Extraneous vowels and doctor productivity: an international comparison

The workload debate has overlooked the time it takes to type those pointless Us, says Jennifer Kasten

Medical English differs notably from standard spoken and written English in the use of jargon, the persistence of Greek and Latin terms, and the dearth of acceptable emojis

G eorge Bernard Shaw once quipped that the United States and the United Kingdom (and, by default, the Commonwealth) are “two nations, divided by a common language.” We assume he was referring to the system of spelling in the US, which began to diverge from Britain’s in the 1830s under the influence of dictionarian Noah Webster. Based on 2005 estimates, the US has the highest worker productivity among English speaking nations: 67.32 as a ratio of gross domestic product to purchasing power. In contrast, Australian worker productivity is 55.87, followed by the UK at 51.38, Canada at 50.29, and New Zealand at 36.83. It is possible that, in the medical realm, time spent typing (or writing) the extraneous vowels in British English accounts for these differences. This becomes the proverbial albatross in inpatient and outpatient settings with heavy documentation burdens, reaching a fever pitch in periods of low staffing such as the Christmas holidays.

Vowels of uncertain significance
Medical English differs notably from standard spoken and written English in (a) the use of jargon; (b) the persistence of Greek and Latin terms; and (c) the dearth of acceptable emojis. It often uses words with the Romance suffix -(o)u(r): colo(u)r, humo(u)r, and behavio(u)r. The extraneous “u” adds a staggering 20% more typing or writing time to an otherwise five letter word, 16% to a six letter word, and so on. Imagine the enormous productivity boon which would arise from dropping the u if you needed repeatedly to document, for example, that one had heard a rumour from his honourable neighbour that the colour of a tumour had changed, while your patient was in labour with a baby of unusual splendour.

Other vowels of uncertain significance (VUS for the molecular geneticists among us) appear in British medical English as Greek and Latin diphthongs (syllables comprised of two vowels, for the phonetics enthusiasts among us). Entire specialties of medicine could see efficiencies: paediatrics, gynaecology, haematology, orthopaedics, etc. The gyn(a)ecologists are double offenders because they often take care of fio(ue)tuses and prescribe (o)estrogen, and the h(a)ematologists don’t get off the hook, with their leuk(a)emias and h(a)emophilia. Even the orthop(a)edists, whom one rarely credits with extraneous wordiness, can blame an(a)esthesia for all their problems, including accidental intubation of the (o)esophagus.

A corollary to the extraneous vowels proposal is the reduction of non-phonetic spellings—specifically, when the phoneme er is spelled re. Although the time spent typing the two variants is admittedly equal in terms of striking the keyboard, the mental gymnastics required (as measured by neuronal synapses and circuit crosstalk) to think the letter r makes a vowel sound, and spell it accordingly, might contribute further to the cognitive burden of documenting. Think of the busy otolaryngologist, attempting to measure goitres in precise increments of centimetres, performing various manoeuvres to biopsy them with needles of appropriate calibre while in the operating theatre, and so on. The heart bleeds, and the duty burden of the holiday skeleton crew piles up.

The way forward
Admittedly, there is a counter argument. The US substitution of the letter r for s in active verbs requires further stretch of the fourth and fifth digit of the left hand on traditional keyboards, and therefore cannot be endorsed.

In conclusion, I propose that anyone finding him/herself staring bleary eyed at a plate of lukewarm, picked-over donuts (37.5% more trim than doughnuts), smo(ul)dering (12.5%) with rage at the thought of being on solo duty for the next 37 hours in a drafty (25% versus draughty) hospital annex(e) (16.7%) over Christmas, drowning in charts, notes, operative reports, and the like, could benefit considerably from streamlined spelling.

And if you say in response that I am talking out of my arse, I’ll happily point out that using ass would represent a staggering 25% gain in efficiency, though admit that probably instituting the US version would result in a system twice as expensive but inferior in all international quality indicators.

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Do the birth month and season affect overall and cardiovascular mortality in US women?

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Objectives Season and month of birth are well established proxies of various environmental and other factors (eg, familial or socioeconomic factors) in early life. Although seasonal birth month effects have been indicated to be associated with variation in overall and cardiovascular disease mortality, epidemiological evidence regarding these associations remains inconclusive, and no previous study has been adequately controlled for potential confounders. This study aimed to evaluate the associations between birth month, birth season, and overall and cardiovascular disease mortality, and to examine the role of familial and socioeconomic factors in these associations.

Design Prospective cohort study.

Setting The Nurses’ Health Study is an ongoing large prospective cohort study in the United States, which was conceived in the early 1970s and initiated in 1976. A total of 121 700 US female registered nurses aged 30 to 55 years were enrolled at baseline and are followed to date via biennial questionnaires.

Participants Female registered nurses who reported information on date of birth at study enrolment were eligible for inclusion in the study (n=116 911, 1976-2014, followed for 38 years). Participants who were diagnosed with any cardiovascular disease before or at baseline, who had no information on birthdate, or were born prematurely, were excluded from analyses.

Exposure Birth month and astronomical birth season (based on solstices and equinoxes as boundaries of the season categories). In view of minor variations on the timings of solstices and equinoxes in different years, four astronomical birth seasons were created following the standard definition of spring (March 21 to June 20), summer (June 21 to September 20), autumn (September 21 to December 20), and winter (December 21 to March 20).

Main outcome measures Age and various multivariable adjusted hazard ratios and 95% confidence intervals for the association between birth months (using November as the reference), astronomical birth season (using autumn as the reference), and overall and cardiovascular disease related mortality were assessed using Cox proportional hazards models. To investigate potential heterogeneity across major cardiovascular disease subtypes, separate analyses (where there was enough power) for ischaemic heart disease and cerebrovascular disease across birth season were performed. In total, four models were performed in this study that adjusted for age, for age and familial and socioeconomic factors, for age and factors other than familial and socioeconomic factors, and for all covariates.

Results Among study participants, 43 248 overall deaths were documented during 4 136 364 person years of follow-up since enrolment, including 8360 cardiovascular disease related deaths. In fully adjusted multivariable analyses, no significant association was observed between birth month, birth season, and overall mortality. Compared with women born in November, increased cardiovascular disease mortality was observed among those born from March to July (hazard ratio for March, 1.09, 95% confidence interval 0.98 to 1.21; April, 1.12, 1.00 to 1.24; May, 1.08, 0.98 to 1.20; June, 1.07, 0.96 to 1.19; and July 1.08, 0.98 to 1.20). Those born in April had the highest cardiovascular disease mortality, and those born in December had the lowest (December, 0.95, 0.85 to 1.06). The relative difference between the lowest and highest risk month was 17.89%. Women born in spring (1.10, 1.04 to 1.17) and summer (1.09, 1.03 to 1.16) had a higher cardiovascular disease mortality than women born in the autumn. Adjustment for familial and socioeconomic factors did not change these results. The relative difference between the lowest and highest risk season was 10.00%.

Conclusion Participants born in the spring and summer (especially those born in March-July) had a slight but significant increase in cardiovascular disease specific mortality. However, no seasonal birth month effect was observed among women for overall mortality. Familial and socioeconomic factors did not appear to alter these associations. Further studies are required to confirm these findings and reveal mechanisms of these seasonal birth month effects in cardiovascular disease mortality.
WHAT IS ALREADY KNOWN ON THIS TOPIC

- Seasonal birth month effect has been consistently observed in previous studies for both overall and cardiovascular mortality
- Previous studies have not been able to adequately control for familial and socioeconomic factors and other potential confounders, limiting the interpretability of their findings

WHAT THIS STUDY ADDS

- Seasonal birth month effect was observed for cardiovascular mortality, but not for overall mortality; the association is unlikely to be related to familial and socioeconomic factors
- Women born in the spring and summer had a slight but significant increase in cardiovascular mortality compared with those born in the autumn; in this study, cardiovascular mortality accounted for a much smaller proportion of overall mortality than in previous reports, suggesting a seasonal birth month effect rather than confounding effect on cardiovascular disease
- The associations of fetal and early life factors with cardiovascular mortality might not all be related to an individual's early environment generally tracking on a similar trajectory throughout life, but related to a small but real seasonal effect on later life
**Objective** To determine the validity of the superstition that utterance of the word “quiet” in a clinical setting increases workload.

**Design** Prospective randomised controlled non-inferiority study.

**Setting** Microbiology department of a large teaching hospital in Lancashire, UK.

**Participants** Two members of the medical microbiology team carried out the duty work on any given weekday and an on-call team member on any weekend day. 29 days were assigned in which staff were to say “Today will be a quiet day” and 32 days were assigned in which staff were to refrain from saying the word “quiet” in any context.

**Interventions** Each day was randomly allocated to either saying “Today will be a quiet day” (intervention group) or refraining from saying the word “quiet” (control group) in any context.

**Main outcome measures** The primary outcome was mean overall workload: a composite of number of clinically related telephone calls, clinically significant results, or validated results processed by the duty medical microbiology team during a 24 hour period referred to collectively as “clinical episodes.” A difference of 30 clinical episodes was considered as the margin of non-inferiority. Secondary outcomes included the individual components of the primary outcome.

**Results** Workload was measured each day over a 61 day period (1 May to 30 June 2019). A mean 139.0 clinical episodes occurred on control days compared with 144.9 on days when the experimental intervention was uttered, a difference of 5.9 (95% confidence interval −12.9 to 24.7). The upper bound was less than the specified margin of 30, providing evidence for non-inferiority. No evidence of a difference in workload was found between interventions with any of the four components, whether considering unadjusted or adjusted analyses, or looking at the subgroups of weekdays or weekends.

**Conclusions** The study findings refute the long-held superstition that audible utterance of the word “quiet” impacts on clinical workload, and therefore it should not be avoided. In the era of considerable staff shortages and increased work related stress, doctors should look to other methods to increase resilience and protect their wellbeing and mental health.

**Trial registration** Lancashire Teaching Hospitals NHS Foundation Trust’s research department SE-259.
Introduction

In the modern era of evidence-based medicine, superstitions abound. One long held superstition is that utterance of the word “quiet” negatively affects a health professional’s shift because of increased workload and complexity of cases. Avoidance of the word quiet has therefore become common practice among healthcare professionals in the UK National Health Service and has also been mentioned in the United States and Japan.

We therefore conducted a randomised controlled non-inferiority trial to evaluate whether utterance of the word quiet increases clinical workload within a microbiology department of a teaching hospital in Lancashire, UK. A secondary aim of the trial was to answer another mystery of the medical world—what medical microbiologists actually do.

Methods

Design and study setting

We conducted a randomised non-inferiority trial to evaluate the hypothesis that utterance of the word quiet increases clinical workload. The null hypothesis for the study was that utterance of the word quiet increases clinical workload by no more than an average of 30 clinical episodes daily. Because the trial participants were healthcare providers we followed guidance that trial registration is not required under these circumstances.

The microbiology department of Lancashire Teaching Hospitals NHS Foundation Trust is based at Royal Preston Hospital. The laboratory team comprises more than 60 laboratory and support staff and 5.8 whole time equivalent microbiology consultants and trainees.

Interventions and randomisation

During the study period a member of the duty clinical team for that day carried out the intervention within the offices of the microbiology department between 8 am and 9 am. The interventions were either saying “Today will be a quiet day” (intervention group) or refraining from saying the word “quiet” in any context (control group). To minimise confounding we did not disseminate the intervention to colleagues who worked in other departments. Each day over a period of 61 days was randomly allocated to the intervention or control using a list prepared before the study. Randomisation was not stratified and was implemented using sequentially numbered opaque envelopes containing that day’s allocation. The duty team was not blinded.

Outcome measures

The primary outcome was a composite of number of clinical episodes processed by the duty medical microbiology team, including on call, weekends, and bank holidays. Secondary outcomes include the individual components of the composite primary outcome.

Sample size

Using data collected over a period of 30 consecutive days in January 2019, we expected a mean of 156 episodes (SD 41) for the composite primary outcome.

The margin of non-inferiority of 30 clinical episodes was prespecified based on the authors’ experience of what would be considered a clinically significant increase in workload. Using a one sided 2.5% level of significance and assuming no difference in the mean primary outcome measure between arms, we calculated that a total sample size of 60 days would be required to show non-inferiority with 80% power.

Statistical analysis

All consecutive days were included in the analysis. If the upper bound of the 95% confidence interval of the difference was less than the margin of non-inferiority of 30, then we considered non-inferiority to be shown. We also calculated the mean difference and 95% confidence intervals for each component of the composite outcome.

Results

The trial was conducted over 61 days, from 1 May to 30 June 2019. The mean number of clinical episodes was 139.0 on control days (n=32) compared with 144.9 on intervention days (n=29), a difference of 5.9 clinical episodes (95% confidence interval −12.9 to 24.7). The upper bound of the 95% confidence interval was less than the prespecified margin of 30 for non-inferiority, thereby providing evidence for non-inferiority. Although the workload was greater on weekdays than at weekends (a mean increase of 34.6 episodes), the differences between interventions were consistent in the subgroups of weekdays or weekends with no evidence for an interaction between treatment and type of day (P=0.870).
Discussion and conclusion

Our study found that utterance of the word “quiet” has no impact on the clinical workload of medical microbiologists. Secondary analyses also found that no individual element of the combined workload was impacted by the intervention.

Our study has several limitations. Firstly, we could not control for the use of the word quiet within the other hospital departments. Secondly, we did not incorporate microbiology ward rounds in our data collection as these are non-standardised and difficult to measure. Thirdly, we did not control for other confounding factors such as seasonal variation, number of samples received, or presence of black cats. Fourthly, while our margin of non-inferiority was prespecified before the study began and was based on the clinical judgment of the authors and colleagues, it was not derived from a formal consensus building approach. Fifthly, a chance imbalance in treatment allocation occurred between weekdays and weekends (table). We have presented adjusted analyses that showed slightly smaller differences between arms, and subgroup analyses with no evidence of interactions. Finally, this trial was conducted in a single study centre over a two month period, which might limit generalisability to other populations.

Clearly this study is somewhat tongue-in-cheek, but it highlights an important problem. The 2018 report from the joint Health Foundation and King’s Fund on the healthcare workforce in England highlighted that “There are significant staff shortages across the NHS. There are over 100,000 vacancies across NHS trusts.” A Royal College of Physicians report in 2016 notes that the NHS is underfunded, under-doctored, and overstretched, resulting in falling morale, productivity, and patient experience. In the face of such obstacles is it any wonder that staff hope that luck falls on their side?

Our study confirms what is probably already known—that superstitions such as not uttering the quiet word will not ease the heavy workload. Healthcare professionals need to be resilient and mindful to care for their own wellbeing as well as those around them.

The hammer: instrument of Thor (and orthopaedic surgeons)

Hosam E Matar and colleagues examine the history of one of our oldest tools

The hammer is arguably the first tool lifted by prehistoric man, and despite advancing digital technology it remains an essential tool in many aspects of modern life. In parallel to the development of the human brain, the hammer evolved along myriad paths to appear in the tool boxes of many professions, from stonemasons and blacksmiths to astronauts. More importantly, however, hammers and mallets are essential tools for orthopaedic surgeons. We look at the science behind their development and longevity.

Evolution

Geological artefacts suggest that hammers made of stones attached to sticks of wood were used as tools from before the Stone Age. The Bronze Age introduced metal to toolmaking, when axes with bronze or copper heads attached to wooden handles appeared in Mesopotamia. By 200 BC iron headed hammers were being used in ancient Rome, and by AD 75 a Roman claw hammer with a striking surface on one side and a curved claw on the other was in use.

Many variations on this basic design have evolved to serve different purposes, from the industrial to the artistic. It is unclear when medical hammers were first used, but one of the first percussion hammers was designed and popularised by the German physicist Max Wintrich in 1841.

Mallets look similar to hammers but typically have barrel shaped heads made of light and low mass materials such as wood, plastic, metal alloys, or even rubber. They produce lower force than hammers and have a wide range of uses, including musical instruments, carpentry, leather work, jewellery making, and surgery.

Throughout history, hammers have achieved a unique symbolic and mythical status from the Norse god Thor, the god of thunder and lightning. Brought to renewed fame more recently by Chris Hemsworth as arguably the most powerful of Marvel’s avengers, Thor wields the infamous Mjölnir hammer to victory against all manner of evil forces. Modern superheroes can conveniently purchase the hammer online.

Further popular hammer imagery can be seen in historic coats of arms and political symbols such as the hammer and sickle, which represents the industrial working class. More importantly, however, hammers have ventured into space to be among the tools used by astronauts landing on the moon during the Apollo missions, perhaps sealing their status as an essential tool for humankind.

Science of hammering

In their most basic design, hammers consist of a head with one or two striking faces and a handle (box 1). The act of hammering is all about transfer of energy and momentum and is governed by Newton’s laws of motion and the principles of conservation of energy and momentum. Kinetic energy (KE) is the energy an object possesses while in motion and is the product of the object’s mass (m) and the square of its absolute velocity (v): KE=1/2 mv^2.

As an example of the mechanical advantage of the hammer, the force of a
When implanting a uncemented stem in the femur during hip replacement surgery surgeons use a larger headed hammer
carpenter’s hammer (mass 0.5 kg) swung at 10 m/s to advance a nail 2 mm into a piece of wood is roughly 10 times the force of a 100 kg man standing on the nail to advance it by the same amount. Therefore, limited hammer force can produce a target force strong enough to bend steel or crack hard stones. Needless to say, in orthopaedic practice, when bone is the target, surgeons make only gentle taps and exert minimal force.

Momentum, on the other hand, is the product of velocity and mass. When implanting a uncemented stem in the femur during hip replacement surgeons use a larger headed hammer to ensure adequate momentum is given to drive the stem forwards at low velocity, and hence relatively lower energy, to avoid femoral fracture. Conversely, small, lighter hammers, (toffee mallets) are used for applications such as hitting a small osteotome to remove osteophytes or to split bone cement in revision hip surgery. Such hammers can be easily brought to rest with little follow through, an important consideration when other structures could be damaged if the osteotome advances too far.

Medical hammers
Hammers and mallets are essential tools for trauma and orthopaedic surgery. They have a wide range of applications, and many specialist hammers and mallets are available for specific roles. Heavier stainless steel hammers, for example, are used when rasping the femoral canal during a total hip replacement or impacting total knee replacement components.

An important aspect of these types of hammers is the shock absorbing capacity of the handle. Handles with an open area in the middle or a rubberised or wooden cover have increased shock absorption, which improves the comfort for the user, particularly as many repetitive blows may be required for each surgery.

The use of softer metal or material for the head is thought to make the hammer more comfortable to use because a small amount of the energy from each blow goes into surface deformation. Our hospital has used soft copper hammers since the days of John Charnley, who pioneered hip replacement surgery. Although they deform greatly over time, they remain a favourite of many surgeons because of the comfort of use, though some of this may be the result of surgeons’ expectations or sense of nostalgia.

Hammers are also widely used in other specialties, including spinal surgery, neurosurgery, and cardiothoracic surgery. Furthermore, almost every medical graduate will have used a tendon or reflex hammer at some point in their career and experienced the spring-like bounce action of its plastic handle.

Hammers and mallets remain a vital tool for orthopaedic surgeons. They have a rich and enduring history, having played an important role in human technological advances since their invention by our earliest ancestors. Science has not produced a replacement, and hammers are likely to continue serving humanity for the foreseeable future.

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Use of a hand hygiene technique as recommended by WHO is vital, but memorising the six steps is a barrier to its adoption. Our musical mnemonic based on Frère Jacques can help regular hand hygiene education at day care and school is recommended as an effective method to prevent gastrointestinal and respiratory infections, which are common in children. Hand cleansing may seem a relatively simple task, and the correct technique can improve the effectiveness of hand hygiene at eliminating microorganisms. Numerous studies have investigated the specific effect of school based hand hygiene interventions on infections and school absenteeism; however, few interventions have focused on how hand hygiene technique is taught to children.

Using songs, in particular musical mnemonics based on nursery rhymes, may help children learn the process of hand hygiene techniques by making it more fun, thereby increasing attention and the development of memory and motor coordination. Learning through lyrics, where the instructions are stated before completion of each step, has been shown to produce quicker acquisition of novel skills compared with prose self instruction. Children are exposed from an early age to musical mnemonics or cues that assist with learning (the ABC song for the alphabet, and the Head, Shoulders, Knees, and Toes song to identify body parts). However, few musical mnemonics exist to help teach hand hygiene to children. We reviewed a convenience sample of 15 videos online that targeted children to determine the following: presence of a musical mnemonic (with lyrics complementing each step of handwashing); song duration; and demonstration of decreased microbial burden as immediate visual feedback. We found no videos that showed the six step technique using a song mnemonic; the few that showed certain steps had songs that were longer than the recommended duration of handwashing (20-30 seconds) and were not easily reproducible by our school aged coauthor.

Fuelled by these findings, we decided to develop a musical mnemonic that targeted school aged children. We used the melody of a well known children's song, Brother John (Frère Jacques), and incorporated the six recommended steps into a song mnemonic:

Wash your hands, Brother John

Use of a hand hygiene technique as recommended by WHO is vital, but memorising the six steps is a barrier to its adoption. Our musical mnemonic based on Frère Jacques can help

Regular hand hygiene education at day care and school is recommended as an effective method to prevent gastrointestinal and respiratory infections, which are common in children. Hand cleansing may seem a relatively simple task, and the correct technique can improve the effectiveness of hand hygiene at eliminating microorganisms. Numerous studies have investigated the specific effect of school based hand hygiene interventions on infections and school absenteeism; however, few interventions have focused on how hand hygiene technique is taught to children.

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steps for hand hygiene (fig 1 and box). The lyrics were developed in collaboration with children of preschool and primary school age, ensuring that our intended audience could easily understand them, and leveraged the rhythmic and rhyme patterns of a popular song to improve memory retention.

To investigate whether this song lyric self instruction method could be effective in reducing microbial burden, fluorescent marking was applied at the outset and hands were examined after washing with soap and water for residual fluorescence. Figure 2 shows reduction in the presence of fluorescent marking on the hands following handwashing while singing the musical mnemonic, indicative of potential effectiveness at decreasing microbial flora.

This song lyric self instruction has broad implications for school based public health campaigns. We showed that a musical mnemonic developed for preschool and school aged children can teach the World Health Organization hand hygiene technique effectively, potentially reducing infection transmission, with a duration of approximately 20 seconds. Given the longstanding clinical challenges of compliance with the six step technique, there is also potential for this musical mnemonic to be adopted in the healthcare setting; further testing would be required before definitive comparisons can be drawn. We plan to test the song in the classroom setting to determine its social acceptability, and its potential for peer-to-peer learning and long term memory retention. With its catchy tune and clear, lyrical instructions, our technique offers the opportunity to develop hand hygiene muscle memory, self-correction, and public health gains among children.

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The six steps to achieve effective hand hygiene, sung to the tune of Brother John (also known as Frère Jacques) (video on bmj.com)

1 Are you sleeping // Scrub your palms
2 Are you sleeping // Between the fingers
3 Brother John, Brother John // Wash the back (one hand), wash the back (other hand)
4 Morning bells are ringing // Twirl the tips (one hand) around (other hand)
5 Morning bells are ringing // Scrub them upside down
6 Ding, ding, dong; ding, ding, dong // Thumb attack (one thumb)! Thumb attack (other thumb)! (sung with gusto)

Each line is repeated as is necessary to complete each step.

EDITORIAL

Skeletorses in the closet: towards the dignified disposal of all human bones acquired for medical education

Human bones have long been used as teaching tools, but this is unnecessary and hard to justify with today’s easily accessible technologies, argue Jonathan Coman and colleagues

Your family is preparing for Christmas. While searching through the cupboard for decorations, you discover an old box. It contains human bones, prompting a battery of questions from the children: Is that a real person? Who? Why are the bones here? What will happen to them? You have few answers.

In this editorial we call for an end to the use of human bones for educational purposes and urge authorities to develop and disseminate legal and ethical pathways for the dignified disposal of any remaining “skeletons in the closet.”

For hundreds of years, grave robbing and body snatching supplied human remains for anatomy students. Into the 20th century, medical students were encouraged to acquire human “bone sets,” often sourced from developing countries. India was a major source, until export bans commenced in 1985 because of concerns about grave robbing. However, evidence shows a persistent illegal trade in human remains.

Buying and selling human bones is prohibited in many jurisdictions. But this is not widely appreciated, and bone sales continue, including through online platforms.

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Centuries of organised medical education have resulted in many human skeletons being in private possession—probably thousands in the UK alone. These skeletons can circulate in the community indefinitely, sometimes being passed down in families. This raises some important legal and ethical issues.

**Respect**

Respect for humans is founded on the ethical principle of respect for autonomy, which asserts that people should have the right to make decisions for themselves. This extends to how their body is disposed of or used after death. Unauthorised taking, processing, and sale of bones without consent are breaches of this principle.

The principle of justice aims to balance competing claims: in this case, balancing the societal benefit (from the education of health practitioners) with a person’s autonomy. Previously, human bones were considered better for education than artificial options. However, with increasing sophistication of 3D printing and associated technologies, high quality alternatives now exist, making the societal benefit argument moot. Continued holding and circulation of existing bones for educational purposes is therefore difficult to justify. Similar concerns have been raised regarding the display of human remains in museums and popular exhibits.

Educational use of human bones is ethically acceptable, provided people give explicit and valid consent to donate their remains to a university or similar institution.

**Dignified disposal**

The disposal of existing collections of human bones is not straightforward and is subject to considerable jurisdictional variation. Unauthorised burial, or disposal in household waste, risks triggering an unnecessary homicide investigation and fails to respect the donor’s dignity. Surrendering bones to authorities, however, potentially risks criminal prosecution in some jurisdictions, and amnesties should be strongly considered in these circumstances.

Other possibilities include authorised burial or cremation. Both usually require permission from relevant authorities, along with procedures to establish the name of the person and identify his or her origin. However, this information is usually impossible to provide. The fact that the bones are unidentified also prevents the disposal of remains in a culturally or religiously appropriate manner. Even if burial were possible the costs would be borne by the “owner” and may be an additional barrier to disposal.

To tackle this problem, health authorities in all jurisdictions must review legislation and develop a sensible, ethical, and locally feasible process for the dignified disposal of educational human bone sets. Specific information for doctors or surviving relatives should then be made freely available and widely publicised. Finally, health professionals and health authorities should start a campaign to encourage disposal of privately held human remains.

**The skeleton in your closet**

Sale, mistreatment, or casual disposal of human bones is clearly inappropriate. As legal processes vary between countries, we recommend seeking advice from a local authority such as a coroner’s office or from a university. In the UK, a respectful cremation or a donation to a university health science faculty is probably appropriate. In universities, a plaque could be added to any display to express respect for people whose bones have been used to educate health professionals, for the benefit of wider society.

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**Coordinated programmes for managing the legacy of human bone use in education are long overdue**

Following the example of the medical defence union, health authorities in all jurisdictions must review legislation and develop a sensible, ethical, and locally feasible process for the dignified disposal of educational human bone sets. Specific information for doctors or surviving relatives should then be made freely available and widely publicised. Finally, health professionals and health authorities should start a campaign to encourage disposal of privately held human remains.