

In December 2010 the Brunel Institute for Bioengineering (BIB) hosted a KT-EQUAL workshop entitled *Continence Matters*.

This addressed an issue which affects many people of all ages, but particularly older people. For example, based on interviews of 1,040 people aged 18 and over, Populus Research reported that 23% had a bladder control problem and 11% a bowel control problem (see presentation by van den Heuvel). Faecal incontinence affects a sizable minority of people with 1.4% of the population aged over 40 having major problems, with a significant impact on the quality of life of half of these. Its prevalence increases with age, yet many people do not seek medical treatment. It is a hidden condition that can be the cause of significant social and psychological disability as well as stigmatisation and social exclusion. The treatment of urinary and faecal incontinence in adults is estimated to account for 2% of the NHS budget, but the indirect non-medical costs are of a higher order of magnitude (see presentation by Quadrucci).

The workshop, which covered issues relating to both urinary and faecal incontinence, provided both a backward and forward look at the role of technology in supporting those who suffer incontinence. As well as presenting scientific and technological developments which have considerable potential for improving on current solutions, there were important reassurances about technology-based improvements which will be available in the shorter term.

Continence is a well-established area for bio-medical research and for some decades has attracted the attention of engineers and physical scientists, not least those with an interest in the development of new devices and new materials for use in catheters. However, given the number of people who have continence difficulties and the severity of their symptoms, it has not received the attention it deserves although recently there has been an upsurge in activity. A number of research initiatives, some with major support from EPSRC, others with cross-research council support, are offering new ways of approaching the management of continence, with

consequent benefits for the individual, their carers and families, and society as a whole.

Basics – trying to live normal lives

Felicity Jowitt, Brunel Institute for Bioengineering, introduced a range of continence difficulties and provided a stark reminder that whilst the problems faced by many older people were widely recognised, those of women, often the result of childbirth injuries or obesity, were often ignored. The practical implications, of always being near a toilet and the need to use some form of protection, such as pads and catheters, were considerable, especially as, for example, pads were prone to fail. The resulting impact on the lives of people, for example, the implications for travelling locally not to mention holidays, could lead to a very solitary existence. Indeed the personal cost of incontinence, for example to personal relationships was high. So too were the financial costs. At the individual level there was the need to wash frequently, and to launder clothes and linen. Thus washing machines wore out more quickly, and there was a need for extra clothes and linen. For society and the public purse, there was the cost of medication, pads, surgery, hospital admission and moving to residential care.

Many individuals rely on continence products and devices to contain leakage but these vary in their effectiveness and some are associated with serious problems with skin health. The research base for informing both individuals and the health services about the effectiveness of these is weak. **Mandy Fader**, School of Health Sciences, University of Southampton is leading a number of projects considering the effectiveness of absorbent pads and other technologies with a view to developing better designs suitable for different levels of severity of incontinence and the capabilities of users. Her work had shown that for women, disposable inserts were better for leakage and skin health, but not discreetness, than menstrual pads or washable pants both of which are cheaper to use and were preferred by some women. Washable inserts were worse especially for leakage than the other three designs. Further comparisons, showed disposable inserts to be worse than pull-ups which were preferred over inserts for daytime use but the new T-shape disposable diaper was no better overall than the traditional disposable diaper. There were differences in preferences and in performance for men and women.

Many people are confined to their homes and suffer severe social isolation because of inadequate provision of public toilets. This provision is worsening as a result of

local authorities reducing expenditure on facilities which they are not legally obliged to provide, sometimes to avoid the costs of making these fully accessible. The number of public toilet facilities is now just one third of the level of 20 years ago. Yet with more older people, with more older bladders, and the need to use the toilet more frequently, there was a need for more public toilets. **Jo-Anne Bichard**, Helen Hamlyn Centre, Royal College of Art, who has been making a major contribution to the development of new designs and standards for public toilets, gave vivid examples of the parlous state of affairs, and the lack of attention being given to the needs of older people. This was in contrast to increased provision in some districts to meet the needs of young men who had enjoyed a night out on the town. The provision of adequate toilets along the transport chain is particularly important, but especially for women, children, disabled and older people. Mainstream cubicles can meet the needs of many people, but an increasing proportion of people need larger cubicles due to a range of disabilities. Current innovations in the provision of public toilets, for example, urinals which pop out of the pavement after dark and descend before dawn, were of little use to older people in the afternoon. Windowless modular pods with automatic doors and other facilities, were frightening, even intimidating, for those who could use them but many could not, for example wheelchair users. Signage is also a problem. A ten minute walk following a sign indicating the existence of a toilet, exhausting for some, might lead to a facility which is inaccessible or closed. Yet new methods of signage are being developed, information technology is being harnessed, for example, websites and iPhone Apps (which can be unreliable) with information about the location of public toilets, and community groups mobilised to improve provision and information. Yet progress is slow. Research on good practice and new design and construction standards typically take 15 years to implement. To be successful, local campaigns for better toilet provision require widespread support, media involvement and considerable persistence,

The contribution of nutrition to incontinence was addressed by **Cath McGrother**, Director of Health and Disability Research, University of Leicester. She drew on evidence from MRC supported studies of diet and lifestyle in Leicestershire, a study of the Boston Area and other studies of weight loss. The Leicester study of 12,500 people aged over 40 found strong associations between urinary storage problems and diet and lifestyle. Details of the relationships which had been revealed can be found in the slides from the presentation available on the KT-EQUAL website. The Boston study was investigating nutrient intake in more detail, producing further compelling evidence. More recent work has focused on the development of disease

models based on the relationship between a sequence of four classes of factors (immutable, diet/lifestyles, morbidities and outcomes), and modelling the casual paths which contribute to overactive bladder and stress urinary incontinence. Obesity and poor quality diet are clearly implicated. The speaker summarised the evidence for healthy diets and recommendations for avoiding and managing certain conditions, such as diabetes, depression, cholesterol, cardiovascular disease and blood pressure and enunciated some principles of a healthy diet. Based on these principles, diet evaluation surveys were being carried out within communities, in some cases with planned interventions aimed at improving the diet of participants. Tracking individuals over time showed important improvements in general health and mental wellbeing associated with dietary changes. Other work, concerned with understanding the pathogenesis of urinary incontinence, was focused on the role of adipose tissue in regulating metabolism, inflammatory processes and vascular haemostasis and how these processes can lead to a number of symptoms associated with the onset of overactive bladder and stress urinary incontinence.

James Malone-Lee, Department of Medicine, University College London, spoke about his work on the detection of urinary tract infections (UTIs). However diagnostic tests which are commonly used are inaccurate and may account for the high prevalence of idiopathic urinary tract disease. Approximately 65% of recurring UTIs seem to be caused by the same micro-organism, and recent evidence suggests this may be due to chronic sub-clinical urinary tract infection, which is missed by tests used by GPs. However newly developed tests are more reliable and cheap to administer.

Lower Urinary Tract symptoms (LUTS) include dysuria, painful bladder, nocturia and over active bladder (OAB), all of which impact negatively on well-being. The prevalence of LUTS increases with age up to 40% for men and 28% for women aged 70-79. Urinary tract infections (UTIs) are a common cause of LUTS. In older people, UTIs are associated with mental confusion; OAB is a major risk factor for falling. Urinary tract infections are often missed when patients present in GP surgeries, clinics and hospitals. Untreated UTI has the potential to develop into chronic, recurring pathology, severely reducing quality of life and independent living for older adults.

Current guidelines for assessing the presence of UTI are based on a 1957 study of normal women by Kass who concluded that 10^5 colony forming units per ml (cfu/ml) discriminated between true urinary bacterial colonisation and contamination. Although Kass did not recommend this threshold for symptomatic patients, 10^5

cfu/ml is currently used in clinical practice to arbitrate on the presence or absence of infection. Urine dipstick analysis is calibrated to the 10^5 cfu/ml threshold and in most cases *Escherichia coli* selective media are used for urine culture. In 1982 Stamm demonstrated, for acute infection, that 10^2 cfu/ml was more befitting than the 10^5 cfu/ml threshold which missed over 50% of UTIs. In a study on patients with painless LUTS and controls, the presenter had found an identical *problem*; routine urine culture missed over 50% of infections. His research team also found serious defects with urine dipstick analysis; leucocyte esterase missed 40%, nitrite 80%, direct microscopy for pus cells (pyuria) missed 34% of infections.

Technology - towards solutions

Adele Long, Director, BioMed Health Technology Cooperative, briefly reviewed the history of catheters since 2000BC before focussing on current developments in the design and operation of indwelling catheterisation. The bladder is an extremely hostile environment for most devices and materials. A range of serious problems for both the patient and devices can arise, such as the development of biofilms which encourage the gradual colonisation of the bladder by *Proteus mirabilis*, a bacterium which has the ability to produce high levels of the enzyme urease. This can lead to an increase in pH, and in turn to the deposition of salts which lead to the encrustation and blockages of catheters. Much effort was devoted to the redesign of catheters through research focussed on the microbiology of the bladder, developing new materials, and better design and engineering. The insertion of catheters can be difficult, especially for men. As a consequence BioMed was also developing better methods of training health practitioners in catheter insertion as part of its endeavour to enhance the adoption of newer technologies. Looking to the future there is the prospect of vaccination against UTIs, non-invasive neuromodulation to stimulate nerves and muscles which control the bladder and even bladder transplants.

Eleanor van den Heuvel, Brunel Institute for Bioengineering, introduced the work of the TACT³ consortium. This involves seven universities or research units, one of which is in Sweden, and eight non-academic partners. Several presentations at the workshop were by members of the consortium, who collectively are focussing on four areas– the development of assistive devices, understanding and challenging environmental barriers to continence (for example provision and accessibility of public toilets), improving continence interventions and services and knowledge transfer to all appropriate stakeholders. Work is progressing on the design of smart

underwear, incorporating wetness detectors and odour sensors. This work incorporates a two stage clinical trial, stage 1 – pilot, assessing function and acceptability, stage 2- larger scale, assessing effectiveness, acceptability, quality of life and psychosocial impact. Developing systems to alert the user to the need to change a pad involved developing vibration sensors to indicate wetness and items, such as a bracelet or key ring, which could change colour to indicate odour. A new project linked to TACT³ involves researchers in Canada who are developing a questionnaire to measure the psychosocial impact of assistive technologies for continence, specifically for older people.

Antonio Quadrucci, Business Development Manager, Enteric, The Bowel Function Healthcare Technology Co-operative, provided a review of current work to take promising ideas about the treatment and management of faecal incontinence from research and to put them into practice. Supported by a very large number of clinical and industry partners, charities and patient groups, and by pursuing a philosophy of “technology pull” into the NHS, his organisation is able to rapidly trial solutions from a wide portfolio of projects and develop them further for adoption by practitioners. This isn’t straightforward. There is limited clinical expertise and access to patients, clinical and patient networks are under-developed, and industry is fragmented. The taboo nature of bowel problems compounds these difficulties.

High risk groups are: any patients with diarrhoea, urinary incontinence, those with anal problems such as third and fourth degree obstetric injuries, frail older people, people with severe cognitive impairment, learning difficulties, neurological problems or spinal disease. Depending on the underlying condition and its severity, faecal incontinence can be managed by changes to lifestyle and diet, drugs, bowel retraining and bio feedback, neuropsychological approaches, neuromodulation and surgery. A comparison of different approaches to neuromodulation was given, an established approach, sacral nerve stimulation, and a new approach, percutaneous tibial nerve stimulation. The success rates of these were broadly similar, between 50% and 70%, but the former requires two operations which could lead to complications. About £10,000 of equipment is required and the direct medical cost is about £11,500 per patient. The new approach does not require surgery so there is no risk of complications. The equipment cost is £800 and the cost per patient is about £1,807. Thus the potential savings for the NHS are immense. Enteric was able to undertake an independent evaluation of these competing technologies in a way which was not possible by industry or clinicians. Constipation was also discussed, another hidden and embarrassing issue which affects many people

especially mothers with young children. Here too there is insufficient expertise amongst professionals, in this case GPs and midwives. Enteric is currently planning to work to improve technologies for Rectal Irrigation.

What the event demonstrated

- Incontinence is not just associated with old age, but affects many people at all stages of their lives. Some young mothers have particular problems which are not widely appreciated. For many people the costs are considerable, social isolation, depression and worse.
- Technologies for diagnosing incontinence have improved but are not widely deployed.
- Technologies for managing incontinence are being developed which should help individuals immeasurably but even so there is still much work to be carried out on a hard and difficult road. Many current practices are not too dissimilar to those used in ancient times!
- The development of new technologies requires large scale research initiatives drawing on a wide range of skills which are not necessarily readily available. The area calls for multidisciplinary approach with strong collaboration with health care providers and a close rapport with incontinence sufferers and their carers.
- Individual lifestyle factors can play an important part. An appropriate diet and exercise are important and can dramatically reduce symptoms and the incidence of distressing situations.

The decline in the provision of public toilets has not been widely appreciated except by those who need to use such facilities such that provision is now at all time low. Designing new facilities is far from straightforward if they are to cater for needs of, say, older people on afternoon shopping expeditions and party-goers in the early hours.

REFERENCES AND WEB LINKS

History

Dirk Schultheiss (editor), A Brief History of Urinary Incontinence and its Treatment, http://www.icsoffice.org/Publications/ICI_4/files-book/historique.pdf

Technology development projects

BioMed Health Technology Cooperative, <http://www.biomedhtc.org.uk/>

Enteric, The Bowel Function Healthcare Technology Co-operative, <http://www.bowelfunctionhtc.org.uk/>

TACT3 Tackling Ageing Continence through Theory, Tools and Technology <http://people.brunel.ac.uk/~tact3/index.php>

Skin health

<http://www.southampton.ac.uk/healthsciences/staffprofiles/mandyfader.html> (provides references)

Public toilets

Jo-Anne Bichard, Away From Home (Public) Toilet Design: identifying user wants, needs and aspirations. <http://www.hhc.rca.ac.uk/cms/files/3.pdf>

Toilet Finder Apps

http://www.knowyourmobile.com/smartphones/smartphoneapps/News/522727/toilet_finder_app_boasts_400000_users.html

Nutrition

For an extensive list please refer to the presentation on the KT-EQUAL website: http://kt-equal.org.uk/uploads/Continence_Cath_McGrother.pdf

Urinary infection

Kass EH. Bacteriuria and the diagnosis of infection in the urinary tract. Arch Intern Med 1957;100:709-14.

Khasriya R, Khan S, Lunawat R, Bishara S, Bignal J, Malone-Lee M et al. The Inadequacy of Urinary Dipstick and Microscopy as Surrogate Markers of Urinary Tract Infection in Urological Outpatients With Lower Urinary Tract Symptoms Without Acute Frequency and Dysuria. J Urol 2010 March

Stamm WE, Counts GW, Running KR, Fihn S, Turck M, Holmes KK. Diagnosis of coliform infection in acutely dysuric women. N Engl J Med 1982 August 19;307(8):463-8