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Opinion

Microbiology service centralization: a step too far

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Introduction

An acute hospital is defined as that offering emergency and intensive care, acute medicine and surgery. These services are generally supported by on-site laboratories but they are being threatened in the current financial climate. Managers see laboratory mergers as financially advantageous because pathology is already well defined as a business package with annual budgets. There are no resident patients to complicate service delivery. Furthermore, pruning does not adversely affect waiting lists since laboratories are seen as 'factory-type' operations with little direct impact on patient care.

In the UK, microbiologists are aware of present moves to create pathology networks, chiefly by centralization of laboratories.^{1–3} 'Centralization' can be defined as building up or relocating one 'central' laboratory while closing or downgrading

one or more 'peripheral' or smaller laboratories in acute hospitals in a Trust or Health Board. Centralization and modernization of microbiology services has already taken place in some countries (e.g. the UK and Germany) or is being considered by a range of healthcare regions and countries. Current trends include concentration of resources (formation of larger microbiological units from the closing of smaller laboratories), amalgamation of services (creating multidisciplinary laboratory facilities), outsourcing of microbiology diagnostics, automation of sample handling and diagnostics, mandatory accreditation, and broadening microbiology staff competencies in order to improve the flexibility of the available workforce.⁴ These encompass specimen reception, decontamination services, cleaning, ordering, secretarial work, blood science support and even mortuary duties, the latter an unwelcome addition for inexperienced laboratory assistants.

Managers believe that centralization of microbiological services will save money.³ This belief centres on the fact that since it takes at least 24 h to culture bacteria on agar plates, transporting specimens 10 miles down the road to a supermarket-type facility can hardly make much difference to clinicians, and, by inference, to patient care. There is little awareness of the impact from loss of rapid testing, altered communication patterns, aspects of specimen timing and transport factors, all of which threaten the safety of patient care, as well as complicating infection prevention and control. Any potential benefits from financial savings, cross-cover options and a greater number and array of possible tests cannot necessarily compensate for deterioration in service quality. Sadly, many managers do not really understand what microbiologists do and how quickly they can do it in the event of an emergency.⁵ It is also true to say that there is minimal scientific or other evidence to justify decisions on service amalgamation.¹ Here we summarize some of the potential consequences of centralizing microbiology services in the UK and beyond.

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Status of peripheral (or spoke) laboratories

Core services for acute hospital microbiology

In the event of proposed centralization, managers may seek to ameliorate concerns over complete closure of on-site services by creating the so-called 'hot' or core laboratory on an acute hospital site. The hot laboratory is usually a remnant of the peripheral laboratory tasked with delivering an agreed range of immediate diagnostic tests as well as managing a 'pack and delivery' service for less urgent specimens to go to the central facility. There is little evidence to justify a hot facility at the present time, and indeed its creation may lead to unforeseen health and safety issues, as well as problems with out-of-hours cover and governance (<http://www.britishinfection.org/professional-affairs/csc-mvd/>).¹ Should there be significant distance between peripheral and central laboratories, however, then it is reasonable to consider a restricted service capable of processing selected microbiological tests (see Box 1). Opening hours, level of service delivery and range of tests that meet patient needs must be agreed and endorsed by users and microbiologists because there are currently no national guidelines.

Box 1

Immediate and critical tests, procedures and services offered by a clinical microbiology laboratory in an acute hospital

These vary according to the clinical services on offer but are likely to include:

- **Blood cultures** including Gram films, direct susceptibility testing, coagulase, oxidase, streptococcal grouping, and pneumococcal antigen tests
- **Microscopy** on urgent specimens; aspirate, sputum, pus; theatre specimens, e.g. tissues, joint aspirates, fluid, vitreous humour, urine, stool; auramine/Ziehl–Neelsen (ZN) staining for mycobacteria
- **Cerebrospinal fluid** including cell counts, Gram stain, auramine/ZN stains, *Streptococcus pneumoniae*, *Neisseria meningitidis* antigen tests; Indian ink stain
- **Broth inoculation** of specimens if anaerobes suspected, such as for urgent theatre specimens to facilitate culture
- **Direct inoculation** of plates at bedside of ophthalmology corneal scrapes
- **Screening for multidrug-resistant bacteria**, e.g. methicillin-resistant *Staphylococcus aureus* so that there is a result within 24 h or earlier
- **Initial screening** for hepatitis B, C, and HIV tests before dialysis, donor testing for needle-stick injuries and transplant screening
- **Latex agglutination** (urine), e.g. *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Legionella pneumophila*, etc.
- **Direct toxin testing**, e.g. *Clostridium difficile*
- **Antibiotic serum levels**, e.g. aminoglycosides and glycopeptides
- **Direct immunofluorescence**, e.g. respiratory syncytial virus, *Mycobacterium* spp., cryptosporidium
- **Molecular methods**, e.g. polymerase chain reaction for influenza and norovirus; Quantiferon tests for tuberculosis
- **Autoclave services** for managing clinical and laboratory waste on a daily basis
- **Retrieval of blood/serum** from blood sciences for additional microbiological testing
- **Timely alerts** to users if specimens are unlabelled, contaminated, leaking or inappropriate to maximize the likelihood of a repeat specimen quickly

If diagnostic microbiology is deemed necessary for a peripheral hospital, then the equipment required duplicates that in the central laboratory and negates any perceived cost savings. Managers should be aware that there is still a need for incubators; manual and/or automated susceptibility testing systems; blood culture equipment; anaerobic culture; safety cabinet and containment facilities for processing expected and unexpected controlled pathogens. All laboratory facilities, whether peripheral/hot or central, remain subject to health and safety standards, spillage containment, waste disposal, appropriate decontamination, and quality control and inspection in accordance with regulatory frameworks. In such circumstances, an acute hospital should campaign for retention of the original facility, given the lack of evidence for financial benefit from replacing it with a hot laboratory; laboratory staff could, however, undertake to liaise and work with the larger/central laboratory to enhance services. Strong support from senior clinicians such as intensivists and oncologists may assist in maintaining on-site diagnostic services. Having an on-site laboratory benefits staff as well as patients due to overlap with occupational health, public health, and infection prevention and control policies.

Issues for proposed central laboratory

General issues

There are general and specific requirements which must be fulfilled by a central laboratory when it agrees or is asked to take over a peripheral laboratory. General needs revolve around the additional space required for all aspects of the service, including staff facilities. Sufficient space for extra specimens, including bench space for daily processing and storage space for out-of-hours deliveries are a priority. Also required is an adequate reception area as well as leisure, study and cloakroom amenities for staff. Space is needed for extra equipment, both operational and storage. Managers must consider the need for new appointments, redundancy in the peripheral laboratory, contractual changes, overtime, and travel expenses. Funding may also be required for duplicate and/or enhanced capacity equipment. There are important issues regarding health and safety, occupational health, personnel, and even parking for extra staff. It is already known that staff experience less job satisfaction in larger laboratories, illustrated by increased retirement and turnover of experienced biomedical scientists (BMS) and support staff.⁶

Specific issues

Specific requirements for proposed microbiology centralization include planning for extended working hours due to inevitable transport delay; this is because of the need to set up specimens for overnight culture. If specimens are not processed on the day of reception, then there is an automatic 24 h delay added on to turnaround time with the potential for inaccurate results. Extended working hours often causes resentment among the BMS workforce. Managers should be aware of the need to negotiate contractual changes, to minimize division and disruption.

There may be equipment saturation at the central laboratory, with priority given to specimens from the central hospital

site rather than from elsewhere. Communication difficulties are a major concern, with the potential for delayed and/or poorly prioritized telephoned reporting and tardy response from an overloaded hospital switchboard. Developments in information technology (IT) infrastructure may help ameliorate this (see below). There may also be delays in timely processing of antibiotic levels, which could lead to withheld doses, or, if given, increased toxicity risks.

Partially processed and/or unprocessed specimens transported from a peripheral laboratory could compromise organism survival; there may also be reporting mismatch; handling risks in the event of an accident; and chance of specimen loss, breakage and/or contamination in transit. Indeed, alerting users if specimens are unlabelled, contaminated, leaking, or inappropriate will also be subject to significant delay if sent to the central laboratory before deficits are recognized. It is poor practice (and embarrassing) to inform a clinician that another specimen is required hours or days after it was originally taken, especially if the patient has gone home or it was difficult to obtain, e.g. joint aspirate; or it cannot be repeated, e.g. abscess drainage; or the patient died; or the patient subsequently received antibiotics, thus rendering any bacteriological analysis obsolete.

The BMS staff at the central laboratory may not appreciate peripheral hospital geography or personnel and they may also lack ownership in a large facility. Staff moving from a smaller (peripheral) to a larger (central laboratory) are expected to adopt new and/or contradictory specimen operating procedures and this, along with greatly increased specimen numbers, might discourage suspicious or premature reporting. Formal reporting would itself be compromised by increased specimen load, as well as difficulties in locating a specific result following a request for clinical advice.¹ Even a few hours of additional delay in processing may be critical for a septic patient or for identifying or controlling an outbreak. Furthermore, centralized laboratories make it infinitely more difficult to share specimens between laboratory disciplines on the same site, e.g. blood submitted to biochemistry or haematology cannot easily be retrieved for urgent microbiology, such as antibiotic assays.

Information technology

Computer systems play a central role in laboratory data processing. They also constitute a difficult decision for managers considering laboratory centralization. The choice lies between expansion of one system at the expense of the other(s) or procurement of a totally new system for all sites which is usually extremely expensive. Both options present a number of challenges: data retrieval from abandoned data base(s) and loss of years of microbiological data for individual patients, units, specialties, and surveillance programmes. Clinical microbiologists rely heavily on past microbiological histories in order to manage acutely unwell patients. Previous reports of specific pathogens and associated antibiogram assist greatly when advising on empirical therapy. For hospitals that have already experienced centralization, lack of a common IT system across a network has compromised service delivery with significant reporting errors.¹ Clinicians working in peripheral hospitals may be unaware of results that could have a direct impact on clinical care.¹

New systems promote the need for staff training and updates. Laboratory reporting procedures need agreement and harmonization between different hospitals. There may also be

unforeseen decommissioning fees and expensive advice from IT consultants. As with any computer system, but particularly that linking a laboratory with acute hospital services, the potential chaos resulting from system failure, malfunction or crash will inevitably affect patients and staff.¹ Contingency plans must be put in place whatever the scenario to safeguard patient safety arising from unscheduled loss of laboratory data that could delay or compromise clinical decisions, extend waiting times, and impact upon operating timetables. Information systems are arguably one of the most important issues to consider when planning the formation of any pathology network, including microbiology.

Transport

Planning specimen collection

Specimens should be transported to the laboratory as rapidly as possible. This is done to prevent the loss of fastidious micro-organisms and discourage bacterial overgrowth obscuring the presence of any pathogens.⁷ Transport planning poses significant problems in the event of centralization, particularly in areas of high traffic density, unfavourable climatic conditions, inadequate road systems, or long distances between health service providers and laboratory. Out-of-hours deliveries promote the need for shift systems for staff, otherwise turnaround times will automatically be extended. Depending upon weekend practices, there could potentially be another 72 h added on to timed reports for non-urgent specimens arriving late on Fridays. There needs to be service planning to allow for public holidays, acute traffic difficulties, or unheralded weather-related disruption. Finally, hospital vans have other duties, particularly in rural areas, and specimen collection may be low priority.

Specimen transport systems might be compromised by inflexible pick-up and delivery times for some hospitals, outpatient clinics, community health consortia, and GP practices. Even if a robust system is implemented, emergency taxis or equivalent will be needed for pandemic influenza, Middle East respiratory syndrome, anthrax, and Ebola specimens, etc. Transport planners should also consider potential litigious aspects, e.g. who takes responsibility for lost specimens, particularly if the specimen in question is unique, cannot be repeated and/or represents an urgent public health request. Loss, breakage, or contamination due to mishandling or delayed transit could result in unacceptable clinical risks to individual patients as well as inappropriate and/or delayed response to a possible outbreak. There are also infection risks to drivers, emergency service personnel and others in the event of an accident involving a delivery vehicle.

Pathogen fragility

Some micro-organisms are vulnerable to conditions imposed during specimen collection and delivery, even if protected by transport media. These include pathogens such as *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Neisseria* spp.^{8,9} Furthermore, microbial toxins present in a specimen may be inactivated during transit, e.g. *Clostridium difficile*. Vans are unlikely to offer optimal storage temperatures whatever the prevailing weather conditions. The best possible recovery of

isolates from the original samples is crucial for identification and further analysis.

Blood cultures are a fundamental investigation in the management of infection.¹⁰ To optimize their clinical utility, the interval between collection of samples and reporting of results should be kept to a minimum.^{11,12} Inoculated bottles should be incubated as soon as possible and certainly within a maximum of 4 h. Time from collection to laboratory reception is dependent on the location of the laboratory in relation to the ward (onsite/offsite) as well as transportation arrangements.¹¹

Some laboratories leave blood cultures at room temperature overnight, which may prolong the detection time for some organisms.¹³ Any delay in reporting positive blood cultures has clinical significance and represents an unacceptable risk for patients with sepsis. There is a statistically significant increase in the mortality rate for patients who have blood cultures processed after a delay (i.e. Gram stain performed ≥ 1 h after being detected as positive; $P = 0.0389$).¹⁴ The number of organisms present in adult bacteraemia is frequently low, often $< 1 \times 10^3$ colony-forming units (cfu)/L; this increases the risk of negative cultures if there is a delay in delivering cultures to the laboratory, and especially so if the pathogen itself is less resilient outside the human host.¹⁵

If direct placement on to the appropriate analyser is not possible, blood cultures may be pre-incubated in a separate incubator.¹⁶ An inadvertent consequence of this is that 2–5% of positive cultures will be undetected when they are eventually placed on to the analyser after pre-incubation.¹⁷ *Streptococcus* species, yeasts, and non-fermenting Gram-negative bacteria, e.g. *Pseudomonas aeruginosa*, are missed by continuous-monitoring blood culture systems if pre-incubated at 35–37°C.^{18,19} When pre-incubation has been sufficiently long for the organism to have gone through the growth phase and reached stationary or decline phase, bottles containing such organisms will not trigger the analyser. This is because detection is dependent upon biochemical changes during the growth phase.

Transporting specimens to an off-site laboratory adds another stage to the journey between bed-side and bench. Isolating a pathogen from a patient's specimen is challenging at the best of times as no laboratory method can ever replicate *in vitro* the *in-vivo* microbiological setting in which the pathogen survives and thrives. Delayed and false-negative results complicate timely infection prevention and control measures, including public health interventions.

Clinical consequences of centralizing microbiology services

The clinical microbiologist faced with centralization has to decide whether to stay with the peripheral hospital, with or without the presence of a hot laboratory, or work on split sites, or move to the central hospital and abandon a clinical presence locally. All of these options present difficulties. Lack of an on-site laboratory condemns the microbiologist to forego specimens, plates, input, and advice from BMS. There may be little or no opportunity for urgent diagnostic tests. Moving to a central laboratory might compel the microbiologist to become a bystander in a largely analytical service without clinical and consultative aspects. This could compromise the needs of the individual patient.⁴ Finally, partitioning a job between sites erodes ownership and imposes a more rigid work strategy.

Contractual visits to both sites fragments the working day and week, complicates communication, wastes time, and often reduces job satisfaction. Split site duties illustrate a particular problem in busy cities, since travelling between the hospitals is subject to traffic delays with circuitous routes. Clinical microbiologists may be tempted to forego ward rounds and/or clinics at peripheral sites simply due to problems with travel.

Relocation of consultant staff could create problems with office space, secretary(s) and car parking availability; the latter, a serious problem at most hospitals. There are also additional travel and mobile phone expenses; different operating procedures; unfamiliar specialist microbiology, e.g. obstetric, paediatric, and cancer care; and again, communication difficulties between BMS, infection prevention and control nurses, hospital staff, and general practitioners. Direct interaction between consultants and their BMS colleagues, in particular, represents a significant beneficial addition to specimen processing that is not currently recognized or quantified.² Examples cited include early emergence of novel antimicrobial resistance patterns or decision-making during an outbreak before formal reporting (<http://www.britishinfection.org/professional-affairs/csc-mvd/>).¹ A readily accessible clinical microbiologist can also direct appropriate testing for a specimen as well as prune superfluous tests in duplicate samples.

It is known that staff attitudes affect quality in clinical microbiology services.⁶ Contradictory policies and protocols create confusion and lead to irritation for clinical and BMS staff alike. Similarly, consultant responsibilities within a centralized network are not always clarified before amalgamation takes place. There is an additional risk that pooled clinical cover, including out-of-hours, will not necessarily provide support for highly specialist services, e.g. cardiac transplantation, where the relocated clinical microbiologist has no background. Displaced consultants may not be aware or not report subtle infection prevention and control issues, because no one can locate them or there is no appropriate alert system.

Microbiology and infectious disease trainees are at risk of fragmented and inadequate teaching if they are not based in the central laboratory.²⁰ Whereas consultant expertise may be centrally concentrated, peripheral hospitals may suffer from lack of consultant supervision and general academic input. Furthermore, interesting or rare cases in a peripheral hospital may not necessarily be used for teaching and training purposes. Research opportunities for staff in peripheral hospitals may also be compromised. Academic interest and training in infection and diagnostic microbiology may stall without support and access to an on-site laboratory and its staff.

The most important psychological consequence for a centralized network is potential loss of ownership and reduced morale for microbiologists and laboratory staff.^{1,6} Experienced microbiologists know that off-site consultation is never as satisfactory as an on-site presence. The clinical service is a 'people business', meaning patients, colleagues, healthcare staff and others who all interact; it is not a factory with a production line. Consequently, the interaction at a personal level remains vital irrespective of any developments in IT, which can never replicate a useful and valuable conversation. Clinical microbiology should not become a call centre. An opportunistic visit to a patient on the way to a meeting or the hospital canteen will simply not happen if the consultant is based elsewhere.²⁰ Such visits inevitably discover vital facts relevant to the case, which may not necessarily be transmitted

by telephone or via IT. These contribute towards the quality of patient care as well as potentially facilitating earlier discharge.

Infection control and surveillance

Hospital-acquired infection (HAI) is an important quality indicator for hospitals. Specifically, in the event of an outbreak at a peripheral hospital, there is a risk that a subtle increase among key pathogens goes unnoticed among the specimen bulk-processed at the central laboratory. Linked cases of specific infections in time and space are more likely to be detected in a hospital with its own microbiology laboratory and resident microbiologist when there is ample opportunity for multiple liaisons with BMS and infection prevention and control personnel throughout the day. The case in point is illustrated by the outbreak at the Vale of Leven hospital in Scotland, where no one noticed escalating reports of toxin-positive *Clostridium difficile* over weeks and even routine surveillance mechanisms failed to alert sister hospitals and national reporting bodies.²¹ The subsequent public inquiry noted that there was no consultant microbiologist based on-site before and during the outbreak.²¹

The infection control nurses (ICNs), an integral part of the infection control team, may be isolated at a peripheral site where there is no laboratory, no consultant, or reduced access to a consultant. Furthermore, the opportunity to discuss an issue in person with the consultant microbiologist can often alleviate a bigger problem as well as providing support to ICNs when liaising with senior management or nursing colleagues. Communication difficulties between microbiologist and ICNs may result in delays in side-room ‘juggling’, which increases outbreak potential and compromises bed management. There may also be delays in immediate access to preliminary microbiology results, which could hinder the management of an individual patient, as well as investigation of cross-infection or outbreaks.

The fundamental basis of all infection prevention strategies is robust surveillance.^{10,22} Without clearly defined incidence data collected over time, infections cannot be properly controlled. Whereas centralization might appear to simplify mandatory reporting, there may be unforeseen complications with surveillance initiatives. Any real or apparent deficit in microbiology access may deter clinicians from sending specimens, thus compromising meaningful surveillance. If samples are sent, it is essential to ensure that they are processed efficiently with optimal recovery of key organisms, and that transport and storage media maintain specimen viability without introducing bias.²³ For example, ‘negative’ cerebrospinal fluid culture seriously impedes the initial public health response to a case of meningitis as well as contributing to systematic under-reporting. Off-site facilities might therefore delay recognition of an infection alert, which could impact on hospital patients and staff as well as on the local community.

The microbiology laboratory acts as an ‘early warning system’ for infection control.²⁴ Centralization could prolong timely responses to burgeoning outbreaks, especially out-of-hours or during a holiday period; communication with public health departments will be delayed; and both hospital and community outbreaks will be more difficult to control if prompt intervention is compromised. There has already been a taste of this with the difficulties surrounding the transportation of swine influenza swabs and difficulties in retrieving timely results from a centralized virology facility.

Antimicrobial stewardship

There is increasing focus on antimicrobial resistance at the present time.¹⁰ Early identification and antibiotic susceptibility results provide valuable diagnostic information on which appropriate therapy can be based, so helping to reduce morbidity and mortality, improve patient care and reduce healthcare costs.^{25,26} Decreasing turnaround times at each stage of the process from specimen transportation to reporting of results is therefore crucial for patient care.¹¹

When a patient receives first-line empirical agents for sepsis, ineffective therapy due to resistance has repercussions far beyond simply failing to cure the patient. Naturally or acquired resistant flora quickly overgrows, potentially causing invasive infection.²⁷ Without timely notification of causative pathogen and susceptibilities in order to adjust therapy, the microbiology becomes inordinately complicated. Even an overnight delay in returning results could be catastrophic for an individual patient with escalating sepsis.

If clinicians recognize adverse delay in specimen processing, they may change their prescribing choices to accommodate delays experienced by off-site laboratories. These would encompass a move from choosing a single agent or narrow spectrum therapy to combination and/or broad-spectrum agents. Antimicrobial stewardship programmes decree that broad-spectrum therapy should always be curtailed as soon as any positive microbiology results are obtained, but it takes a brave individual to stop the original regimen and initiate narrow-spectrum drugs when a patient is rapidly responding. This is one area where an on-site microbiologist would quickly identify a chance for effective stewardship. Such communication would be difficult based at an off-site facility, let alone the reduced opportunity for corridor or canteen conversations.

Various strategies aimed at better identification and management of patients with acute sepsis have been implemented over the last few years.^{28,29} These strategies clearly state that administration of effective intravenous antimicrobials within the first hour of recognition of septic shock is one of the main goals of therapy. However, without on-site microbiology services, determination of what antibiotics actually are ‘effective’ will be delayed or non-existent, if the facilities for rapid processing of blood cultures and other key specimens are situated miles away.

There is escalating interest in rapid diagnostic tests to encourage more ‘appropriate use’ of antimicrobials.³⁰ The UK Research Council is also supporting diagnostic development and the influential Longitude Prize (<https://longitudeprize.org>) is to be awarded to whoever first produces a specific rapid diagnostic tool.³¹ Instant molecular tests would help inform and guide clinicians’ prescribing rather than reliance on a cocktail of broad-spectrum agents. However, making the best use of such a strategy depends upon a microbiology laboratory in close proximity, with 24 h staffing, excellent transport systems and multi-faceted communication links.² Centralizing laboratories compounds this, with a possible scenario whereby it takes hours or even days to deliver a specimen to the nearest laboratory but only minutes to process it.

Benefits from centralization

Some benefits have been reported following centralization of microbiology services (<http://www.britishtinfection.org/>

[professional-affairs/csc-mvd/](#)).¹ The Carter Review of Pathology services 2008 suggested that revenue savings of up to 20% could be realized and that these should be reinvested in the service.³ Evidence supporting such savings has yet to be published.³² Service improvements mostly related to IT systems, out-of-hours cover and enhanced laboratory services, such as the provision of new equipment and tests, may also accompany centralization. In networks where infection specialists have been closely involved in designing and implementing change, progress has been made: fit-for-purpose IT systems, investment in technology, and extended service provision in time and techniques. It is true to say, however, that many of these have also taken place in the absence of networks. Clearly, evidence for patient and financial benefit from centralization is urgently needed.

Conclusions

The creation of a pathology supermarket attracts the business-minded but in the case of microbiology, big is not necessarily better. With the emphasis on saving money, the definition of a quality service becomes somewhat labile. Who determines quality? Where this is mandated by government, it may be impossible for local staff to offer the traditional level of service. If it is determined locally, increased clinical risk following centralization could be attributed to clinicians rather than managers. Medical staff should highlight the clinical consequences from laboratory closure and try to retain on-site services if at all possible. Many of the points made in this article are supported by responses from the British Infection Association (BIA) audit (<http://www.britishinfection.org/professional-affairs/csc-mvd/>).

Are there really substantial savings to be made by centralizing laboratories? The answer is variable, but quite often it is 'no'.^{2,32} Feedback from colleagues in peripheral laboratories indicates that they failed to see any benefits after centralization; this includes a lack of financial return as demand management and streamlined testing algorithms have been lost. It is possible that the original review supporting the creation of laboratory networks failed to consider basic principles of diagnostic microbiology and its public health contribution, as well as the spiralling increase in antimicrobial resistance and continued risk from pandemic and/or novel pathogens.³

Laboratory reviews, themselves hugely expensive, do not necessarily recognize hidden costs such as taxis for specimens and staff, IT overhaul, travel expenses, extended working hours, decommissioning charges, telephone switchboard upgrade, and redundancy payments. The most damaging costs are, however, subtle deterioration in infection prevention and control services and delayed responses to clinical problems, including poor antibiotic management.³³ Even highly experienced consultants in non-infection specialties do not always know which antibiotic might save a life, or which specimens could aid rapid diagnosis courtesy of on-site attention. Moving services off-site denigrates patient care at the expense of perceived financial savings.

If a hospital strives to provide a quality clinical service, then this must include acute laboratory specialties. The clinical microbiologist acts as a 'gatekeeper' for the approval of requests for testing, contributing towards a cost-effective service.⁴ Separating the clinical microbiologist from patient care

risks undermining the diagnosis and management of infection and fragments the infrastructure underpinning infection prevention and antibiotic stewardship.⁴ Removing the consultant from a laboratory could precipitate an infection control disaster costing thousands of pounds and causing unnecessary deaths.²¹

The microbiology laboratory, BMS, support, consultant(s) and infection control staff comprise a package that does not function at a high quality level if fragmented.³⁴ Furthermore, unlike other laboratory sciences, microbiology and infection control contribute enormously to public health, not just locally, but nationally and internationally. The work performed by a microbiology laboratory provides the basis for all infection management, antimicrobial stewardship, and infection control policies for the benefit of the hospital, healthcare region, and further afield. This is best accomplished by retaining clinical laboratories on the same site as the healthcare institution they serve. This is especially pertinent in the case of acute hospitals, in order to provide the public and the physicians who care for them with the necessary diagnostic testing, means of epidemiological detection, and future innovation required in an era of emerging and re-emerging infectious diseases.²⁰

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