

User perspectives, preferences and priorities relating to products for managing bladder and bowel dysfunctions

Proc IMechE Part H:
J Engineering in Medicine
2019, Vol. 233(1) 7–18
© IMechE 2017
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/0954411917750193
journals.sagepub.com/home/pih

Brian S Buckley^{1,2,3}

Abstract

A great many people of all ages around the world cannot fully control their bladder or bowel, or both. Either in the short or long term, they rely upon products and devices to manage the emptying of their bladders and bowels and to collect, absorb and contain leaked urine or faeces. The incontinence product market is large and growing, and ongoing developments in materials and technologies should lead to improvements in these products and devices. Engineers and designers who work in this field – or who plan to do so – need to recognise the breadth of factors that affect the effectiveness and acceptability of products. The primary functions of products for managing bladder and bowel dysfunctions are the collection and containment of urine or faeces – and the associated engineering and design challenges may be considered in terms of flow rates and volumes and methods of acquisition and containment. But products will fail if they do not take into account other factors, some of which relate less directly to these primary functions and some not at all. This article aims to highlight the product characteristics that are most important to the people who use them, and areas where user-centred innovation and development may lead to improvements.

Keywords

Incontinence, management, bladder and bowel dysfunctions, incontinence products, user perspectives

Date received: 30 June 2017; accepted: 1 December 2017

Urinary and faecal incontinence is the involuntary leakage of urine and stool, respectively, and both can range from irregular and episodic to continuous, and be slight or heavy in terms of volume. A separate but sometimes coexisting bladder dysfunction is urinary retention, in which the bladder does not empty; this can range from an inability to empty the bladder fully to complete inability to pass urine.¹

Bladder and bowel dysfunctions can have an enormous impact on a person's life, both practically and psychosocially. Finding a cure is the preferred outcome for all those affected, but many must find ways to manage their bladder and/or bowel dysfunction day to day either while awaiting successful treatment or if no cure is possible.²

A wide range of products is used to manage bladder and bowel control problems. Disposable absorbent pads that absorb and contain urine until they can be changed are the most commonly used products for urinary incontinence (Figure 1). They are also the most familiar and accessible, as they are advertised in mainstream media and available through many retail

outlets. Much of this article's focus will therefore be on these products, but other product categories will also be discussed including indwelling catheters and sheaths (also called condom catheters) used with leg bags, intermittent catheters, and products and devices for faecal incontinence.

This article is aimed primarily at engineers who work in the area of continence technology, or who plan to do so. Early sections will provide an overview of developments to date in products for bladder and bowel control problems, and the growth of the market globally.

¹Department of Surgery, Philippine General Hospital, University of the Philippines Manila, Manila, Philippines

²Urology Department, Zhongnan Hospital of Wuhan University, Wuhan, China

³The Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, Scotland

Corresponding author:

Brian S Buckley, Department of Surgery, Philippine General Hospital, University of the Philippines Manila, Taft Avenue, Manila 1000, Philippines.
Email: briansbuckley@gmail.com

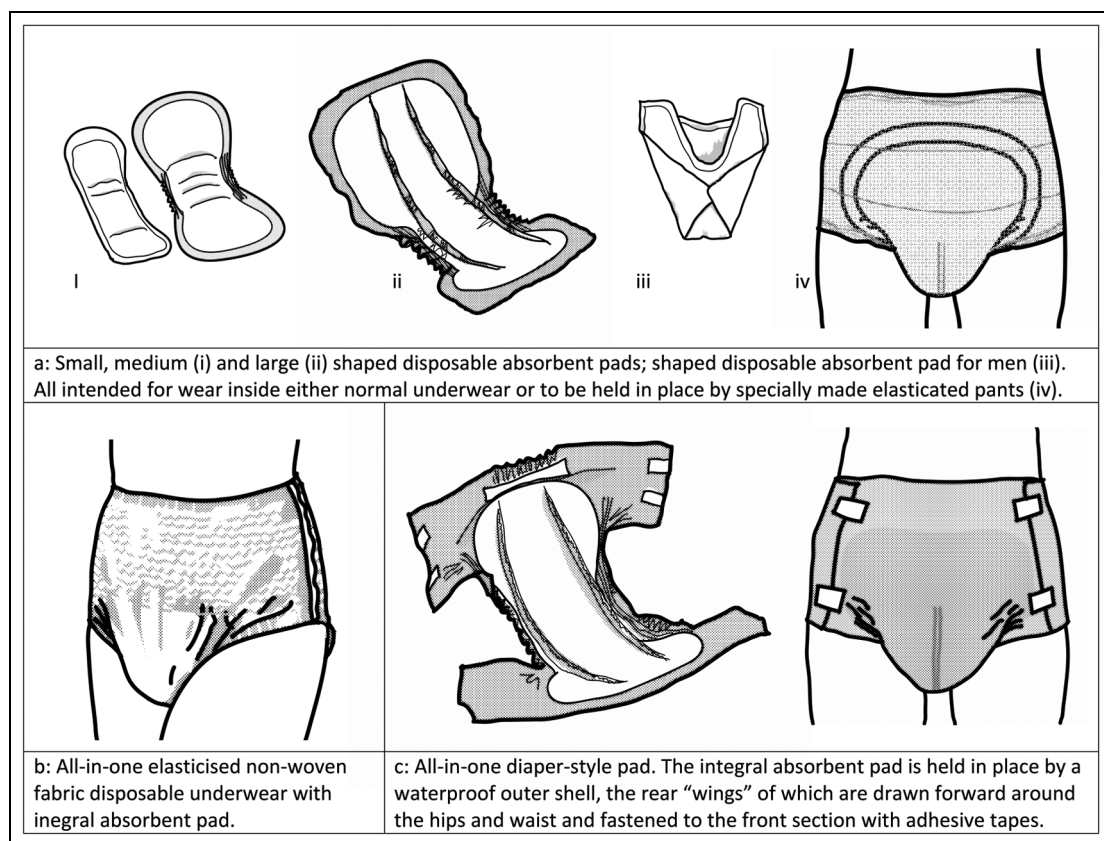


Figure 1. Principle types of disposable absorbent incontinence products.

Subsequent sections will draw upon research evidence and other sources that provide insights into users' perspectives, preferences and priorities in relation to product use. A broad range of factors will be highlighted that influence whether or not products are considered effective and acceptable by users. This range of factors is for the most part applicable to all product types.

Evolution of incontinence technology

Four or five decades ago, the absorbent products available to manage incontinence were basic to say the least, both technically and aesthetically. Absorbent pads similar to sanitary towels were used for light urinary incontinence. Body-worn products for heavier urine leakage were limited to plastic or rubber waterproof pants or fabric pants with a waterproof area, all intended to be used with an absorbent insert of some kind, made of basic paper pulp materials or cloth. Bedding protection involved waterproof mattress covers, perhaps with a drawsheet.

In the 1980s, the absorbent incontinence product market started to change dramatically, benefiting from technologies that were developed for the baby diaper market. Disposable all-in-one diapers in adult sizes and anatomically shaped absorbent insert pads for wearing inside pants became available. With a stay-dry permeable top layer worn against the skin, an absorbent core and an integral waterproof outer layer, these were a

huge improvement for users compared to the old products. Combining fluffed wood-pulp fibres with superabsorbent polymer powders that turn to gel meant that urine could be more efficiently absorbed and reliably contained. Developments in adhesives and materials meant that smaller pads could be held more securely in place inside normal underwear or diapers could be fitted securely and reopened with adhesive tapes (Figure 1).³

In more recent years, technical development has been less dramatic, although advances in elastic and nonwoven technologies have allowed for some new products. Disposable all-in-one elasticised pull-up pants with integral absorbent pads have become a major focus for manufacturers and are marketed for most degrees of incontinence. Highly elasticised semi-disposable pants are produced to hold disposable pads in place (Figure 1). Adult diapers have received less attention. One attempt to redesign the diaper for adults saw products in which a broad elasticated nonwoven belt is first fastened around the waist and then an absorbent pad attached at the rear is drawn forward between the legs and secured at the front. Otherwise, adult diapers remain essentially larger versions of those for children, available in a limited range of sizes, with the only major change in both baby and adult diapers being the introduction by many manufacturers of a nonwoven 'cloth-like' waterproof outer layer that is intended to be breathable and more comfortable than plastic outer layers. In Asia, composite diapers are

produced in which only the side panels or 'wings' are made from breathable nonwoven materials, while the absorbent pad area has a plastic outer, and it is common for insert or 'booster' pads to be worn inside adult diapers.^{4,5}

In the non-absorbent product area, the main innovations are largely related to new materials and disposability. For men, sheaths (sometimes called external catheters) can be used to collect leaking urine, which passes through a connecting tube to a urine collection bag that is emptied as needed. With the emergence of new materials, new features and new fixation methods through the decades, these systems have become more reliable and comfortable.

Both men and women who are unable to empty their bladders can use a technique called intermittent self-catheterisation, in which a catheter (a thin tube) is passed into the bladder through the urethra to allow urine to drain. The catheter is then removed. Originally, plain plastic catheters were used with separate lubricating gel, after which the catheter was washed and stored for reuse. Since the 1980s, the use of single-use disposable catheters has grown, and they are now used almost exclusively in some countries.⁶ Single-use catheters are often 'self-lubricating': some feature a hydrophilic coating which becomes slippery when water is added to the packaging; in others, a reservoir of lubricant gel is incorporated in the packaging. Some intermittent catheter products are intended to be all-in-one systems that incorporate both lubrication and a pouch into which urine can be drained.

The indwelling Foley catheter has been used since the 1930s to manage both urinary incontinence and urinary retention in men and women, and has changed little since. Indwelling urethral catheters (passed into the bladder through the urethra) or suprapubic catheters (passed into the bladder through the abdominal wall) remain in place so that the bladder drains continually into a urine collection bag.

In addition to these main types of products for bladder management, there are others that are less commonly used. Some people with indwelling catheters use a valve at the external end of the catheter. The valve is opened periodically to allow the bladder to drain. Body-worn urinals are external urine collection products that are less commonly used now than they once were before the development of reliable sheath systems. Penile compression devices (clamps) can be used for temporary, short-term prevention of leakage.⁷

Some of the absorbent products principally intended for urinary incontinence are also used for faecal incontinence. When this is the case, unless urinary incontinence is also present (double incontinence), the absorbent properties of the products are less important than the ability to contain stool and if possible mask odour. Other faecal incontinence devices are available such as anal plugs that are intended to prevent leakage and rectal pouches, tubes and catheters that collect and contain leakage.

A growing market

The absorbent incontinence product market is already large and is the fastest growing retail disposable hygiene category globally for several reasons. Ageing population worldwide means that the markets for incontinence products aimed at this demographic group has grown and will inevitably continue to do so. For example, sales of adult diapers are already set to outstrip infant diaper sales in some Asian countries.⁸⁻¹⁰ And socioeconomic advancement in many developing countries around the world means that these countries are emerging markets, in which the prevalence and impact of incontinence are no less than in developed countries and increasing number of people can afford commercial incontinence products.^{11,12}

In many countries such as the United Kingdom, discussion and awareness about continence problems in all ages and both sexes have grown encouragingly. Increasingly, absorbent products are advertised in the mainstream media, most recently even on television, and are available and highly visible in supermarkets and other mainstream outlets, whereas once they were only stocked by pharmacies and medical and nursing stores. In the United Kingdom, the growth of the retail market may be at least in part a result of budget constraints that have affected health service supply of products to users, but it is also a result of and a contributing factor to increased awareness and understanding of continence problems. This is good in terms of reducing the taboo around incontinence: greater visibility of the products helps to move incontinence away from being a hushed and stigmatised medical problem to being a fairly commonplace, if unwelcome, part of life.

The non-absorbent incontinence market has also grown. One reason for growth is that in some countries, single-use, disposable products have replaced ones that were previously reused: for example, in the United Kingdom, single-use catheters have all but replaced reusable ones for intermittent catheterisation.⁶ However, this trend is context-specific and dependent upon the reimbursement capacity and methods of health systems: because of the prohibitive costs, single-use products are unlikely to fully replace reusable ones in developing countries or countries where medical products are out-of-pocket expenses. In addition, new products have been developed such as semi-permanent indwelling intra-urethral devices with valves that can be actuated externally when the bladder is to be emptied, and implants that can be inflated and deflated to support the relevant anatomy to prevent both urinary and faecal incontinence.²

All this is undoubtedly very exciting for companies that produce products for managing incontinence. But are growth and optimism in the market leading to product innovation and improvement? And, importantly, do product developments address product users' experiences, needs and opinions about the aspects of product use that are most important to them?

With product engineers and designers in mind, this article aims to highlight the product characteristics that are most important to people who use them, problems and challenges that most concern users, and areas where user-centred innovation and development may lead to improvements.

Sources of incontinence product user experiences, views and priorities

Formal research in the area is sparse. Research on the relative effectiveness of products is methodologically challenging, can be undermined by frequent product design changes and is affected by lack of resources, since the topic is seldom considered a priority in health research.⁴ There is an even greater paucity of published research on user experiences, views and priorities relating to incontinence products. A small number of research studies that have involved interviews with users shed light on their preferences and priorities for incontinence management methods, product characteristics and performance.^{3,4,13,14} Other sources from which users' opinions can be drawn include patient support groups for people affected by incontinence, which receive feedback on products from many users, and online incontinence forums through which users' opinions can be both gleaned retrospectively and solicited.^{15,16}

The available research evidence may not be considered to be of high quality, given methodological challenges and relatively small sample sizes, while users' views gathered from forums or other sources can be considered anecdotal at best. However, consistency of opinions across sources and the regularity with which specific preferences or problems are expressed confers some degree of validity. Whether users are women or men, have light or moderate to heavy urinary incontinence, or live in the community or nursing homes, there is a high degree of consistency with regard to aspects of product performance that are considered most important, which will be considered in subsequent sections. In addition to general consensus on major priorities, the comments of individual users provide insights into very specific concerns or factors that may not be identified by formal research methods.

Factors affecting effectiveness and acceptability of products

The factors that influence whether or not products are considered effective and acceptable by users fall into a number of broad categories:

- *Product technical performance.* Factors directly associated with the incontinence (or urinary retention) that the products are intended to manage; absorbency, drainage, containment and leakage; flow rates and volumes of urine; and consistency of faeces.

- *Comfort and reliability in use.* Factors less directly associated with incontinence (or urinary retention), but which significantly affect products' effectiveness and acceptability in use: comfort, fit and security; perceived reliability; odour; and skin care.
- *Ease of use.* Factors that affect product use: body size and shape; mobility, manual dexterity, eyesight and mental acuity; level of independence; and carer preferences and abilities.
- *Personal preferences and priorities, lifestyle factors.* The effectiveness and acceptability of products can be determined by many user-related factors: day-time or night-time use; home, work and travel; activities; laundry, disposal and storage; self-esteem; body image and aesthetics; discretion versus security; and clothing preferences.
- *Provision and accessibility.* Variations in markets globally; socioeconomic issues.

Insofar, as is possible factors included in each of these categories will be described in subsequent sections, although some factors could be considered to belong to more than one.

Crucially, products are unlikely to be considered effective and acceptable if engineers, designers and manufacturers focus only on the first category and think only in terms of the technological challenges of flow rates, acquisition and containment.

Product developers should also bear in mind that it is unlikely that any single product type will be considered appropriate for all occasions. Research has shown that many users manage their bladder or bowel dysfunction most successfully when they have access to a range of products, which they can utilise according to priorities and preferences that may be context specific. For example, absorbency and skin protection may be the most important factors when a product is used for quite long periods in bed at night, so that quite bulky products may be acceptable, whereas during social activities, visual discretion and odour control may be prioritised.^{2,17} The effectiveness and acceptability of products may be enhanced if they were designed to be context specific.

Technical performance of product

Absorbent products

The primary functions of products for the management of bladder and bowel dysfunctions are the collection and containment of urine or faeces. The associated engineering and design challenges may be considered in terms of flow rates and volumes and methods of acquisition and containment.

Across all sources of evidence, for day and night use, it can be no surprise that the effectiveness of pads of all types in absorbing and containing urine without leaking is considered the most important aspect by those affected by urinary incontinence.^{3,13,15,16} Ineffectiveness

in doing so is not only a failure in their prime function but can also affect how users feel about themselves and how they may be seen and judged by those around them. Users of absorbent pads have been described as living in a perpetual state of anxiety over concerns about product performance, to a degree that their ability to work, travel or socialise is compromised.¹³ In a series of absorbent product trials that involved nearly 200 community-dwelling men and women and around 100 nursing home residents, insufficient absorbency and problems with leakage were reported for all product designs by not insignificant proportions of users, especially those with moderate to heavy urinary incontinence.^{3,18} Leaking products may be caused by poor product selection and fitting, but can also result from product design or technical failures.

Designing products and product ranges that can cater for differing patterns of incontinence and widely varying anatomies, including for increasing extremes of obesity, is challenging. The type of absorbent disposable pad needed by any individual with urinary incontinence depends on the volume of urine leaked, frequency of leakage and rate of flow, all of which can vary from one person to another and for individuals at different times – for example, during the day or night, and in warm or cold weather. In simplest terms, a pad must be capable of absorbing urine at the highest likely flow rate and containing urine without leaking until it can be changed. For faecal incontinence, absorbency is less important than a product's ability to contain stool, which will be affected by its mass and consistency as well as by flow rate.⁴

The capacity of pads to absorb and contain urine without leakage is sometimes tested in laboratory settings. The longstanding and relatively simple Rothwell method, which tests pads' total absorbent capacity, has been found to correlate relatively well with the probability of leakage in use.¹⁹ However, laboratory tests, which must be consistent and replicable, cannot fully reflect real-life pad use or predict the problems users may have. In use, especially by mobile users, a wet pad is exposed to ever-changing stresses from movement, compression through the weight of the user sitting or lying, and changing pressures and directions of gravity associated with different positions. For example, a fear is often expressed about pads leaking when sitting down: a user can be confident that a wet pad contains urine well when standing up, but may very well leak when contained urine is displaced by compression or a change of posture.^{13,15}

Typically, pads will leak before they are 'full': that is while significant proportions of the absorbent core contain no liquid. A difficulty is designing absorbent products that have sufficient absorbent materials in the correct places, that take into account widely differing anatomies between and within sexes, and that are not unfeasibly bulky. For daytime use, pull-up pants with integral absorbent pads have been found to be effective by many, but a greater proportion of men have

reported that they are prone to leaking and do not have enough absorbent material or that it seems to be in the wrong place. Diapers may be more effective than pull-ups in terms of fewer leaks in both men and women. They are, however, more bulky and potentially noticeable, although this has been reported as less of an issue for men than women. Both sexes report more problems with pull-ups leaking at night than during the day. And while diapers are associated with less leakage at night than any other product, problems are reported by those who sleep on their sides, especially men.^{3,18}

Despite manufacturers' claims to the contrary, users report that pads also leak through their waterproof backing. In plastic-backed pads, this occurs through pinholes in the plastic, possibly caused by granules of superabsorbent materials either during manufacturing processes or when compressed for packaging. The newer 'cloth-like' waterproof backings also leak, possibly for the same reason, but whereas small leaks through plastic backings dry rapidly, the nonwoven outer surfaces of the newer pad designs absorb and retain leaked urine so that they can constantly feel damp as a result.^{15,16}

Washable products tend to need to be more bulky if they are to match disposable ones in terms of absorption of urine. That, along with the need for laundering, means that most people tend to prefer disposable products. However, one trial of absorbent product types for moderate to heavy incontinence found that for night-time use, washable diapers were found to be more absorbent and less likely to leak than disposables by many participants, especially men. These included all-in-one washable garments with their own waterproof outer and simple towelling diapers worn inside waterproof pants. Given their cost-effectiveness over time, washable diapers may be a product area worthy of further attention, although it is likely a small market suitable only for niche companies.³

Discreet disposable or reusable portable urinals are a product area that has received relatively little attention. Products that can be used discreetly for urination and for storage of passed urine until they can conveniently be emptied may be very useful to people whose ability to access a toilet is affected by reduced mobility or who experience an unexpected or frequent need to empty the bladder, potentially doing away with the need for other incontinence products. Although technically more challenging, the same is true for faecal collection devices. Crucially for designers and engineers and the companies they work for, the market for such products may not be limited to those with bladder or bowel dysfunction. People everywhere are familiar with the experience of needing relief while stuck in traffic. In some countries in contexts in which access to toilets is reduced, the occasional usefulness of adult diapers is recognised for people not normally affected by incontinence: in China, sales of incontinence products soar prior to the Lunar New Year's mass exodus from cities to family homes and at least one Chinese brand includes travelling as an

indication for use on its packaging, while in Japan, it is recommended that diapers are part of the emergency packs that are required in preparation for disasters when access to toilets can become a source of anxiety, especially for women and the elderly.^{20,21} In all these circumstances, portable collection devices may provide a solution.

Non-absorbent products

Efficient acquisition and reliable storage are also crucial factors for non-absorbent products such as catheters or sheath systems and the urine collection bags used with them. Some developments have improved performance of these product types: the shape of the distal end of sheaths can improve the efficient flow of urine into the collection bag tube; products have become available that are intended to improve comfort and security of sheaths and catheter systems when worn and prevent discomfort and leaks associated with tugging; and changes in the valves used to empty collection bags have made them easier to use and less likely to open unexpectedly. That said, although materials and designs have evolved, the range of non-absorbent management options for bladder dysfunction has evolved little further than tubes and bags.

Restoring continence or enabling timely emptying of the bladder through the use of products such as artificial sphincters, inflatable anatomic support devices or neurological stimulation implants has previously involved invasive approaches. Considerable commitment has been required from potential recipients, success has been far from guaranteed and complication rates have been relatively high.^{22–25} The use of artificial sphincters and neurological stimulation implants for faecal incontinence has had similarly mixed success.^{26,27}

That may be set to change, and medical engineers or designers working in the area have a critical role to play in product innovation. Advancements in materials, manufacturing and technologies should allow for greater development in the area of devices that use less invasive approaches and are more attractive options for potential users.

Relatively recently, a semi-permanent intra-urethral device has been introduced that is inserted transurethally into the bladder under local anaesthetic in women with acontractile bladders, who would normally require intermittent or indwelling catheterisation. When in place, the stent maintains continence until an external magnetic device actuates a turbine-like valve-pump, which empties the bladder. Being no more invasive than a catheter, and replaced periodically, the device offers potential users the option of trying it out without the need for surgery.² Non-permanent and minimally invasive devices such as these, if developed for other types of bladder dysfunction and for both sexes, would have the potential to help many people to regain continence and freedom from other management methods.

Comfort and reliability in use

While acquisition and containment may be the primary functions for incontinence products, effectiveness in those functions alone will not make products successful or acceptable. Other factors that relate less directly to incontinence are very important to users, although they may be less obvious to engineers and designers.

Comfort

How products feel when worn is an important issue for users and might be given more attention by designers.¹⁸ In general, a well-fitting product is fairly comfortable when first put on, but may become less so when worn for extended periods. Heat and perspiration can be an issue because of the necessary waterproofing.³ Breathable nonwoven outer layers in which the waterproof element is restricted to the area of the absorbent core have gone some way to help in this. Similarly, flocked rear surfaces on urine collection bags have made them more comfortable in use.

Wearing pads can lead to rubbing and consequent chafing, especially in mobile people and if the product does not fit well. Some users find that the nonwoven backed products cause more rubbing than plastic-backed products.¹⁵ Conversely, plastic-backed products can lead to the build-up of perspiration where the backing is in contact with the skin, such as between the legs or in the groin, which can lead to skin irritation. Users report problems with the absorbent core of pads of all types breaking up with wear and movement, forming uncomfortable lumps and becoming less effective at absorbing and containing urine.^{13,15,16}

Secure fit

Products that fit well and are held securely in place either by integral or separate fixation methods not only feel more comfortable and cause less rubbing but are also more likely to absorb urine more efficiently. The importance of effective fixation methods in terms of pad effectiveness, comfort and skin health has been emphasised by national patient group experts as well as individual users and researchers.^{3,4,13,15,18,28} To afford a secure fit, users report the need to wear close-fitting elastic undergarments over absorbent products that are intended by manufacturers to provide their own secure fixation.^{15,16}

Insert pads worn inside regular underwear or specially designed underwear are reported to be less likely to stay in place than all-in-one products such as pull-ups or diapers.³ Users have reported anxiety when they feel that insert pads move around because they fear that this will lead to leakage.^{3,13,15} Some users have reported that insufficient elasticity and the very limited range of sizes means that it is difficult to find pull-ups that feel secure or 'snug'.¹⁵

Although nonwoven outer layers are popular with manufacturers, users have identified fitting and security problems with diapers that have 'cloth-like' outer surfaces. Some feel that the nonwoven panels stretch and the products have a tendency to slide down the hips in a way that less elastic plastic-backed diapers do not. Others have commented that friction between outer clothing and the nonwoven diaper surfaces means that the diaper can be moved around unhelpfully by normal activities, whereas clothes slipped over plastic-backed diapers.¹⁵

The reliability of methods used to secure diapers in place is a subject of concern to users. Many diaper designs have a panel at the front where the fixation tapes attached to the rear are fastened. This may be a polymer film panel to receive adhesive tapes or a looped nonwoven panel to receive hook and loop tapes. The traditional adhesive tapes and polymer film 'target panels' have improved over time and in most brands allow for refastening, but adhesive reliability is reduced each time they are opened and closed; the velcro-like tapes on some diapers can fail with movement and can be opened by catching on clothing or bed clothes.¹⁵

Sizing

Fitting, the range of sizes in which products are available, and the security of fixation methods are areas in which the development of absorbent incontinence products for older children, teenagers and adults has not received the same attention as the baby product market. Diapers and pull-ups for babies and children are available in many sizes and types designed for different ages, levels of activity and sexes. In contrast, despite the enormous variations in adult body shapes and sizes, products for older children, teenagers and adults are often only available in retail settings in medium and large, and only pull-ups are available specifically for men and women.

A 'one size fits all' approach translates in practice into 'one size fits only a few people well'. National consultations, national patient group experts and individual users have highlighted the need for a greater range of sizes in these products, including sizes for older children, teenagers and young adults.^{15,18,28} In addition, products need to have as much adjustability as possible to take into account different body shapes. Inconsistencies between manufacturers in product sizing have also been reported as leading to difficulties in product selection.²⁸

Skin health

The ability of a wet absorbent product to keep skin with which it is in contact dry is important both for comfort and skin health.^{4,28,29} It is seen as a priority by users, especially at night, when pads stay in place for longer periods of time.¹³ Although modern nonwoven permeable acquisition layers can be quite successful at

feeling dry even when the absorbent core is wet during the day, users still report discomfort from wet pads, and this is especially true when seated, when wet pads are pressed against the skin.^{13,15}

Odour

Containment of odour is also of great importance to people affected by urinary incontinence. Users are aware that any smell of urine will draw attention to the fact that they are wearing products and will affect how other people see them.¹³ While the likelihood of odour is affected by hygiene practices and by regularity of changing or emptying of incontinence products, some product characteristics also contribute. Users of 'cloth-backed' products who have observed urine leakage through the waterproof membrane have also commented that the nonwoven outer material can become smelly as a result in a way that plastic-backed diapers do not. Odour associated with faecal incontinence is of course a much greater problem than urinary incontinence and is a major concern for those affected, especially mobile community-dwelling individuals who are eager to conceal their problem.

A good many users of absorbent products for urinary or faecal incontinence or both report wearing plastic or polyurethane laminate pants to provide additional protection against product leakages or odour, a fact that might in itself point to a failure in product designs.^{15,16}

Ease of use

Other factors that are of importance to users but less obvious to designers and manufacturers relate more to individual users and personal preferences than they do to the problem of bladder or bowel dysfunction.

Ease of use is an important consideration for people who rely upon incontinence products of all kinds, and this is affected by both product and user characteristics. User characteristics that affect ease of use include mobility, dexterity, eyesight, mental acuity and whether an individual cares for himself or herself or has a carer. Product characteristics that affect ease of use include fixation methods, requirement for adequate storage or changing space, suitable surfaces or furniture for product use, and ease of opening packaging.

Insert pads are perhaps the most easy-to-use absorbent product. While pull-ups are considered easy to use by many, they are less easy to use for people with reduced mobility or agility. That they require the removal of trousers makes them less convenient to use for many others. Diapers are found to be difficult to use by some, especially if they must be changed in confined spaces, if reduced dexterity makes using tapes challenging, or if vision difficulties preclude locating and placing fixation elements.

Manufacturing process or quality-control problems that affect fit and consequently product performance

are reported most frequently in relation to diapers. The front panels commonly feature numbers or markings, intended to facilitate an even placing of fixation tapes and consequent centering of the absorbent core when the product is worn. However, when the waterproof outer layer, the marked fastening area and the absorbent core are not well centred during manufacture, the result is that the poorly centred markings are misleading and the side 'wings' that form the sides of the diaper can extend further from the absorbent core on one side than the other. These problems can lead to difficulties in putting the product on evenly, reduced comfort, and a greater likelihood of leakage due to poor fit or because the absorbent core is too close to one side of the outer layer.

Many non-absorbent products such as sheaths, urine collection bags, anal plugs and catheters for intermittent use involve features or actions that are challenging for those with reduced dexterity, agility or vision such as packaging, application or insertion, valves, fixation components and connections.

Personal preferences and priorities, lifestyle factors

Product choice and personal preferences

People seem best able to manage incontinence when they are able to make choices about the products and methods they use at different times. This may mean using bulkier but cheaper absorbent products at home and more discreet but expensive products when at work or in social situations. Some may use a mixture of absorbent products and male devices depending on the situation or activity. Those with catheters may use urine collection bags most of the time, but a catheter valve when playing sport or dancing.^{2,4,13,17,30} To assist in such choices, a website has been developed by academic organisations with an interest in continence that is intended to provide users and healthcare professionals with access to impartial advice about the range of products and devices available (www.continenceproductadvisor.org).⁷

Making choices about products requires the availability of a range of options. Yet, despite a growing market size, the range of absorbent incontinence products remains limited and it is uncertain whether product developments reflect what the users want, or what the manufacturers think they want. The absorbent products manufacturers' retail focus has been on pads for lighter urinary incontinence (UI) and on pull-up disposable underwear. The latter are regarded as effective by many and are preferred because they look more like regular underwear than a diaper and are easy to put on and take off. Some regard them as feminine, a quality that is appreciated by women but not some men. They are also relatively expensive products, a factor that is surely not lost on the manufacturers promoting them.³

In the United Kingdom, unlike in many other countries, all-in-one diaper products are much less frequently seen or available in retail settings. This may be because a larger proportion of the perceived target population for these more absorbent products are more seriously incapacitated people who may be more likely to be entitled to provision of supplies from the health services. Or it may be that embarrassment persists around adult diapers in a way that is not true in other countries: while in some Western settings, these products are referred to as 'adjustable underwear', 'slips' and 'briefs', in many parts of the world, they are referred to and labelled frankly as 'adult diapers', are promoted prominently in retail outlets and are regarded simply as practical items.

Whatever the case, some research evidence suggests that adult diapers should not be excluded from the levels of promotion and redesign afforded to insert pads and pull-up pants. While pull-ups may be better overall for women during the day or night, for men, diapers are most effective overall and in terms of absorbency and reduced leakage compared to other product types. Diapers are considered by many to be more effective and reliable for extended wear and protection at night. Diapers received fewer negative comments from men than any other product type for day or night use; for women, they received fewer negative comments than all products other than pull-ups.³ Older patients often preferred diapers over other management options, especially if they had had previous experience of diaper use, in contrast with the preferences of healthcare providers and family members who may make care choices for them.¹⁴

Discreetness

The discreetness of products is considered an important priority during the day, particularly by women, while at night this is less of an issue.³ Women have expressed considerable anxiety about the need to conceal their incontinence and the effect this has on clothing choices, activities and even whether they will leave the house.¹³ For many, there is a trade-off between confidence that products will not be noticed and confidence that they will not leak: smaller, thinner products are less noticeable, but need to be changed more often and offer less certainty that they will not leak, whereas larger, thicker products may provide more certainty, but may be more likely to be noticed. Reaching an appropriate balance between the two factors is a matter for personal preference and can be affected by situation, clothing and activity.^{4,13}

Discreetness is not only a matter of pads being seen when worn. The need to change pads often or the length of time taken to do so may be more noticeable than a slightly bulkier pad. The need to remove outer garments such as trousers to change pull-ups may attract attention when changing in the confined space of public toilet cubicles, as may the noise of opening

packaging, unfolding pads or undoing noisy adhesive tapes. Difficulties disposing of pads when in public is another problem reported by users.^{4,13} Many of these concerns also affect people who use non-absorbent methods to manage continence issues: noisy packaging and the need to dispose used items can attract attention to those who use intermittent catheterisation; urine collection bags that slip, bulge unnecessarily or that have noisy or difficult emptying valves can be noticeable to others, as can drainage tubes between bags and indwelling catheters or sheaths that are difficult to secure discreetly against the leg.⁶

The need to carry spare products can also be noticeable, arguably more so for men who may not normally carry bags with them and for whom items like intermittent catheters are larger than for women.^{6,13} Discreetness can be undermined if the clinical appearance of incontinence products or their packaging means that they draw attention when carried. Products and packaging whose design is cheerful and visually consistent with other products in daily use such as tissues, wet-wipes and sanitary napkins may be less likely to draw attention. Some manufacturers have produced carrying pouches and other items intended to disguise or 'normalise' products when carried.

The storage of products presents a problem for many users. Some may find difficulties storing products discreetly yet accessibly, while others may be unable to store large number of products, such as those in shared accommodation or who have little or no living space.

Product aesthetics

The aesthetics of incontinence products is not something that is often discussed, yet it is an issue that is important to users. Incontinence products will never be objects of desire, but they are items that a sizeable proportion of the population must live with day to day and that can affect body image, so it is not unreasonable to expect that consideration is given to how they look, how they are packaged and how they might be carried.

The appearance of products and packaging can impact self-image and discretion in use, and women in particular have reported that wearing absorbent pads can result in a loss of perceived femininity and attractiveness.¹³ Products that are visually 'clinical' unhelpfully further medicalise the body image of users, which has already been undermined by a stigmatised health condition. Products that are babyish in appearance or whose name or packaging has infantile connotations may be unacceptable to older children, teenagers and adults.

Some efforts have been made to improve product aesthetics. In the United Kingdom, packaging, and to some extent products, have evolved for the growing number of users who purchase products in retail contexts: packaging has been made more attractive and informative, while some degree of effort has gone into

designing absorbent products that are better suited to either men or women and are visibly more attractive and less medical. Washable pants with integral absorbent pads that are designed to resemble normal underwear styles such as briefs, thongs, Y-fronts and boxers are also produced, although their effectiveness compared to disposable absorbent products is uncertain.³ Urine collection bags and covers for them are being produced in more discreet or attractive finishes and systems designed that can be worn in different positions to suit individual user's needs.

In Asia in particular, manufacturers are recognising the need to address clinical aesthetics in the design and promotion of disposable products. Manufacturers do not shy away from cheerful, non-clinical colours, patterns, coloured strips and motifs on adult diapers. In China, disposable absorbent pull-up pants are designed and marketed specifically for teenage girls and young women (Figure 2). In Japan, pull-ups are produced in a range of colours and designs, and attention is given to ensure the elastic nonwoven fabric pants look like normal cotton.³¹

Provision and accessibility

The range of products available to users can vary enormously between and within countries, affecting users' ability to make choices. Product availability and accessibility can be affected by socioeconomic factors, healthcare policy and financing, and the logistics of supply. In countries with publicly funded healthcare systems, some incontinence products may be provided free of charge. In others, cost-sharing policies may be in place, or the cost of products may be reimbursed by insurers. In a great many countries, consumers must pay out-of-pocket for incontinence products.

In low- or middle-income countries, many people have a limited ability to pay for incontinence products, which in turn affects the size and complexity of the market. In such contexts, the range of products available is often very limited, in part because products can only be made available at affordable prices if suppliers can benefit from economies of scale that are only possible with restricted choices.^{2,12,32,33} With pull-up absorbent pants being relatively expensive, cheaply and locally produced adult diapers are the standard incontinence management product.

For some, even the most basic and cheaply commercially produced incontinence products remain unaffordable. In many countries, cloth pads intended for menstruation are used for incontinence and washed, although for some, the potential cost-savings of reusable products is undermined by a lack of reliable water and sanitation infrastructure and suitable washing facilities.³⁴ It is not uncommon in hospitals catering to the less advantage in low- and middle-income countries to encounter both men and women using disposable baby diapers inside underwear.



Figure 2. Disposable incontinence products from Asian countries.

A similar need for improvisation has resulted from the trend towards disposability of non-absorbent incontinence products. In some developing countries in Asia, disposable sheath and urine collection bag systems are either unavailable as an option or are prohibitively expensive, and some men resort to improvised fixation system to hold a plastic bag in place. In low- or middle-income countries, single use of catheters is not affordable by many who must perform intermittent catheterisation. As a result, single-use catheters or more affordable Foley catheters – although not ideally suited to the task – are frequently cleaned and reused for extended periods.⁶ In stoma care, the reuse of products intended for single use is not possible. With disposable products not affordable and reusable products unavailable, people with stomas and low incomes in some countries resort to fashioning improvised devices to hold readily and cheaply available products such as sandwich bags over their stoma.³⁵ In many low- and middle-income countries, a variety of toileting aids are improvised from recycled materials.³⁴

The reuse of supposedly single-use products such as catheters is not limited to developing countries: in Australia and Canada, reuse of intermittent catheters has been reported in around half of users, while in the United States, reuse has been reported in 35%–83% of users, with catheters reused a median of 20 times each. These figures suggest that the industry's focus on

disposability is not in line with the preferences of a proportion of users: from a practical standpoint, reusing catheters means less need to carry and dispose of products in public, and some users have expressed environmental motivations for reuse. In the United Kingdom, where single use has been the only option for several years, the potential for reuse is being explored and catheter users have reported that having the opportunity to use single-use and multi-use catheters might provide optimal choice.⁶

Interest in reusable products may be driven by personal preferences and environmental considerations in developed regions, while reuse, improvisation and adaptation of products are borne of necessity in developing regions. But both point to populations and areas of incontinence product design that have increasingly been disregarded by industry. The development of reusable products using modern technologies to provide greater choice for users in higher income countries may be commercially unattractive, but may be a popular strategy with commissioners given constraints of health system budgets. In low- and middle-income countries, the design and provision of affordable reusable products has the potential to improve the lives of many who currently must improvise their own management methods, may find new markets and would demonstrate the social responsibility of multinational industries.

Risks associated with product use

As well as being effective and acceptable, it is important that the design and development of products for bladder and bowel dysfunctions consider and minimise the risks associated with their use. For worn products such as pads that collect and contain urine or faeces, skin health is a major concern: conditions such as incontinence-associated dermatitis are often challenging to heal.³⁶ The use of other devices such as sheaths and penile clamps can similarly involve risks to skin or soft tissue health. Urinary tract infections are a major issue for users of catheters or other intra-urethral or intra-vaginal devices. The blockage of catheters by crystalline biofilms and the twisting of drainage tubes can stop urine drainage and potentially result in dangerous retention and vesicoureteral reflux. Product designs and technologies may have a crucial role to play in reducing such risks in the future. One recently proposed technology that has been tested in vitro is the use of an infection detector coating in indwelling urinary catheters, which would detect elevated presence of bacteria and provide an early warning of potential catheter blockage by releasing an indicator dye into the urine collection bag.³⁷

Conclusion

The market for products to manage bladder and bowel dysfunctions is huge and growing. While there have been developments in the products for managing bladder and bowel dysfunctions, there is still a great deal of room for improvement in the products available. Products and methods for managing bladder and bowel dysfunctions should recognise that users have lives, friends, family and relationships. Many users of incontinence products are active and mobile, and their requirements from products may differ from those who are less so. People have been found to manage bladder and bowel dysfunctions most successfully when they use a range of products depending on different activities, contexts and priorities.

Product engineers and designers should not focus solely on functionality of acquisition and containment. Many other factors are important to users: comfort, reliability, ease of use, skin protection, odour control, discretion, context-specific factors, aesthetics and body image. Products will not be considered effective and acceptable if these factors are ignored or considered to be less important. Ideally, users' needs and opinions should be involved at each stage of product development and evaluation.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

ORCID ID

Brian S Buckley  (<http://orcid.org/0000-0002-6007-9238>).

References

1. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology* 2003; 61(1): 37–49.
2. Cottenden A, Fader M, Beeckman D, et al. Management using continence products. In: Abrams P, Cardozo L, Wein A, et al. (eds) *Incontinence: 6th international consultation on incontinence*. Tokyo, Japan: ICS/ICUD, 2017. 2306–2426.
3. Fader M, Cottenden A, Getliffe K, et al. Absorbent products for urinary/faecal incontinence: a comparative evaluation of key product designs. *Health Technol Assess* 2008; 12(29): iii–iv, ix–185.
4. Cottenden A, Bliss D, Buckley B, et al. Management using continence products. In: Abrams P, Cardozo L, Khoury S, et al. (eds) *Incontinence: 5th international consultation on incontinence*. Paris: EAU/ICUD, 2013. 1651–1786.
5. Shigeta Y, Nakagami G, Sanada H, et al. Factors influencing intact skin in women with incontinence using absorbent products: results of a cross-sectional, comparative study. *Ostomy Wound Manage* 2010; 56(12): 26–28, 30–33.
6. Buckley B, Fader M and Macaulay M. Giving intermittent catheter users more choice. *Br J Gen Pract* 2015; 65(637): 419.
7. International Continence Society, International Consultation on Incontinence, University College London, et al., <http://www.continenceproductadvisor.org> (2017, accessed 21 May 2017).
8. Reuters. From cradle to grave, Japan's Kewpie adapts menu to feed ageing nation 2014, <http://www.reuters.com/article/us-japan-elderly-food-idUSKBN0GH0QZ20140817> (accessed 6 April 2017).
9. Reuters. Firms in aging Thailand bet on demand surge for robots and diapers 2016, <http://www.reuters.com/article/us-thailand-ageing-idUSKCN10Q284> (accessed 6 April 2017).
10. Unicharm. Integrated report 2015 (annual report), http://www.unicharm.co.jp/english/ir/library/annual/_icsFiles/afiedfile/2015/07/23/1_All_E_2015.pdf (2015, accessed 3 April 2017).
11. Euromonitor. Strategy briefing – adult incontinence: demand factors and growth strategies, <http://www.euromonitor.com/adult-incontinence-demand-factors-and-growth-strategies/report> (2016, accessed 4 April 2017).
12. Walker G and Gunasekera P. Pelvic organ prolapse and incontinence in developing countries: review of prevalence and risk factors. *Int Urogynecol J* 2011; 22: 127–135.
13. Getliffe K, Fader M, Cottenden A, et al. Absorbent products for incontinence: 'treatment effects' and impact on quality of life. *J Clin Nurs* 2007; 16(10): 1936–1945.

14. Pfisterer M, Johnson T, Jenetzky E, et al. Geriatric patients' preferences for treatment of urinary incontinence: a study of hospitalized, cognitively competent adults aged 80 and older. *J Am Geriatr Soc* 2007; 55: 2016–2022.
15. Incontinence Resource Centre USA, <http://www.incontinencesupport.info/> (2017, accessed 4 April 2017).
16. Patient Platform Limited. Patient UK, <https://patient.info/> (2017, accessed 4 April 2017).
17. Macaulay M, Broadbridge J, Gage H, et al. A trial of devices for urinary incontinence after treatment for prostate cancer. *BJU Int* 2015; 116: 432–442.
18. Dunn S, Paterson J, Kowanko I, et al. *Final report in relation to services for development of a consumer guide and information on continence products*. Canberra, ACT, Australia: Department of Health and Aged Care, 2000.
19. Cottenden A, Fader M, Pettersson L, et al. How well does ISO 11948-1 (the Rothwell method) for measuring the absorption capacity of incontinence pads in the laboratory correlate with clinical pad performance. *Med Eng Phys* 2003; 25(7): 603–613.
20. Liang Q. Adult diaper sales soar before long trips home. *China Daily*, 24 January 2006. http://www.chinadaily.com.cn/english/doc/2006-01/24/content_514899.htm.
21. Shoji K. When disaster strikes in Japan, keep calm and carry a diaper. *Japan Times*, 14 September 2015. <https://www.japantimes.co.jp/life/2015/09/14/language/disaster-strikes-japan-keep-calm-carry-diaper/>.
22. Herschorn S. The artificial urinary sphincter is the treatment of choice for post-radical prostatectomy incontinence. *Can Urol Assoc J* 2008; 2(5): 536–539.
23. Montague D. Artificial urinary sphincter: long-term results and patient satisfaction. *Adv Urol* 2012; 2012: 835290.
24. Herbison G and Arnold E. Electrical stimulation of nerves with permanently implanted devices for adults with abnormal urine storage or voiding. *Cochrane DB Syst Rev*. Epub ahead of print 9 February 2009. DOI: 10.1002/14651858.CD004202.pub2.
25. Silva L, Andriolo R, Atallah A, et al. Surgery for urinary incontinence due to presumed sphincter deficiency after prostate surgery. *Cochrane DB Syst Rev*. Epub ahead of print 13 April 2014. DOI: 10.1002/14651858.CD008306.pub3.
26. National Institute for Health and Care Excellence (NICE). Artificial anal sphincter implantation. *Interventional procedures guidance [IPG66]*. London: NICE, 2004.
27. Thaha M, Abukar A, Thin N, et al. Sacral nerve stimulation for faecal incontinence and constipation in adults. *Cochrane DB Syst Rev* 2015; 8: CD004464.
28. Muller N and McInnis E. The development of national quality performance standards for disposable absorbent products for adult incontinence. *Ostomy Wound Manage* 2013; 59(9): 40–55.
29. Gray M, Black J, Baharestani M, et al. Moisture-associated skin damage: overview and pathophysiology. *J Wound Ostomy Continence Nurs* 2011; 38(3): 233–241.
30. Fader MJ, Cottenden AM, Gage HM, et al. Individual budgets for people with incontinence: results from a 'shopping' experiment within the British National Health Service. *Health Expect* 2014; 17(2): 186–196.
31. 軽失禁ケア下着感覚で機能とイメージアップの商戦熱. Tokyo, Japan: Mainichi Shimbun, https://headlines.yahoo.co.jp/hl?a=20170611-00000013-mai-bus_all (2017, accessed 6 June 2011).
32. Brand-Kirsh S. *Race to win over a new generation of consumers in Asia*. Ramsey: NJ Nonwovens Industry, 2016.
33. Wagg W, Newman D, Leichsenring K, et al. Developing an internationally-applicable service specification for continence care: systematic review, evidence synthesis and expert consensus. *PLoS ONE* 2014; 9(8): e104129.
34. Giles-Hansen C. Hygiene needs of incontinence sufferers. *How can Water, Sanitation and Hygiene actors better address the needs of vulnerable people suffering from urine and/or faecal incontinence in Low and middle income countries*. Brighton: Institute of Development Studies/Water-Aid/Community-Led Total Sanitation, 2015.
35. Buckley B, Gonzalez J, Razon-Gonzalez E, et al. The people that the ostomy industry forgot. *Br J Gen Pract* 2012; 62(603): 544–545.
36. Doughty D, Junkin J, Kurz P, et al. Incontinence-associated dermatitis: consensus statements, evidence-based guidelines for prevention and treatment, and current challenges. *J Wound Ostomy Continence Nurs* 2012; 39(3): 303–315.
37. Milo S, Thet NT, Liu D, et al. An in-situ infection detection sensor coating for urinary catheters. *Biosens Bioelectron* 2016; 81: 166–172.