UCL Research Frontiers since 1826

Phosphorus necrosis unravelled

--- A letter written 105 years ago ---

UCL joint effort in combating phosy jaw

Posted on 18 April 2012

Several folders kept in the Royal Society of Chemistry contain letters addressed to Sir Henry Enfield Roscoe from academics, including the one I showed you previously (see "A letter written 105 years ago"). The eminent Sir Roscoe actually graduated from UCL and joined his Alma Mater as Lecture Assistant. He then spent most of his life at Owens College, Manchester where he taught Prof Watson Smith. At the age of 51, Sir Roscoe received a knighthood. In his early 60s, he returned to London and was Vice-Chancellor of the University of London for six years.

--- Finishing a PhD in 6 months ---

This blog is to celebrate UCL Research Frontiers since 1826. With the support of Grand Challenge, I am studying a PhD on a drug side effect causing jaw bone death. A similar disease also occurred in Victorian times. Through this blog, I hope to share my views regarding some of its past and present aspects. (Phosy jaw?)

Keywords:
- 1826 UCL Grand Challenge First English case
- Phosy jaw Genetics
- Diphosphonates
- Salvation Army
- Charles Dickens
- BONJ

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- Finishing a PhD in 6 months!
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Past and Present

Polly Pok-Lam Fung

Grand Challenge PhD Student

2011-15
I am now doing first year PhD in Dentistry, on a UCL Grand Challenge project aimed at finding the genetic causes of a drug side effect which causes jaw bone death (bisphosphonate-associated osteonecrosis of the jaw - BONJ). Joint collaboration has been crucial: the dental institute has knowledge about the disease and works with other medical departments in recruiting participants, while colleagues in genetics and statistics help with the analysis.

BONJ was first reported in 2003. In Victorian times, however, there was a similar disease among match workers exposed to phosphorus vapour, known as phosphorus necrosis or phossy jaw. Like BONJ, it affected patients badly and could be lethal. I first knew about the Victorian disease in a lecture during my master course at UCL and have been fascinated about it ever since. Having stayed in London, a city rich in history and culture, for over a year, I became interested about things in the past. Initially, my search about the old disease was just to satisfy my curiosity, but I soon realised that my friends and fellow researchers found it intriguing too and at the same time, I learned about the UCL Research Frontiers since 1826 Contest. This was how my blog was born to share the past and present aspects of the disease and my PhD project, recognising past researchers’ efforts and celebrating the foundation of UCL. Since my first blog entry on 5 March, I am proud to announce that my blog has attracted more than 1100 viewers from 21 countries.

It has been a valuable opportunity for me to gain an in-depth understanding about the past and present diseases. They are indeed related to the same chemical and display identical clinical features. The causes of both diseases remain unknown although phossy jaw disappeared after the ban of white or yellow phosphorus, while BONJ is still haunting us. My project will therefore not only benefit patients at present, but also address a question of two centuries.

Interacting with past UCL research frontiers through reading their publications and knowing their work have brought us much enlightenment. There was University College Hospital Surgeon Mr W. C. Wright who had the foresight to know that the solution to phossy jaw was not merely dilute acids as medical treatment, but also to draw public attention and ultimately health and safety legislation. UCL Chemical Technology Prof Watson Smith, and Sir Henry Enfield Roscoe, UCL alumnus who went on to become Vice-Chancellor of the University of London (1896-1902), promoted the use of red phosphorus safety matches which actually helped combat the dreadful disease.

All in all, blogging has been fun! I hope you enjoy reading my blog as much as I enjoy writing it. If you want to find out what Charles Dickens had written about phossy jaw and who had completed his PhD in six months, start reading!

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“\nThis is fascinating, valuable stuff and quite little-known – congrats on the research!”
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Louise Raw  
Author of “Striking a Light: The Bryant & May Matchwomen and their place in History”, 2011, Continuum.

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PHOSPHORUS NECROSIS IS A DREADFUL DISEASE

POSTED ON 5 MARCH 2012

The disease first appeared in Victorian times and affected match workers exposed to white phosphorus. It was first recorded in 1839 in Vienna as phosphorus necrosis or phossy jaw. Back in 1852, the celebrated Charles Dickens in his weekly periodical *Household Words* reported three phosphorus necrosis cases including a 21-year-old match worker, about whom he wrote, “He has now no teeth in his lower jaw, of which a great part is destroyed.”

The disease was painful and could affect both the upper and lower jaws. The most distinctive feature was the exposed necrotic jawbone, accompanied by loose teeth, swollen gum, bleeding, pus discharge and jaw fracture. In severe cases, the disease could spread and cause facial disfigurement.

Two centuries later, phosphorus necrosis has returned as a drug side effect among osteoporosis and bone cancer patients treated with bisphosphonates. Reported first in 2003, the disease is now known as bisphosphonate-associated osteonecrosis of the jaw (BONJ).

In our bodies, white phosphorus (match ingredients) reacts with water to form pyrophosphate (Equation 1), which when combining with carbonic acid (Equation 2) and amino acid, for instance lysine (Equation 3), becomes bisphosphonates. The past and present diseases are therefore related to the same chemical and are indeed the same disease, displaying identical clinical features.

\[
\begin{align*}
P_{2}O_{10} + 4 H_{2}O &\rightarrow 2 P_{2}H_{4}O_{7} \quad [1] \\
P_{2}H_{4}O_{7} + H_{2}CO_{3} \text{ and/or tetrahydrofolate} &\rightarrow P_{2}H_{6}CO_{3} + O_{2} \quad [2] \\
P_{2}H_{6}CO_{7} + C_{6}H_{14}N_{2}O_{2} &\rightarrow C_{9}H_{17}NO_{7}P_{2} + CO_{2} + NH_{3} \quad [3]
\end{align*}
\]

In the face of this dreadful jaw condition, doctors remained unfazed. The first recorded case of phosphorus necrosis in England had been under the care of University College Hospital and was described in the *Medical Times* in 1846. Mr W.C. Wright, the surgeon, gave a detailed account on the patient’s progress and the treatment of this, in his own words, “frightening and disgusting” disease. Having received a “cocktail” of dilute hydrochloric acid, dilute sulphuric acid and etc, the condition of the 30-year-old match worker improved and he was discharged.

Concluding his paper, Mr Wright made a strong statement urging factory legislation in enforcing workplace health and safety, in which match makers should work behind a glazed screen to avoid phosphorus vapour and should be given breaks to obtain fresh air. Mr Wright’s dedication and foresight still command much inspiration and respect even to this day. He believed phosphorus vapour caused jaw necrosis and was aware that the solution was not merely dilute acids, but also to draw public attention and ultimately health and safety legislation. The use of white phosphorus in matches was prohibited by the International Berne Convention in 1906.

Phosphorus necrosis vanished after the prohibition of use of white phosphorus in matches. In the context of the modern disease – BONJ (bisphosphonate-associated osteonecrosis of the jaw), it is not a simple matter of banning the prescription of bisphosphonates. First, the drug is effective in managing skeletal complications; second, BONJ does not affect all patients exposed to the drug. To date, the cause of BONJ remains largely unknown and is considered incurable. Patients are managed with symptomatic treatment, consisting of mouthwash, antibiotics and surgical removal of necrotic bone.

Due to its occurrence in only a subset of patients, it is likely that the development of BONJ is associated with genetic variations among individuals. In this regard, it has become a subject of the UCL Grand Challenge of Global Health to identify a particular part of BONJ-causing gene by comparing the whole genome among subjects exposed to bisphosphonates, including both BONJ patients (case) and non-BONJ individuals (control). The identified gene will be utilised as biomarkers and subsequently help develop effective prevention and management strategies.

I decided studying BONJ for my PhD mainly because of my previous clinical experiences. As a dentist, I have encountered cases of severe jaw pain and facial disfigurement, but it is most upsetting to learn in my master project that there were patients who still suffered from jaw pain when they passed away from cancer. With support from the Grand Challenge Studentship in Biomedicine, I wish to play a greater role in helping patients in a more fundamental manner by furthering the profession’s understanding in the genetic variations among patients suffering from BONJ. As BONJ and phosphorus necrosis are one and the same, the research therefore brings the exciting prospect of not only finding the cause of the 21st Century disease, but also the historical phossy jaw at the same time.
The first “friction match” was invented by John Walker, an English chemist, in 1826. He discovered that a stick coated with chemicals (antimony sulfide, potassium chlorate, and etc.) could start a fire when he scraped it across his hearth at home. The first “friction matches”, commonly known as the “Lucifers”, didn’t give rise to phosphorus necrosis. They however caused explosive ignition and unpleasant odour.

A few years later, Charles Sauria, a French chemist, invented new matches that solved the Lucifers’ problems, but they began the dread of phosphorus necrosis among factory workers as they contained white phosphorus.

In 1844, matches with no poisonous white phosphorus were born. They were invented by Gustaf Erik Pasch, a Swedish professor in Chemistry. Non-toxic, less inflammable red phosphorus replaced the culprit of phossy jaw and it was coated on the outer surface of the match box. The matches didn’t burn spontaneously and hence the name “safety matches”.

There was not only advancement in the chemistry of matches, but also engineering in the manufacturing process. The first automatic match machine was designed by Alexander Lagerman, a Swedish engineer, in 1864.

Production of matches with red phosphorus was introduced in the UK by the Salvation Army in 1891. The matches were called “Lights in Darkest England” by the founder of the Army, General William Booth. These old match boxes are on display in the Museum of London.

Phosphorus necrosis finally came to an end.


THE 21ST CENTURY DISEASE – BONJ

POSTED ON 25 MARCH 2012

Much has been discussed about its history, but what exactly is the disease?

It has been described by several terms and when I do literature search, I have to look under more than one name: bisphosphonates associated/related/induced osteonecrosis of the jaw, or osteochemonecrosis… and the list goes on.

**B** – Bisphosphonates: drug used in treating osteoporosis, bone cancer and other bone diseases, such as osteogenesis imperfecta (brittle bone disease) and Paget’s disease. It was first introduced in the 1990s and its effects on the jaw were not known then. In the early 2000s, a few cases of jaw bone death were reported and all these patients were on bisphosphonates.

**Associated/related/induced** – these ambiguous terms reflect the fact that we don’t yet know exactly how bisphosphonates cause jaw bone death.

**ONJ** – OsteoNecrosis of the Jaw: bone (osteo) death (necrosis) at the upper and/or lower jaw.

If you know people who are on bisphosphonates, don’t go crazy warning them against BONJ. They should already have been informed by their prescribing physicians. It is **not** advisable for patients to stop medication on their own without consulting their physicians. Fortunately, not all patients taking the drug develop jaw diseases: BONJ occurs in 0.1-10% of patients only (it however can be severe).

The clinical features, diagnosis and management of BONJ will be discussed in later blog entries.

I hope from this blog onwards I can use the term BONJ without stating its full name. (Can I?) For those who need further explanation, please click “BONJ” at the colourful “Keywords” on the right hand side and this will lead you to my previous blog entries.

I have had lectures on BONJ, the modern disease, when I had my dentist training in Hong Kong, where I come from. But I never knew that there was a similar disease to BONJ in Victoria times (phosphorus necrosis/phossy jaw) until I had my master course at UCL. The lecture was given by Dr Stefano Fedele, Senior Lecturer of the Eastman Dental Institute, now my PhD supervisor. He told the class that there are a few phossy jaw specimens at the Hunterian Museum.

One of the specimens was from a 35-year-old male match worker and his phossy jaw caused fracture of his lower jaw. Though not mentioned, I suspect the match worker died from the jaw disease as the mortality rate was high before the invention of antibiotics in the 20th Century. In a study in France in 1858, more than half of the 60 cases died. Some committed suicide due to severe pain and facial disfigurement.

Although the death rate now is not as high as before, some BONJ cases can, sadly, still progress to a very severe stage. The radiograph below belonged to a 71-year-old male who received bisphosphonates intravenously for bone cancer and his BONJ caused fracture of his jaw (circled), as with phossy jaw.

One of the reasons why I am interested in studying BONJ is its old disease and I do hope other researchers can also get some inspiration from the history of the topics they are investigating.

Note: The Hunterian Museum is closed in Easter, but do plan a visit there in future. It is an amazing place and is just a 5-minute walk from the Holborn tube station.

Have a happy holiday!


SALUTE TO MY PATIENTS

POSTED ON 10 APRIL 2012

My PhD project involves the collection of blood from BONJ patients (cases) and those who are on bisphosphonates but are free from the jaw disease (controls). DNA will then be extracted and analysed by an advanced technique known as microarray. Its results will look something similar to the picture on the right side of the banner above. Isn’t it beautiful?

Our patients have been enthusiastic in participating in the research when they know that the project is to find out the genetic cause of BONJ. So far, we have recruited hundreds of participants from Italy, Spain, Sweden, Japan and the UK, and hopefully more collaborating centres in future including my home town, Hong Kong.

Many of our blood donors are cancer patients as bisphosphonates is used to treat skeletal complications of bone metastases and multiple myeloma. Regrettably, I found out that one of our previous subjects had passed away due to cancer. Her precious blood was collected some time before her death and is now stored in our freezer with many other samples.

To me, the patients are heroes: they are sick, many of them fighting hard against cancer, and yet they still want to contribute towards solving BONJ. As a researcher, I do not see their blood as just tissue samples, but invaluable donation from some remarkable individuals.

Salute to my patients!

Note: Potential collaborators and bisphosphonates patients who are interested, please feel free to contact me via pok.fung.10@ucl.ac.uk.
THE FIRST SURGEON (UCL) WHO TREATED PHOSSY JAW COULD BE MY NEIGHBOUR?!

POSTED ON 15 APRIL 2012

There is a British TV programme called “Who do you think you are?” on BBC about celebrities using archives and meeting historians in tracing their ancestors. I enjoy watching the programme and I am stunned by the fact that, in general, European countries keep very good records and we can still get access to documents hundreds of years old. I have got someone in mind – Mr W. C. Wright, the University College Hospital (UCH) surgeon who treated the first case of phosphorus necrosis in England in 1846 and this marked the start of my journey of searching.

With the information from the Medical Times report written by Mr Wright, (see my previous blog entry “The first English phosphorus necrosis case”), I contacted UCH archive to see if the original medical record is available. However, the archivist could not identify anything relevant.

I then approached the two Royal College of Surgeons (RCS), Edinburgh and England respectively as Mr Wright, bearing the post-nominal initials MRCSE, was a member with one of them. A librarian from RCS Edinburgh promptly checked their historical records and told me that there was no evidence of anyone by this name from their College.

The search didn't stop there. At RCS England, Archivist Karen guided me through different materials I can refer to. I spent one whole morning on the Medical Directories from 1845 till 1894 and there were two possible matches:

1. Mr William Wright – a general practitioner, obtained his MRCSE in 1793, lived on Grenville Street and his record on the Directory only appeared till 1846.

2. Mr William Wright – a more high-profile surgeon who published a few papers on ear anatomy and disease. Although he specialised in ear, he could still be interested in the jaw as it is part of the head and neck region. However, Karen and I thought, unlike the surgeon above, the second W. Wright reported to the Directory his publications including an essay, a handbook and an article on Lancet. So he should have included the one on phosphorus necrosis in Medical Times if he had authored it.
So where is my *Mr Wright*? I haven't a clue yet. If he was the first one, living at 3 Grenville Street, now the International Hall where I live, he could be my neighbour across two centuries! The real searching is not as easy and romantic as it seems in "Who do you think you are?", but I will visit RCS England again soon. Stay tuned!

I was excited to find out yet another link between phossy jaw and UCL – Chemical Technology (now Chemical Engineering) Professor Watson Smith recommended harmless red phosphorus matches. Poisonous white or yellow phosphorus caused phosphorus necrosis/phossy jaw, whereas the red type did not and was introduced by the Salvation Army in 1891 in England (see my previous blog entry “Pioneers in the match industry”).

Prof Smith was a Fellow of the Institute of Chemistry (now Royal Society of Chemistry, RSC) and a Fellow of the Chemical Society. He joined UCL in about 1888. Since then, he became interested in occupational health including phossy jaw. In 1893, he delivered an address on "Diseases Incident to Workpeople in Chemical and other Industries." at the University College Chemical and Physical Society, and in 1906, he wrote a book on “The Chemistry of Hat Manufacturing”.

To search for more information and start another journey of “Who do you think you are?” for Prof Smith, RSC, I am coming!


As a fresh researcher, I always wonder, how do scientists look for new research areas? Ask the crystal ball? Perhaps looking into history may help……

The most widely accepted BONJ definition is exposed jawbone, it may get infected, gum tissue then becomes red and swollen, and there can be pus oozing from the wound causing bad breath. Extensive dead bone can perforate the roof of the mouth or fracture the lower jaw. Infection can spread from gum to facial tissue, causing abscess and scarring. This tremendously affects normal function, such as eating, speaking and appearance.

Can dentists detect BONJ early? There are some patients complaining of pain mimicking toothache not related to local teeth problems but are indeed caused by early BONJ. In addition, there can be ulcers and loose teeth. These early signs and symptoms do not involve exposed necrotic bone and are known as the “non-exposed variant”.

BONJ was first reported in 2003 and the “non-exposed variant” was introduced in 2008. I am lucky to have my PhD studies supervised by Dr Stefano Fedele who was among the first researchers to look into this and have written a case series involving the largest group of patients so far.

We thought the “non-exposed variant” was something new in BONJ, but similar features in phosphorus necrosis/phossy jaw had been observed as early as 1862! “……The disease, it was noticed, began usually with aching in one of the teeth. At first, this was probably mistaken for ordinary toothache…….”, reads a discussion in the Report of Occupations which have to do with Phosphorus. Since the time I read this, I couldn’t wait to learn more from the Victorian time disease. I hope you can gain some inspiration from the history of the field you are working in too.


Working at school on black Friday (13 April 2012) might not be a good idea, so I paid a visit to the Royal Society of Chemistry (RSC) to try to find Prof Watson Smith, UCL Professor in Chemical Technology who recommended “Lights in Darkest England” – matches containing no phossy-jaw-causing white or yellow phosphorus (see my previous blog entry “Another link with UCL in history”).

Prof Smith was born at Stroud, UK in 1845. He had his Chemistry education at Manchester, Heidelberg and Zurich. When he finished his study, he returned to England and worked in the industry for some years before he joined the academia in Owens College, Manchester, where he had his first training. During his lectureship, he pioneered the first *Journal of the Society of Chemical Industry* in 1882 and remained the editor after he became professor at UCL. He had served the Journal for nearly 40 years until his passing and his contribution was recorded in the Society’s Special Jubilee issue.

I have always admired past researchers who possessed the vision and resourcefulness to study abroad, which was one reason why I seized the opportunity to come to London for my postgraduate training. Even now, it has not been easy for me to manage funding, accommodation and all the rest of it, but if people in the past could make it, so can we!
The RSC’s library is situated in the beautiful Burlington House in Piccadilly, London, just opposite Fortnum & Mason the department store. I finished working just as the bells of the famous clock chimed, and for the first time I saw Mr Fortnum and Mr Mason stepping forward and bowing to each other! What a lovely day!

Needless to say, a proper diagnosis begins with history-taking. To confirm BONJ, clinical examination is most important. In addition, we need imaging of the jaw to see through the underlying bone and in extensive cases, to plan surgery. Biopsy is very rarely done as we now know that the disease is associated with bisphosphonates, whereas in early 2000, it was thought to be caused by the spreading of cancer and biopsy was used to exclude metastases.

Managements of phosphorus necrosis/phossy jaw in Victorian times and BONJ nowadays are similar in a way that both consist of medical and surgical treatment. Before the era of antibiotics, poor phossy jaw patients received hydrochloric acid, sulphuric acid and other potions, see abstract of the first case in England in 1846. For BONJ, there are guidelines recommending its treatment although they are not universally agreed. A rule of thumb is that patients need to keep their mouths clean in order to prevent infection and if there were pain and inflammation, pain-killers and antibiotics are required.

In advanced cases, we need surgery. I am not going to post real photos here since they are too graphic. Below is a wax model illustrating a jaw surgery. It could be showing the removal of a tumour, but the approach is similar. The left cheek of the frowning patient is opened and the flying hands of the surgeon are holding a saw, the blade of which has been wrapped around the jaw. Of course nowadays we do surgeries under general anaesthesia instead of chloroform and we have more advanced tools to help us, the theory is still the same as in the past – cut the diseased part, then reconstruct the jaw to restore function and appearance.
Now you think BONJ is curable? With the above symptomatic treatments, disease at one site can heal, but it can come back afterwards, at the same site or another. Therefore, patients are advised to have regular review appointments.

If you are worried, a dentist should be able to help. Seek treatment early. It is important for everyone to have good dental health and have check-up at least once a year.


This is a letter from Prof Watson Smith to Sir Henry Enfield Roscoe, FRS, his teacher at Owens College, Manchester. For background of Prof Smith, please see previous blog entry “Black Friday with Prof Smith”. The letter was dated 21 April 1907, 25 years after the launch of the Journal of the Society of Chemical Industry, edited by Prof Smith. In summary, Prof Smith reported that the Journal had made good progress in the past years and he was thankful for Sir Roscoe’s teaching.

From their portraits, hand-writing, education, work, and how others described them, we are not only gathering facts but also having a feel about their personalities. I am no historian but I find the exercise of tracing the history of past UCL people fascinating.

How do you want others to see you hundreds of years later? This is a truly enlightening question. For me, I am working hard to become an academic, hoping someday to contribute to society through my professional field, in a manner worthy of my training.
Several folders kept in the Royal Society of Chemistry contain letters addressed to Sir Henry Enfield Roscoe from academics, including the one I showed you previously (see “A letter written 105 years ago”). The eminent Sir Roscoe actually graduated from UCL and joined his Alma Mater as Lecture Assistant. He then spent most of his life at Owens College, Manchester where he taught Prof Watson Smith. At the age of 51, Sir Roscoe received a knighthood. In his early 60s, he returned to London and was Vice-Chancellor of the University of London for six years.

As one of the most notable English chemists, he wrote quite a few popular textbooks. *Chemistry in the Science Primer Series*, first published in 1872, were widely adopted and translated into nine languages. It covered topics such as air, water, earth, metal and non-metal elements, including phosphorus. At that time, non-phossy-jaw-causing safety matches made from red phosphorus had been invented in Sweden but were not yet introduced to England. In his book, Sir Roscoe explained the mechanism of safety matches. The old matches contained inflammable white or yellow phosphorus and burned themselves whereas the new matches carried no phosphorus and safe red phosphorus was coated on the matchbox.

Both Sir Roscoe and Prof Smith promoted red phosphorus matches as they were safe from a chemical point of view. With that, they in effect also helped combat this dreadful disease. Fifteen years after *Chemistry (Science Primers)* was published, the Salvation Army opened the first red phosphorus match factory in England in 1891 and Prof Smith’s recommendation was found in the advertisement (see “Another link with UCL in history”). In 1906, the use of white or yellow phosphorus in matches was prohibited by the International Berne Convention and this saved match workers from the painful jaw necrosis.
I think this case demonstrated beautifully cross-disciplinary efforts in the face of such a complicated problem. In Victorian times, different disciplines worked independently towards phossy jaw and the match industry in different ways they had still been successful. In the 21st Century, we work much more closely: my project collaborates with experts in genetics, statistics and dentistry from different countries. So, can we solve BONJ quicker than our predecessors? Fingers crossed!

I was astonished when I read this from the Oxford Dictionary of National Biography about Sir Henry Enfield Roscoe: “Roscoe received his PhD by oral examination ‘[s]ix months after I first went to Heidelberg’ (Roscoe, 58).”! Before his training at Heidelberg in 1854, Sir Roscoe entered UCL in 1848 and finished his Bachelor of Arts, with honours in Chemistry, in 1853.

My first 6 months has passed already and I haven’t even upgraded from MPhil to PhD (normal upgrade is 12 to 18 months after start of MPhil)...... To gain a PhD, I need to do much more than an oral examination...... Now I have loads of questions in my mind. Was it only Sir Roscoe who could do that in 6 months? How was PhD like in the 18th, 19th centuries? If say most students could finish it so quickly, it must have been very popular! Oh, someone please bring me to Victorian times; I can do a project on phossy jaw for PhD!

Note: From UCL Bloomsbury Project, Sir Roscoe was born at No. 10 Powis Place, off Great Ormond Street, in Bloomsbury, London. It is near UCL and as you can see from the map, it is just opposite to the International Hall where I live!

  http://www.oxforddnb.com/view/article/35827

- UCL Bloomsbury Project.
  http://www.ucl.ac.uk/bloomsbury-project/streets/powis_place.htm
I wish to express my heartfelt thanks to the archivists, librarians, and historian Louise Raw, who have given me very useful guidance on the approach in searching for historical materials related to phosphorus necrosis or phossy jaw.

- Annie Lindsay, Trust Archivist, UCLH NHS Trust
- Karen Syrett, Archive Assistant, The Royal College of Surgeons of England
- Library & Information Centre, Royal Society of Chemistry
- Lindsay Ince, Records Manager and Archivist, Royal College of General Practitioners
- Louise Raw, author of “Striking a Light: The Bryant and May Matchwomen and Their Place in History”
- Steven Kerr, Assistant Librarian, The Royal College of Surgeons of Edinburgh

I owe my deepest gratitude to my supervisors for their encouragement and inspiration.

- Stefano Fedele, Senior Lecturer, UCL Eastman Dental Institute
- Stephen Porter, Director, UCL Eastman Dental Institute

My thanks also go to my readers, colleagues and friends, for their support, and “comments, likes and shares” via Facebook.

Last but not least, this blog would not have been possible without my boyfriend, Eugene, who helped me lots with WordPress.