Digital pen and paper technology: a tool for data capture and patient management

As pressure for scarce health service resources rises, tissue viability services are coming under increasing pressure to justify both their service provision and treatment decisions, as well as demonstrate quality outcomes. In this paper we demonstrate how digital pen and paper technology can be used to capture and computerise patient data, while maintaining a convenient paper record without removing healthcare professionals from the immediate care environment.

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KEY WORDS
Digital pen and paper (DPP) technology
Audit
Wound care form design
Information technology (IT)

Experience with the Bradford wound care audit (Vowden and Vowden, 2009a, b, c, d) highlighted the difficulties, such as eliminating data and transcription errors, and time involved in converting paper-based records to a digital format for analysis. Capture of ongoing care data and incidence data is equally challenging. This problem is not helped by the variety of care settings and data management systems involved in the delivery of wound care, as both documentation and computer systems differ markedly both within and between care organisations. This makes data exchange and ongoing analysis difficult.

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For a number of years the authors have used a standard wound assessment tool and have manually entered selected patient data into an Access-based database (Microsoft). A fortuitous meeting with Longhand Data Ltd (York, www.longhanddata.com/) introduced the unit to digital pen and paper (DPP) technology and provided the opportunity to develop a series of digital forms based on the unit's proven wound assessment tool. The authors experience developing this system was presented at Wounds UK conference in Harrogate in November of 2009 and provided the experience and information base from which the National Wound Assessment form reported by Fletcher (2010) was developed. Information technology can act as a barrier between patient and healthcare professionals, with attention being focused on the computer screen and keyboard rather than the patient. The authors were keen to avoid this when integrating computerised records into the wound healing unit.

From the user's perspective, digital pen and paper technology allows the healthcare professional to continue working within a familiar environment using pen and paper. To use the technology requires no additional computer skills and only asks that the user writes legibly. The technology consists of two components; paper pre-printed with a unique patented dot pattern (Anoto Group AB, Lund), that is overprinted with the data entry form and a digital pen, consisting of a normal ballpoint pen, an integrated digital camera, an image processor, memory for data storage and a mobile communication device and docking port which also acts as a charger for the pen (*Figure 1*). Each pen has its own unique code that allows data to be related to that specific pen. When writing, the pen takes a series of snapshots, more than 50 pictures being captured per second. The captured images are automatically date and time stamped and contain positional data derived from the unique underlying dot pattern, that also links the data to a specific form. The pen can also capture nib pressure data that further assists in text recognition. A managed database,

utilising this digital pen and paper technology and based on the National Wound Assessment Form is now commercially available from e-fficient.

The pen-captured data is encrypted and downloaded either locally or to a central server for processing, interpretation and verification. The data downloaded from the pen is first assembled as a picture that combines data downloaded from the pen and the appropriate form. In this case, the final image was provided in pdf format. Text recognition software converts written data to a computer readable format, in this case an xml file. This data was validated and corrected where necessary, by comparing the text contained in the image file to the data held in the xml file (*Figure 2*). Once validated, the data can be exported to either a spreadsheet or database for analysis.

Method

The structure of the existing paper-based forms were analysed and converted to a series of digital fields consisting of tick boxes, lists, specified alpha-numeric fields and free text entries, and a supporting coding sheet for fields relating to treatment actions and dressings was developed. Versions of the forms were trialed by the wound healing unit staff on a number of different acute and chronic wound types until an acceptable, and user-friendly data entry tool was obtained that was acceptable to the leg ulcer and wound care nurses working within the vascular and wound healing unit. Work continues to further refine this for specific chronic wound types, such as pressure ulcers, diabetic foot wounds and venous leg ulcers.

Currently, two specific forms have been developed, one for general wound care and the other for patients with leg ulcers, each of these forms share a common core data set. The leg ulcer form, for example, contains additional data sets relating to Doppler assessment and compression therapy. Data was collected for both inpatients and outpatients at initial referral and for some patients at their follow-up visits. One of our main concerns in developing the DPP technology was to ensure that the system met all IT data security and encryption criteria, and that it was compatible with the National Spine and Connecting For Health NHS (this aims to introduce modern computer systems into the NHS nationally to integrate patient care. The NHS Care Records Service [NHS CRS] comprises national [the 'Spine'] and local databases; http://onlinetog.org/cgi/content/full/10/1/27).

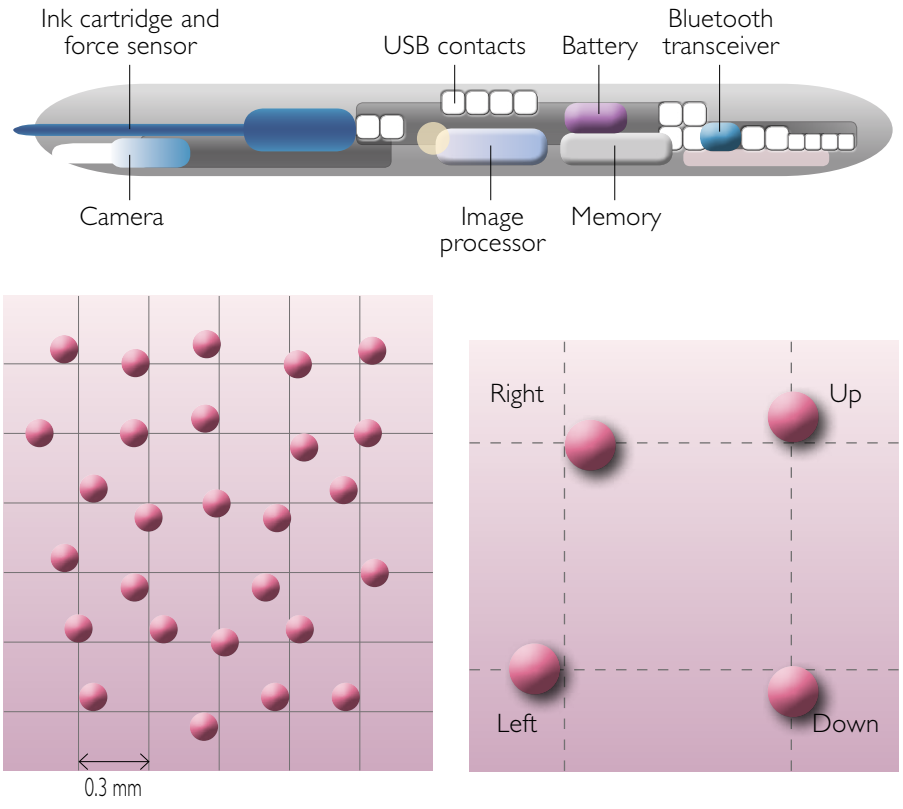

Figure 1. Diagrammatic representation of the pen and paper technology.

Results

Over a six-month period starting in January 2009, the authors' unit have recorded wound care activity on over 500 referred patients using this DPP technology. The data has allowed individual patient activity to be reviewed and tools to allow analysis of outcome using a TELER-based system of indicators (Browne et al, 2005) are now being developed. This should allow more accurate assessment of outcome over time and will capture patient opinion as well as clinical data. Interim analysis as part of the data entry validation process is currently being undertaken. This process is being used to identify areas within the form which require modification, and to improve letter and number legibility for individual healthcare professionals.

The first 436 wound care assessment records have been reviewed for transcription accuracy and validated against the hospital patient administration system (PAS), and are being used to inform staff training and form design. Examples of areas where accuracy needs to be improved include writing of certain letters, 'E' being the most commonly noted error (*Figure 2*), with the patient's name field being the most likely area where this error occurred. This was easily rectified during data review. Numeric data was very accurate, approaching 99% accuracy. Free text fields were most difficult to review and use for analysis but the handwriting, despite being variable, was reasonably accurately translated into typed script.

Discussion

The NHS faces a huge challenge computerising patient records across care settings. Patients with a wound cross many professional and healthcare

boundaries, receiving care from a variety of healthcare professionals working in separate disciplines at disparate locations within different provider organisations, and, like many care groups with chronic diseases, often have extensive care records. In many ways, the frequent care episodes patients with wounds require exacerbate this problem. These difficulties have all contributed to the well-recognised deficit in accurate data collection on treatment outcomes for patients with wounds. The documentation system that the authors have developed jointly with Longhand allows a patient-held paper record with live data capture, without removing the healthcare profession from the clinical environment. Important lessons have been learnt, both in the form of design and data entry. The next stage is to trial this system more widely outside of the authors' trust and to extend the system to other areas of care.

Conclusion

This pilot has demonstrated an effective method of data capture that is, in the authors' opinion, applicable to all care settings and which has the potential to be compatible with existing data systems. It is simple to use, requires no computer skills, and frees clinical staff from a computer, allowing them to continue with a familiar paper-based record system.

What have the authors' unit learnt from their early experience developing and using this data capture system? The first, and perhaps most important factor, is that it is easy to use, maintains the advantages of a paper record, yet overcomes the task of transcribing data from paper to computer.

In addition, the system has been found to work well. Analysis of the first 436 forms available for validation showed that a slower, consistent and accurate writing style is necessary. Accuracy varied between staff, the most common error related to the letter 'E', and this occurred predominantly in the patient's name but was easy to correct during data review. Numeric data was accurately captured. Multi-entry fields were accurate but more difficult to extract data from. Free text, given the variety of writing styles was

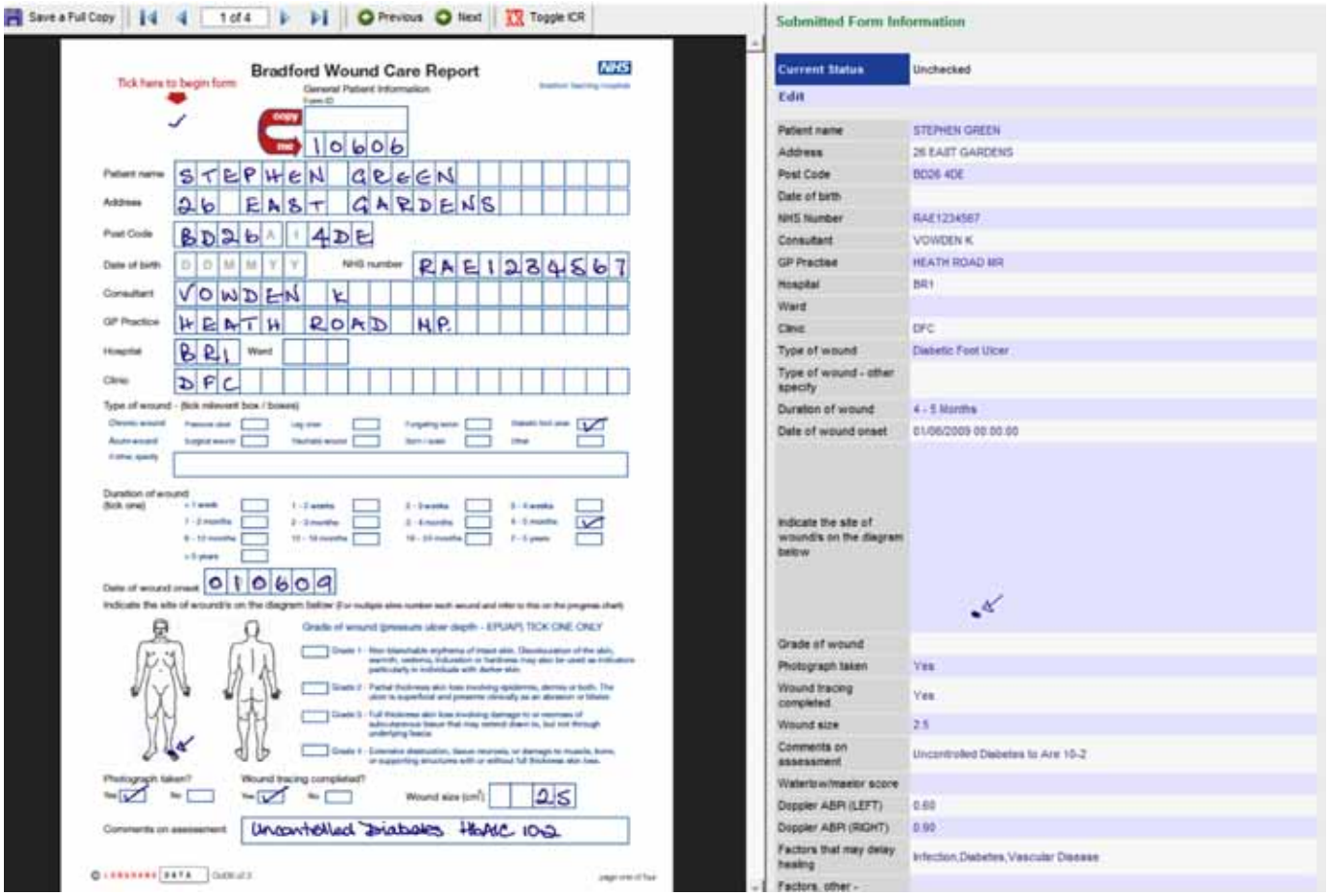

Figure 2. Computer screen shot showing a reconstructed page from the digital pen captured data and the automatically generated spreadsheet available for data validation.

recognised accurately. It is also possible to annotate the form, but this data is only available from the form image and not the spreadsheet.

Where is this system going? Many patients have multiple wounds and the authors have therefore introduced a wound ID that will allow outcomes and treatments for each wound to be followed. Clear outcome points have been added and further work to integrate TELER into the system is being undertaken, which will allow more detailed analysis of outcome data. Additional wound-specific data sets are being developed to allow easier capture of wound specific data, as are a series of data analysis tools that will help with outcome reporting and standard report generation.

Healthcare professionals are under increasing pressure to justify the value and quality of their work. The only way to do this is by providing detailed, accurate and current data which details and supports clinical activity and cost-effectiveness, while highlighting the quality of the service provided. Audit and ongoing clinical data capture can provide the necessary supporting evidence (Vowden and Vowden, 2010). The authors believe that digital pen and paper technology provides healthcare professionals with an effective tool to allow them to capture this data and therefore satisfy some of the demands placed upon them by the quality agenda (Department of Health [DH], 2009). WUK

The pens, paper and ongoing development of this project has kindly been funded by Coloplast Ltd. For further information on accessing Digital Pen and Paper, please visit www.e-fficient.co.uk.

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