had not been exposed above ground for any significant time, and consequently it is likely that the faunal remains were deposited during, or a relatively short time prior to, the founding of the graveyard.

C.7.4 Potentially, while not necessarily deriving from the hospital itself, assemblages clearly dated to the post-medieval centuries may provide information pertaining to the investigation of animal utilisation in the Oxford area at this time. Consequently, the small quantity of faunal remains from securely dated 18th-19th century pits and similar features warrant full recording and analysis, although as the number of bones from these features is small they can not provide much useful information about meat consumption at the hospital. The assemblages of bone potentially of mixed provenance from Phase 2 grave fills and general soil layers from Phase 1 and 2 are unremarkable and have limited interpretative value, although likely to be more or less contemporary with the use of the cemetery. Consequently, beyond a basic record of this assemblage no further work on the bone from these deposits is recommended. Although a relatively small post-medieval assemblage, the data from it should be made available for future research into post-medieval/early modern animal husbandry and animal utilisation in Oxford.

C.7.5 The contexts also need be scanned for disarticulated human bones.

C.7.6 It should be noted that as the entire human assemblage has not been assessed at this stage, the number of faunal remains from grave fills may increase.

Table C7.1: Quantification of animal bone fragments by feature type and phase

	Phase 1		Phase 2	Phase 3
	MIA pit 4203	18th century features		
Pit	5	155	27	16

Charnel pit			5	
Grave backfill			356	
Bedding trench		2	25	
Construction cut				8
Layer		4	30	51
Evaluation trench backfill				73
Totals	5	161	443	148

Appendix D. Proposal for Scientific Analysis of Human Remains from Radcliffe Infirmary Site

By Mark Pollard and Peter Ditchfield

D.1 Bone and dental isotopes

D.1.1 Following our discussion of these remains, we would now like to make a proposal for the chemical analysis of a number of the skeletons. For parts i) and ii), this would involve removing (by drilling) approximately 1g of bone powder from each of the rib and femur of an articulated individual, plus removing a small chip of dental enamel from the M2 or M3 of the same individual.

D.1.2 We have three research questions in mind:

I) As part of our long-term programme of the scientific study of the population of Oxfordshire, it is important that we document a sub-set of the human remains from this site, since they represent a time period (post-medieval) and a population (?working class) that we have not yet been able to study. We also note that such assemblages have rarely been scientifically studied anywhere in the UK, so these data would be of national importance.

ii) Methodologically, we would like to use this population to refine our procedures for identifying 'local' vs 'incomers' in a skeletal population. According to the documentary evidence, it appears that the majority of the adult males seem to be relatively local (Upper Thames Valley to West Country). The preliminary osteology report suggests, however, that four individuals have skull morphometrics which indicate non-Caucasian. This assemblage therefore offers a unique opportunity to test some of the assumptions frequently made when determining the ratio of 'locals' to 'incomers' in skeletal populations, since it would appear that the majority of these individuals should conform to a local/regional dietary and strontium isotope signal. These data will then be compared with our extensive database to ascertain if they conform to what we expect for a local signal.

D.1.3 In order to address these two related questions, we therefore propose sampling the following:

a) the four putative non-Caucasian skeletons;
b) a sample of 20 adult males, across the age categories young to mature adult
c) a similar sample of 20 females,
d) a sample of six older child/adolescents.

D.1.4 For each skeleton, we request permission to:

Sample by removing approximately 1 gram of bone from the rib and femur of each selected skeleton by drilling. Isotopic measurements ($\delta^{13}C$ and $\delta^{15}N$) will be made on collagen isolated from each sample taken. Unused collagen will be returned for archiving with the original skeleton or reburial.

Sample the dental enamel by removing a small chip of enamel (*c*. 30 mg), usually from M2 or M3. These will then be submitted for strontium isotope analysis (we usually have these measurements done at Cape Town), and also measure $\delta^{13}C$ and $\delta^{18}O$ in the dental carbonate within the enamel. Any unused enamel will also be returned.

D.1.5 The third research question we would like to address using this material is the natural variation in carbon and nitrogen isotopes in different skeletal elements of the same skeleton. We and others have observed small differences between relatively rapid turnover bone (e.g. rib) and slower turnover (such as femur) in the same individual, which are commonly interpreted as differences in diet between earlier and later life. We have, however, from a combination of studies of modern cadaveric material and complete archaeological skeletons, begun to suspect that there might be systematic differences between skeletal elements due to physiological variation, which might be more related to age than diet. To test this, we request permission to sample six individuals (3 males, 3 females) to compare variation within a single skeleton. For each skeleton, we will sample up to 30 different bones.

D.2 Intestinal Parasites

D.2.1 Soil samples were collected from around 100 individual graves, of which 50 were inspected under the microscope for evidence of intestinal parasites (report to follow). Parasite eggs were not found in any of the inspected samples, and we therefore do not propose to follow up this work at this stage.

Appendix E. Methods Statement for Fragmentation Surface Condition and Overall Preservation

Fragmentation definitions

Low = <25% of present bone fragmented
Medium = 25-75% of present bone fragmented
High = >75% of present bone fragmented

Surface condition (McKinley 2004, 16)

Grade 0: Surface morphology clearly visible with fresh appearance to bone and no modifications.
Grade 1: Slight and patchy surface erosion.
Grade 2: More extensive surface erosion than grade 1 with deeper surface penetration.
Grade 3: Most of bone surface affected by some degree of erosion; general morphology maintained but detail of parts of surface masked by erosive action.
Grade 4: All of bone surface affected by erosive action; general profile maintained and depth of modification not uniform across whole surface.
Grade 5: Heavy erosion across whole surface, completely masking normal surface morphology, with some modification of profile.
Grade 5+: As grade 5 but with extensive penetrating erosion resulting in modification of profile.

E.1 How to work out overall preservation

E.1.1 Decide upon the surface condition using McKinley (2004, 16) and the degree of fragmentation as described above. Cross reference the surface condition grade with the fragmentation level on Table E.1 below to obtain a preservation score. The preservation category with which the score is equivalent to, is given in Table E.2.

Table E.1

Surface condition (McKinley 2004)	**Fragmentation level/ value**		
	Low (1)	**Medium (2)**	**High (3)**
0	1	2	3
1	2	3	4
2	3	4	5
3	4	5	6
4	5	6	7

5/5+	6	7	8

Table E.2

Score	**Preservation category**
1	Excellent
2 - 3	Good
4 - 5	Fair
6 - 7	Poor
8	Destroyed

APPENDIX F. BIBLIOGRAPHY

Adams, B J and Byrd, J E, 2008 *Recovery, Analysis, and Identification of Commingled Human Remains* Humana Press, New York

Atkinson, D, and Oswald, A, 1969 London clay tobacco pipes, *Journal of the British Archaeological Association* **32**, 171-227

Aufderheide, A.C and Rodríguez-Martín, C, 1998 *The Cambridge Encyclopedia of Human Paleopathology*, Cambridge University Press, Cambridge

Austin, F, 1951 Symphalangism and related fusion of the tarsal bones, *Radiology* **56**, 882-5

Berry, A C, and Berry, A J, 1967 Epigenetic variation in the human cranium, *Journal of Anatomy* **101**, 361-379

Boston, C and Webb, H 2012 Early medical training ans treatment in Oxford: a consideration of the archaeological and historical evidence, in *Anatomical Dissection in Enlightenment England and Beyond: Autopsy, Pathology and Display* (ed P Mitchell), Farnham, 43-68

Boston, C, Witkin, A, Boyle, A and Wilkinson D R P, 2008 *'Safe moor'd in Greenwich Tier': a study of the skeletons of Royal Navy Sailors and Marines Excavated at the Royal Hospital, Greenwich,* Oxford Archaeology

Boulter, S, Robertson, D J, and Start, H, 1998 The Newcastle Infirmary at the Forth, Newcastle upon Tyne: Vol 2, The osteology: people, disease and surgery, unpub ARCUS rep 290

Brickley, M, Buteux, S, Adams, J and Cherrington, R 2001 S*t Martin's Uncovered: Investigations in the Churchyard of St Martin's-in-the-Bull Ring, Birmingham,* Oxbow Books, Oxford

Brickley, M, and McKinley, J I, 2004 Guidelines to the standards for recording human remains, IFA paper No. **7**, British Association for Biological Anthropology and Osteoarchaeology and the Institute of Field Archaeologists

Brickley, M and Ives, R, 2008 *The Bioarchaeology of Metabolic Bone Disease*, Academic Press, Elsevier, Oxford and London

Brown, D H, 2007 *Archaeological archives: a guide to best practice in creation, compilation, transfer and curation*, Archaeological Archives Forum

Buikstra, J.E and Ubelaker, D.H, (eds.) 1994 Standards for data collection from human skeletal remains, *Arkansas Archaeological Survey Research Series* **44**, Arkansas

Caffell, A, and Holst, M, 2007 *Osteological Analysis: Whitefriars, Norwich*, York Osteoarchaeology Report No. 0806

Chamberlain, A, 2000 Problems and prospects in palaeodemography, in *Human osteology in archaeology and forensic science* (M Cox and S Mays), Greenwich Medical Media, London, 101-115.

Church of England and English Heritage 2005 *Guidance for Best Practice for Treatment of Human Remains Excavated from Christian Burial Grounds in England*

Cotter, J, 2008 Ceramic building materials, in Excavations at The Classics Centre, 65-67 St Giles, Oxford, (G Cockin and A Norton), *Oxoniensia* **73**, 187-9

Emery, P A and Wooldridge, K, 2011 St Pancras Burial Ground Excavations for St Pancras International, the London Terminus of High Speed 1, 2002-3, Gifford

English Heritage, 1991 *Management of Archaeological Projects,* 2nd edition.

English Heritage, 2006 *Management of Research Projects in the Historic Environment: The MoRPHE Project Managers' Guide*, English Heritage, Swindon

English Heritage 2011 *Conservation Bulletin,* The Heritage of Death, Issue 66: Summer 2011

Finnegan, M, 1978 Non-metric variation of the infracranial skeleton, *Journal of Anatomy* **125**, 23-37

Fowler, L and Powers, N 2013 Doctors, Dissection and Resurrection Men. Excavations in the 19th-century Burial Ground of the London Hospital, 2006. MoLA

Gill, G W, 1986 Craniofacial criteria in forensic race identification, in *Forensic osteology: advances in the identification of human remains* (ed. K J Reichs), Charles C Thomas, Springfield, Illinois, 293-318

Gill, G W, and Rhine, J S, (eds) 1990 *Skeletal attribution of race: methods of forensic anthropology*, Anthropological Papers **4**, Maxwell Museum of Natural History, Albuquerque, NM

Hassall, T G, Halpin, C E and Mellor, M, 1984 Excavations in St. Ebbe's, Oxford, 1967-1976: Part II: Post-medieval domestic tenements and the post-Dissolution site of the Greyfriars', *Oxoniensia* **49**, 153-275

Hauser G, DeStefano G F, 1989. *Epigenetic Variants of the Human Skull*. Stuttgart: Schweizerbart.

Henderson, D, Collard, M, and Johnson, D A, 1996 Archaeological Evidence for 18th-century Medical Practice in the Old Town of Edinburgh: Excavations at 13 Infirmary Street and Surgeon's Square. Proceedings of the Society of Antiquities, Scotland **126**, 929-941

Hind, J., 2010 The Post-Medieval and Modern Period (1540-). Solent Thames Research Framework Research Agenda

Institute for Archaeologists 2013 *Code of Conduct*, revised edition, http://www.archaeologists.net/sites/default/files/node-files/IfA-BYLAWS-Code-of-Conduct.pdf, accessed Septmeber 2014

Jurmain, R D, 1999 *Stories from the skeleton: behavioural reconstruction in human osteology*, Gordon and Breach, Netherlands

Kausmally, T, 2010 William Hewson and the Craven Street anatomy school, *American Journal of Physical Anthropology* 141(50), 140.

LAARC, 2007 Post 1992 Museum of London code expansions: Post-Roman pottery, London Archaeological Archive and Research Centre,

http://www.museumoflondonarchaeology.org.uk/NR/rdonlyres/F0118AAF-EF24-4228-A07A-39F89E6F092E/0/post92mol_post_roman.pdf

Lambrick, G, 2013 Prehistoric Oxford, *Oxoniensia* **78**, 1-48

Lovell, N, 1997 Trauma analysis in palaeopathology, *Yearbook Physical Anthropology* **40**, 139-70

Mays, S, 2012 The relationship between palaeopathology and the clinical sciences, in *A companion to paleopathology*, (A L Grauer ed.), 1st edn, Chichester, Wiley-Blackwell, 285-309

Mays, S., 1999 The study of human skeletal remains from English Post-Medieval sites, in G Egan and R.L. Michael, *Old and New Worlds*, pp331-341. Oxbow, Oxford

Mays, S, 1998 *The Archaeology of Human Bones*, Routledge, London

Mays, S, Brickley, M, and Dodwell, N, 2004 *Human bones from archaeological sites: guidelines for producing assessment documents and analytical reports*, English Heritage and BABAO

McCarthy, R, Clough, S, Boyle, A, and Norton, A, 2012. The Baptist Chapel burial ground, Littlemore, Oxford. *Post Medieval Archaeology* **46(2)** p281-290

McKinley, J and Roberts, C 1993 *Excavation and post-excavation treatment of cremated and inhumed human remains*, IFA Technical Paper No. 13

Medline Plus 2013, *Dwarfism*, online at: http://www.nlm.nih.gov/medlineplus/dwarfism.html, [accessed: 22/11/13], Maryland, USA, Medline Plus, service of the National Library of Medicine, National Institute of Health

Mellor, M, 1984 Hair and wig curlers, in Hassall *et al*., 262-3

Mellor, M, 1994 Oxfordshire pottery: a synthesis of middle and late Saxon, medieval and early post-medieval pottery in the Oxford region, *Oxoniensia* **59**, 17-217

Miles, A, Powers, N, Wroe-Brown, R and Walker, D, 2008 *St Marylebone Church and Burial Ground in the 18th to 19th Centuries. Excavations at St Marylebone School, 1992 and 2004-6*, MoLAS Monograph 46, MoLAS, London

Mitchell, P.D. (ed) 2011. Anatomical Dissection in Enlightenment Britain and Beyond: Autopsy, Pathology and Display. Aldershot: Ashgate

MoLA, 2009a Radcliffe Infirmary Burial Ground, Walton Road, Oxford: documentary research

MoLA, 2009b Oxford University: Radcliffe Observatory Quarter (Radcliffe Infirmary Site), Oxford Evaluation Report

MoLA, 2010a Oxford University: Radcliffe Observatory Quarter, Radcliffe Infirmary Burial Ground, Oxford, Evaluation Report

MoLA, 2010b, Radcliffe Observatory Quarter, Oxford, Summary of Results: archaeological watching brief during installation of new foul-water drain below access road from Walton Street in the vicinity of the Infirmary burial ground, 30/11/2010 to 01/12/2010

MoLA, 2011 New Jericho Health Centre Building, Walton Street, Oxford: Historic Environment Assessment

MoLAS, 2007 Oxford University: Radcliffe Observatory Quarter (Radcliffe Infirmary Site), Oxford, Archaeological Evaluation Report

Morris, J, Fowler, L, and Powers, N, 2011 A hospital with connections: 19th century exotic animal remains at the Royal London Hospital, *Post-medieval Archaeology* **45 (2)**, 367-373

Munby, J, 2013 Former Radcliffe Infirmary Burial Ground, Oxford: Archaeological Recording Specification for Removal of Human Remains from the Burial Ground

Murphy, C, 2011 What can an osteological investigation reveal about medical education in 18th-century Dublin? *Archaeol Ireland* **25(3)**, 30-4

Norton, A and Webb, H, 2009. The Medieval and Post-medieval Graveyard of St Peter-le-Bailey at Bonn Square, Oxford, *Oxoniensia* **74**, pp137-179

OA, 2013 Radcliffe Infirmary Burial Ground: Written Scheme for Investigation for an Excavation

Ortner, D J, 2003 *Identification of pathological conditions in human skeletal remains*, Academic Press, London and San Diego

Oswald, A, 1975 *Clay pipes for the archaeologist*, BAR Brit Ser **14**, Oxford

Oswald, A, 1984 Clay pipes, in Hassall *et al*., 251-262

Oxford City Council *Oxford Archaeological Research Agendas 2011. Post Medieval (1500-1800)* Online at: http://www.oxford.gov.uk/Library/Documents/Planning/Archaeology%208%20-%20Post-medieval%20Research%20Agenda.pdf [accessed 23.03.13]

Ponec, D J, and Resnick, D, 1984 On the etiology and pathogenesis of porotic hyperostosis of the skull, *Investigative Radiology* **19**, 313-317

Purcell Miller Tritton, 2005 Radcliffe Infirmary Site Conservation Plan

Purcell Miller Tritton, 2010 Addendum to the Conservation Plan focusing on the Infirmary burial ground

Resnick, D. (ed.), 1995 Diagnosis of Bone and Joint Disorders (3rd ed.), 6 Volumes, W.B. Saunders Company, Philadelphia, London, Toronto, Montreal, Sydney and Tokyo

Roberts, C and Cox, M, 2003 *Health and Disease in Britain From Prehistory to the Present Day*, Sutton Publishing, Stroud, Gloucestershire

Roberts, C, and Manchester, K, 1995 *The archaeology of disease*, 2nd edn, Sutton Publishing, Stroud, Gloucestershire

Rogers, J, and Waldron, T, 1995 *A field guide to joint disease in archaeology*, J Wiley Chichester, New York

Steckel, R H, Kjellström, A, Rose, J, Larsen, C S, Walker, P L, Blondiaux, J, Grupe, G, Maat, G, 2009 Summary measurement of health and wellbeing: the health index, *American Journal of Physical Anthropology sSupplement* **48**, 247

Stuart-Macadam, P, 1991 Anaemia in Roman Britain: Poundbury Camp, in *Health in past societies: biocultural interpretations of human skeletal remains in archaeological contexts* (H Bush and M Zvelebil), BAR International Series **567**, Tempus Reparatum Archaeological and Historical Associates Limited, Oxford, 101-113

Thomas, R, 2009 Bones of contention: why later post-medieval faunal assemblages matter, in *Crossing paths or sharing tracks? Future directions in the archaeological study of post-1550 Britain and Ireland* (eds A Horning and M Palmer), Boydell, Woodbridge, 133-148

Trotter, M, 1970, Estimation of stature from intact long bones, in *Personal identification in mass disasters* (ed. T D Stewart), Smithsonian Institution Press, Washington DC, 71-83

Trotter, M, and Gleser, G C, 1952 Estimation of stature from long-bones of American whites and negroes, *American Journal of Physical Anthropology* **9**, 427-440

Trotter, M, and Gleser, G C, 1958 A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death, *American Journal of Physical Anthropology* **16**, 79-123

United Kingdom Institute for Conservation (UKIC), 1990 *Environmental Standards for the permanent storage of excavated material from archaeological sites*, London

Walker, K, 1990 *Guidelines for the preparation of excavation archives for long term storage*, London

Walker, P L, Bathurst, R R, Richman, R, Gjerdrum, T, and Andrushko, V A, 2009 The causes of porotic hyperostosis and cribra orbitalia: a reappraisal of the iron-deficiency-anemia hypothesis, *American Journal of Physical Anthropology* **139 (2)**, 109-125

West, B A, 1980 The sawn human bone, *Barts J* (Spring issue), 24-6

Western, A G, 2012 A star of the first magnitude: osteological and historical evidence for the challenge of provincial medicine at the Worcester Royal Infirmary in the nineteenth century, in *Anatomical Dissection in Enlightenment England and Beyond: Autopsy, Pathology and Display* (ed P Mitchell), Farnham, 23-41

White, T D, 1992 *Prehistoric Cannibalism at Mancos 5MTUMR-2346, Princeton University Press,* Princeton

Witkin, A 2011 The Health of the Labouring Poor, Surgical and Post-mortem Procedures at the Bristol Royal Infirmary, 1757-1854 : a biohistorical approach. University of Bristol unpub. Dphil thesis

Wright, R, 2008 Detection of likely ancestry using CRANID, in *Forensic approaches to death, disaster and abuse* (ed. M F Oxenham), Australian Academic Press, Queensland

Figure 1: Site Location

X:\o\OXIB13_Radcliffe Infirmary Burial Ground\010Geomatics\02 CAD\001current\Figure 2.dwg(A3 landscape)***OXIB13*Emily Plunkett* 07 Nov 2014

CHECKED BY:

Figure 2: Plan of excavation

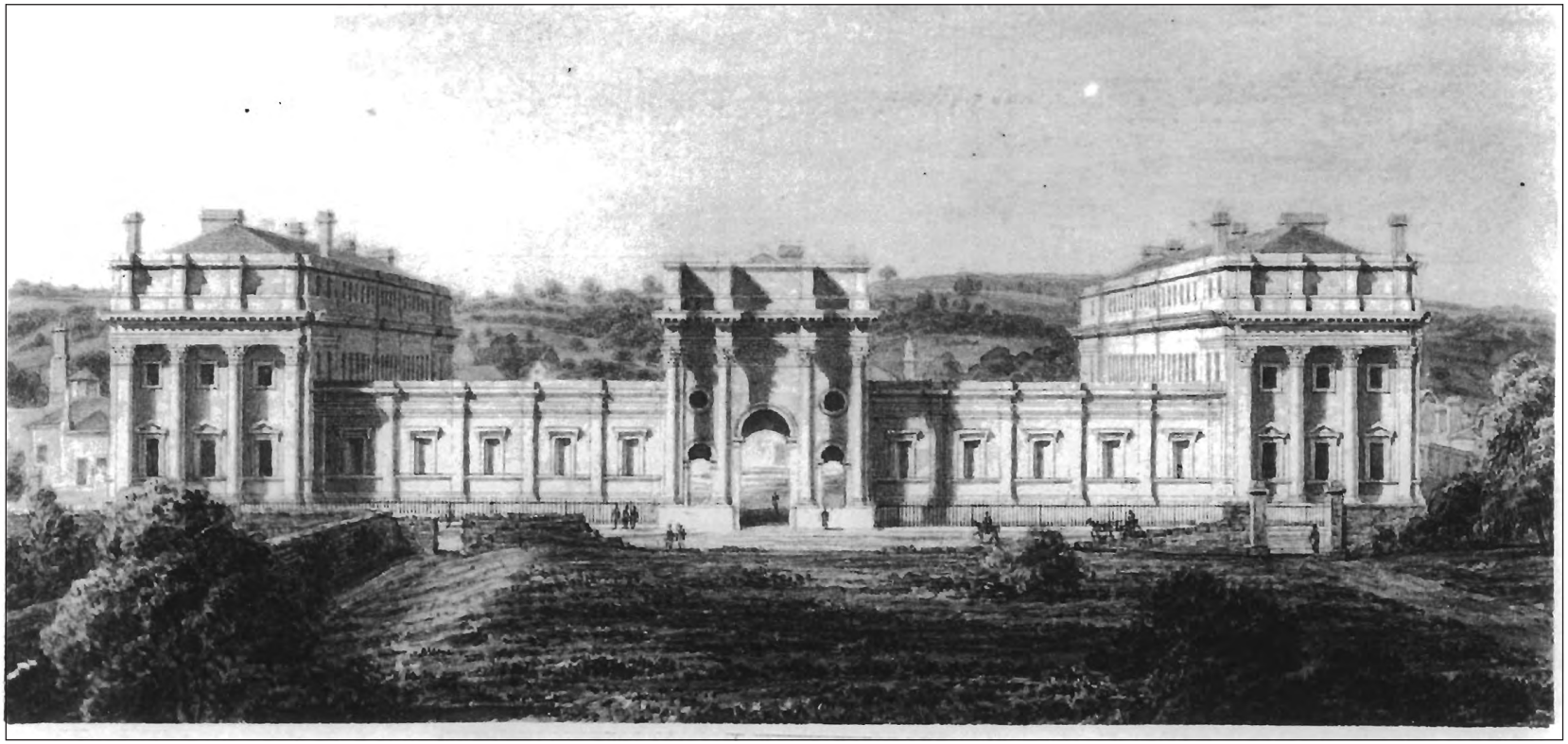


Figure 3: ‘The University Printing House, from the Infirmary’, engraving by J Le Keux, published by J H Parker of Oxford in 1833

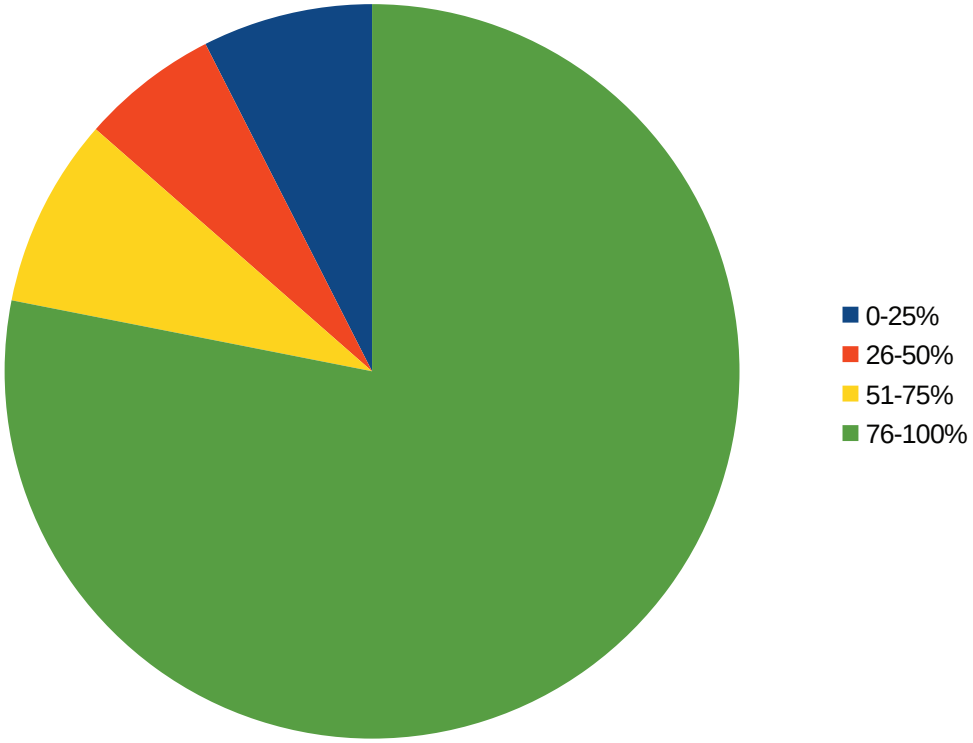


Figure 4: Completeness of the articulated skeletons (N=347)

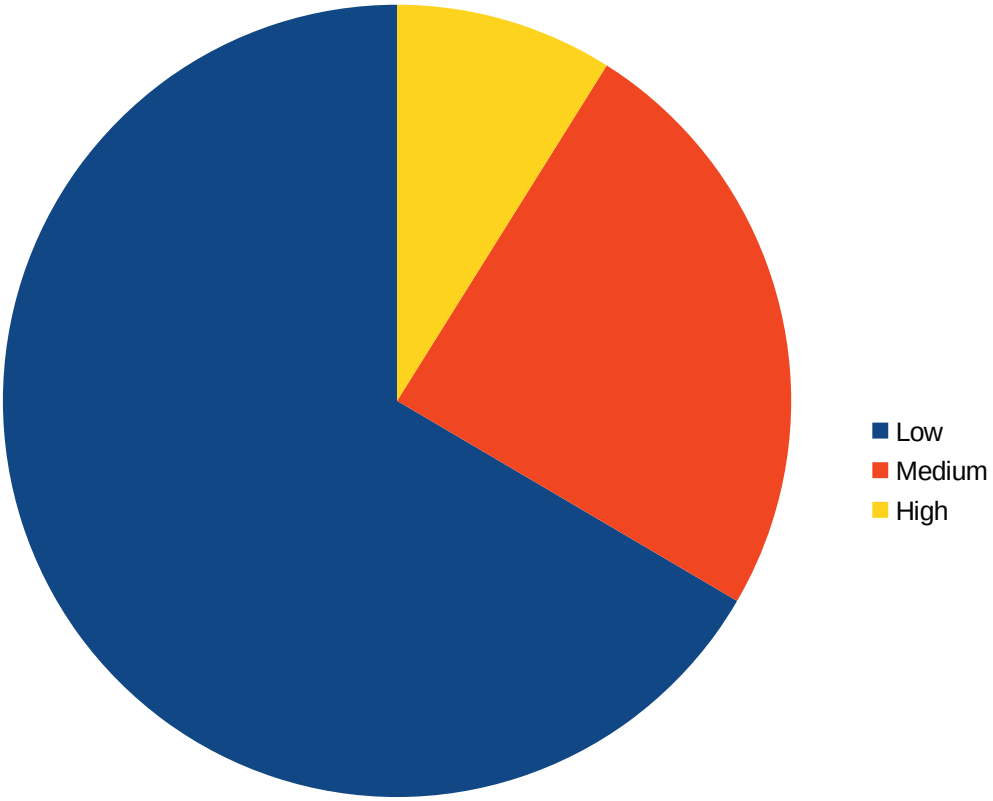


Figure 5: Fragmentation of the articulated skeletons (N=347)

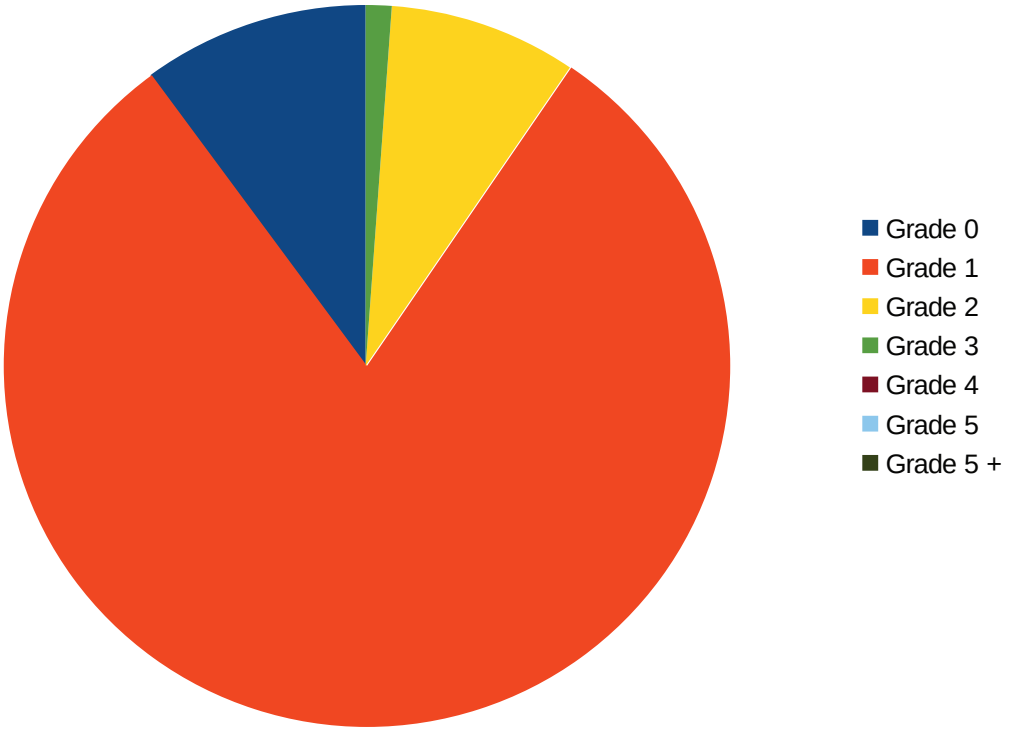


Figure 6: Bone surface condition in the articulated skeletons (N=347)

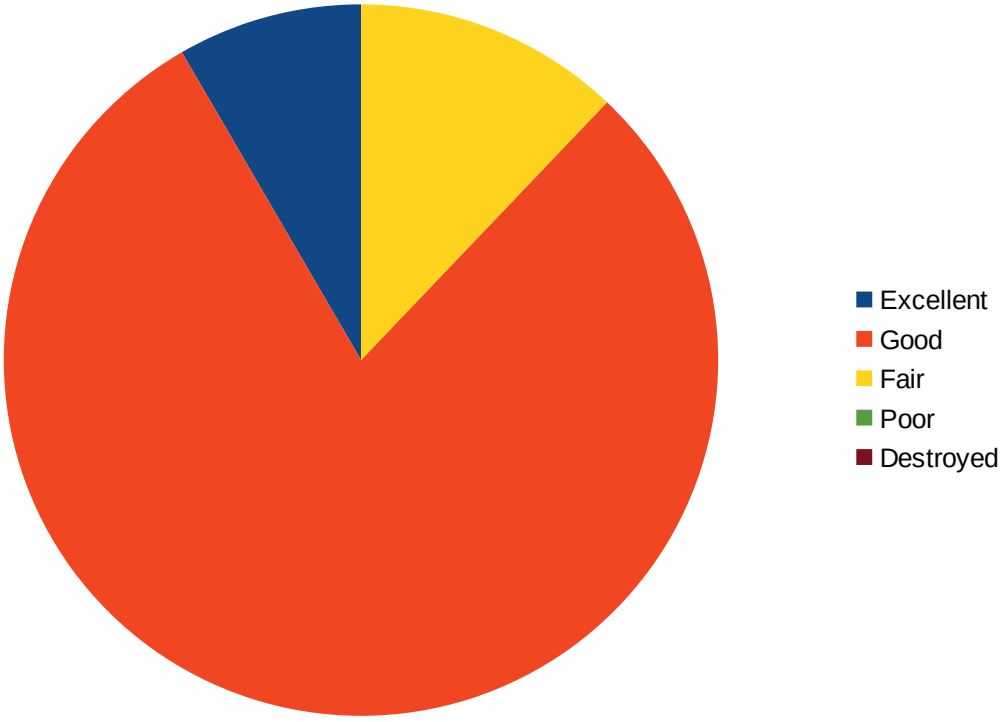


Figure 7: Overall preservation of the articulated skeletons (N=347)

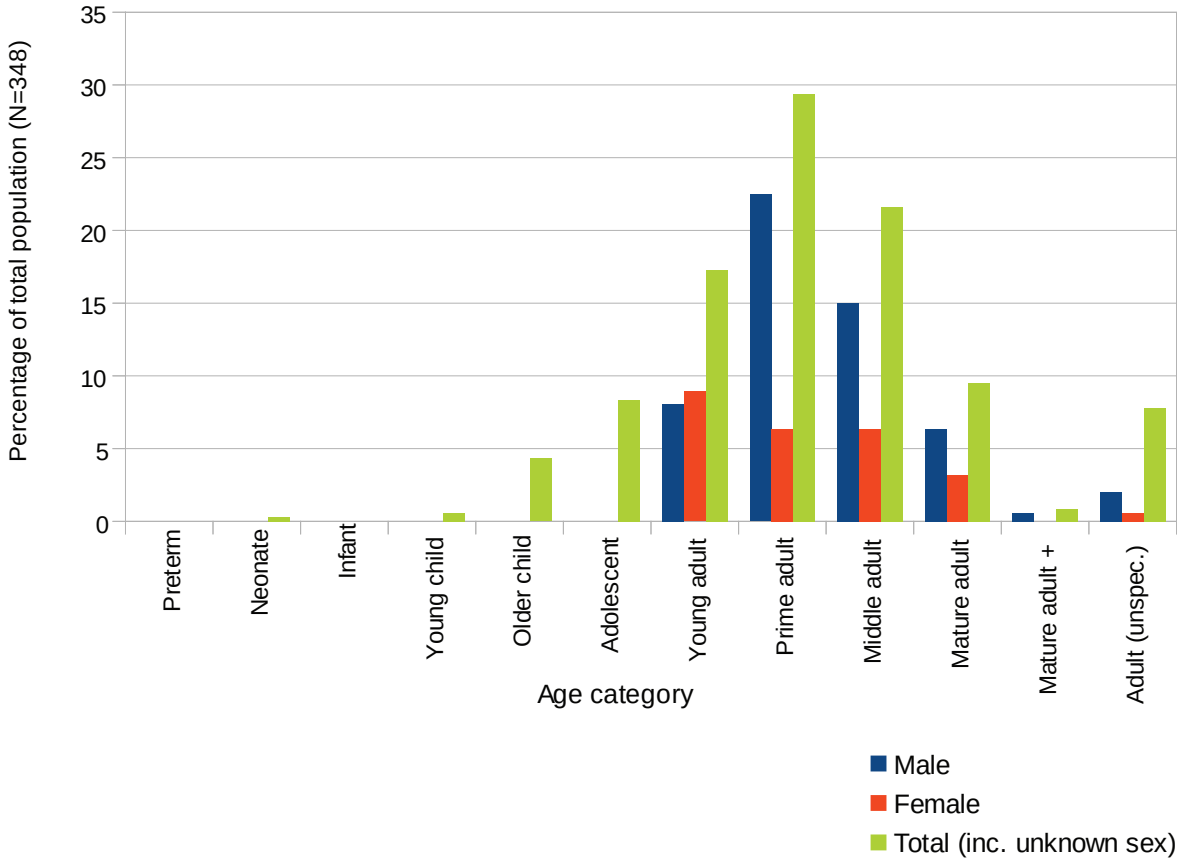


Figure 8: Mortality profile of the articulated skeletons (N=347)

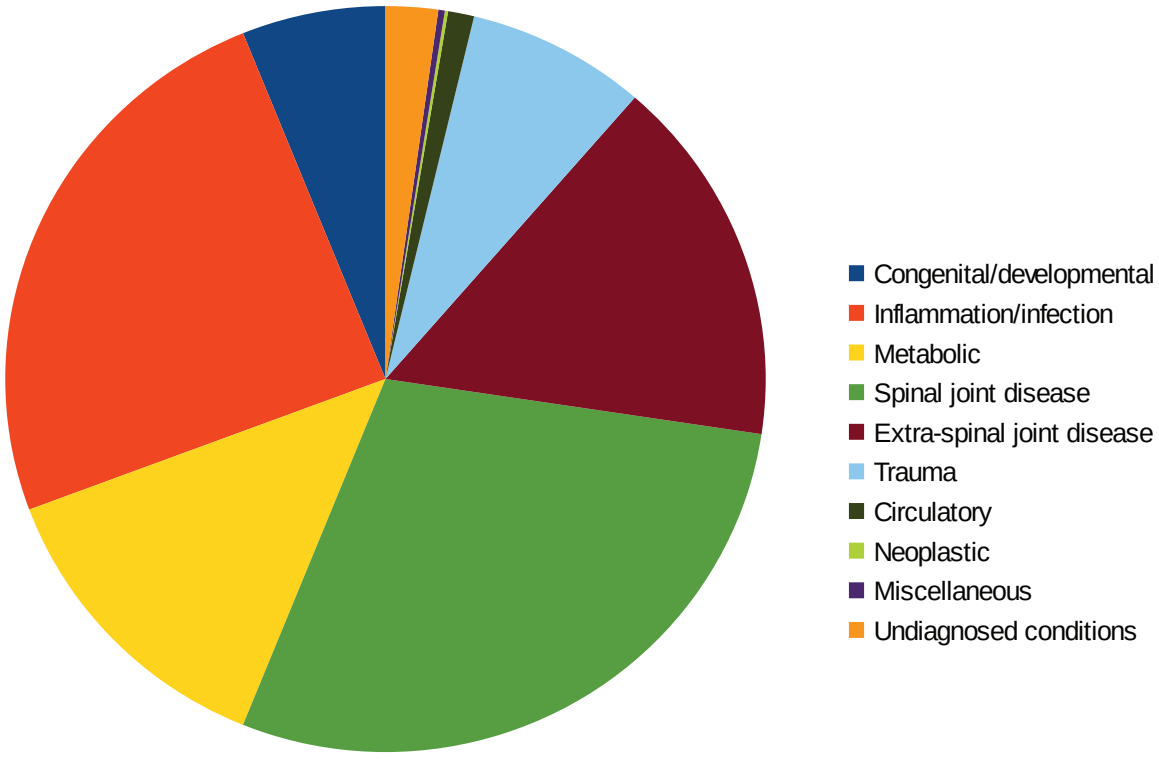


Figure 9: Crude prevalance rates of skeletal pathology in the articulated skeletons, by category (N=720)

Plate 1: Graves exposed as soilmarks during the machine-excavation of overburden within the footprint of the south-western part of the Eye Hospital

Plate 2: The same view after excavation of the graves

Plate 3: Graves on the Walton Street frontage, with the concrete foundations of the Eye Hospital to the right and Freud's Cafe in the background

Plate 4: Excavating burials in the south-eastern part of the site, with Oxford University Press in the background

Plate 5: Recording skeleton 3686

Plate 6: Skeleton 3392 truncated by the concrete foundations of the Eye Hospital

Plate 7: Skeleton 3078, showing craniotomy

Plate 8: Skeleton 3801 with leg amputated

Plate 9: Amputated leg 3190

Plate 10: Charnel pit 3227

Head Office/Registered Office/ OA South

Janus House
Osney Mead
Oxford OX2 0ES

t: +44 (0) 1865 263 800
f: +44 (0) 1865 793 496
e: info@oxfordarchaeology.com
w: http://oxfordarchaeology.com

OA North

Mill 3
Moor Lane
Lancaster LA1 1QD

t: +44 (0) 1524 541 000
f: +44 (0) 1524 848 606
e: oanorth@oxfordarchaeology.com
w: http://oxfordarchaeology.com

OA East

15 Trafalgar Way
Bar Hill
Cambridgeshire
CB23 8SQ

t: +44 (0) 1223 850500
e: oaeast@oxfordarchaeology.com
w: http://oxfordarchaeology.com