

Understanding community health care: Implications for technology design

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Abstract

This paper reports on a qualitative case study of a community health care setting. The intention of this study was to better understand work 'on the ground' in order to inform the design of technology solutions to enhance the delivery of care in this setting. This paper is very much from the community health care workers' point of view. To realise quality health care, systems need to take advantage of what future technologies have to offer, but also to adapt the beneficial work practices observed from existing and past systems. Time was spent in the field, observing nurses delivering care, focusing on their information needs and as a result we have developed a deep understanding of their work practices. The most important findings are related to three areas of work practice. It was observed that it was difficult for nurses to achieve synchronous contact with other health care providers. A solution that involves the use of an asynchronous communication tool (e-mail) is outlined. In addition, the importance of the paper-based client chart in the nurses' work was identified, and subtleties regarding its use in practice were revealed. The complex issues surrounding the implementation of an electronic client chart are explored, and recommendations and cautions are made such as including informal working documentation. Finally, given the mobility of community care nurses, important factors for consideration in the selection of appropriate mobile information devices are highlighted. Issues that need to be considered, e.g. robustness, matching the job at hand, when designing an information system to support these mobile workers are discussed. Future work will implement and study the use of these devices and information systems within this environment.

1. Introduction: The popularity of home-based health care (Allen et al., 1999; Warner, 1997; Yellowlees and Brooks, 1999) is driving the demand for better technology support for both patients in their own home and the community health care workers. There have been two main areas of technology focus: telehealth, where care is delivered from a distance to the home, often involving the use of videoconferencing (Freeman, 1996; Gelber, 1999); and the use of information technology and telecommunications systems to support community health care workers in the field and in the office (Bitenc, 2000). This paper focuses on the latter. Community nursing organisations are replacing paper systems with information systems, laptop computers, hand-held information devices and wireless communications (Braunstein, 1994; Herbert, 2000; Larrabee, 1999; Mallard and Mitchell, 1998; McManus, 2000; Wilson and Fulmer, 1997). The use of these devices for timely access to information regardless of location is also being considered in other health care settings such as hospitals (Ammenwerth et al., 2000).

As mobile workers it is anticipated that community care nurses will benefit from appropriately designed mobile information devices and supporting information systems for remote access to information, electronic health records and for communication and collaboration. Some potential benefits are: more than one health care worker can have access

to the same information at the same time, less physical duplication of information would be needed and more time may be available for care-based activities. However, it is known that the introduction of technology into health care impacts the nature of that care (Fitzpatrick, 2000; Greatbatch et al., 1995). In order to understand the type of system that would be most appropriate in this setting, it is important to consider the subtleties in the accomplishment of current home health care delivery, which are not always detailed in procedure manuals (Fitzpatrick, 2000). In a study of nurses delivering home health care in rural India (Grisedale et al., 1997), observations of health care workers performing their daily functions preceded any technology development and deployment and helped inform the eventual design of a software interface for Apple Newtons to support the nurses in the field.

The intention of this qualitative study of a community health care setting was to better understand the richness and complexity in the practical accomplishment of work, that is, work 'on the ground', in order to inform the design of technology solutions to enhance the delivery of care in this setting. The initial thinking was that technology would be deployed into people's homes – as the study progressed it quickly became clearer that greater value in the first instance would come from support of the information needs of the community health care worker. This paper focuses more on information needed at the point of care rather than information needed for care delivered at a distance (i.e. telehealth).

Time was spent with a community care organisation understanding the information needs related to delivery of home health care. A retrospective account of a mobile device that was trialed within the organisation was also explored. The setting and methods are outlined in the next section. A brief overview of community health care is then given, focusing on describing the nurses' work, and is followed by a discussion of the technology implications with regards to communication with care providers and electronic health records (referred to as the electronic client chart in this paper). Then the organisation's past use of a mobile device is explored, and is followed by a discussion of mobile information devices as they relate to this environment.

2. Case Study – setting and methods: The setting for this study was a state-wide community care organisation that provides a range of community and residential care services, such as community home nursing, respite services, allied health care, residential care and disability services. The organisation has many centres in rural and urban Queensland that service their surrounding geographical regions. This study focused on nurses delivering care in the home and is part of a larger homecare study.

Nine person-days of fieldwork were undertaken by four researchers. To gain as rich an understanding as possible within the time constraints, a range of centres and people to study were selected. In total five different centres, covering urban and rural areas and a range of centre sizes were visited. Nursing staff (of differing levels of experience), were observed working in the car, in clients' homes and in the office. Mostly, one researcher worked with a particular staff member for the day, who provided a focus for observations and in-context interviews. The study schedule is shown in Table 1. At centres 2 and 5, one researcher spent the day in the centre to observe general activities there.

One semi-structured interview was conducted to explore the past use of Apple Newton MessagePad mobile information devices, trialed within the community care organisation from approximately

1995 to 1999. The interview was conducted by three researchers and attended by two staff from the community care organisation.

The researchers collectively attended 46 client visits in the home and 3 client visits in the centres. The patients observed fell broadly under the following categories: wound care, palliative care, dementia care and support and maintenance. Other interventions such as postal-natal care were not observed in this study. Most patients were elderly and had little experience using computers and information technology. Client information was gleaned indirectly during home visits and additional focused client studies would be needed to more clearly identify their needs.

Table 1. Overview of Study Schedule

Blue Care Centre	Size & Location	No. of Researchers	Staff in focus	Duration
Centre 1	Medium; urban	2	Level 1 Nurse; Level 2 Nurse	1 day
Centre 2	Large; urban	3	Level 1 Nurse; Level 2 Nurse; Staff in centre	1 day
Centre 3	Small; rural	1	Level 1 Nurse	1 day
Centre 4	Medium; rural	1	Level 1 Nurse; Staff in centre	1 day
Centre 5	Small; urban	3	Level 1 Nurses Staff in centre	1 day 1 2hr interview

Methods: Observations of community care work were made from different researchers' perspectives and with different nursing staff. Qualitative methods were used for data collection. These included direct observation, informal questioning of staff as they went about their work, semi-structured interviews, logs of photocopy use, and sitting in on a centre meeting. Each researcher took their own notes and collected various artefacts such as copies of notes and forms (and de-identified them before removal from the centres). Digital photos were taken to illustrate significant aspects of the nurses' work as well as uncommon incidences that occurred. In some cases an audio recorder was used to record the nurses' thoughts and her interactions with clients. Data was analysed collectively using a grounded theory approach, whereby theories and concepts are intimately related to the data collected (Strauss, 1987).

The following discussions represent a small part of the ongoing analysis of the richness and complexity of the practical accomplishment of health care in this setting as it relates to nurses. Further observational studies will focus on the perspectives of the client and other clinicians such as allied health, the hospitals and doctors.

3. A brief overview of community health care: In this section, a high-level overview of the work of the community nurse is painted. The main issues are then discussed in more detail in the section to follow.

Nurses described their role as autonomous and delivering holistic care. As one nurse commented, “when you’re out there [in client’s homes] ... you have to be able to do everything”. They are coordinators of care, liaising with many other health care practitioners and community care organisations to deliver the best care to the patient (referred to as clients within the organisation). They have a place in a larger community health care team. From observation it appears that they require not only clinical, but also social, organisational, political and navigational skills within community health care.

They tend to be highly dedicated, and often give of their own resources in the interests of better quality client care, for example, using their own mobile phone, missing meal breaks, working overtime, typing out referral letters after hours at home. The nurses are very patient-focused as evidenced by their willingness to use their own resources. However, they believe that their job is becoming increasingly stressful, with more driving, and more administration and paperwork.

Each nurse works for a centre, which services a particular geographical region. A nurse usually visits clients within a sub-region of their centre’s region (as part of a team). Typically a nurse’s day is split into two sections: in the morning and early afternoon a nurse will visit clients at home (where they alternate between the car and client homes); and in the afternoon they go back to the centre for follow-up work. As such the nurses’ work takes place in three very different locations: in the car, the home and the office.

In the Car: Observed time spent in the car was approximately 5-10 minutes between each visit for urban centres, with times in rural centres ranging from 5 minutes to an hour. Apart from being a means of transportation, the car also served as a mobile office, where nurses occasionally received or initiated phone calls on their mobile phone, reviewed charts or other documentation associated with clients they were seeing that day. The car was also a supplies store, a lunchroom and a place for timeout to listen to music and as one nurse said, “to not have to think”.

In the Home: Visit times varied depending on the nature of the visit. For example, the nurses would typically take 90 minutes for a new admission, while care-based visits usually took 15-30 minutes. Client charts were reviewed and documented during visits. Apart from the client charts, nurses used a range of other less formal ‘working’ documentation e.g. listing actions that needed to be followed as a result of a visit. They also used a range of other often unanticipated information sources such as relevant community services (e.g. Spanish-speaking day centre).

The documentation in the client charts only reflected a small part of what happened in a client visit. Many activities and interventions happened other than the primary reason for the visit. For example while attending to a client, the nurse asked the client’s wife “You are losing weight, are you eating ok?” This led to a long discussion about Meals on Wheels. A lot of these interventions came about through simply ‘being there’ - the nurses could use all their senses to pick up on information. For example the nurse could *smell* burnt milk from a pot indicating diminishing self-care in a dementia client; they could *see* what pills have been taken or not; they could *read* the client’s own notes (client generated notes not contained in client chart); and they could notice that another family member was not well.

The client-nurse relationship was also important. Because the same nurse or nurses tended to visit the same clients, they were able to build up real relationships as evidenced by terms of endearment. For many, the nurse’s visit was a highlight of their day and in some cases the nurse was their only

visitor. So there was much conversation, both care-related and social chat. The patients had a high level of trust in the nurse.

It was also observed that it was difficult for nurses, when in the home or centre, to make phone contact with doctors. Similarly, there were delays in being able to get an Occupational Therapist to come and assess a home.

In the Office: In the early afternoon, they would arrive back at their centre where they would process information relating to the clients they saw that day, complete documentation for external funding agencies and work through calls to other health care providers. They would also prepare equipment and information for visits the next day. There were other more subtle yet critical activities that happened back at the centre in the interactions between staff members. The time back at the centre was invaluable for peer support, skill sharing, keeping up to date with what was happening with other patients, and so on. Even being able to overhear or oversee other activities was important.

In summary, the nurses have three main locations of work: the car, clients' homes, and the centre they work at. All of these locations are quite distinct places of work that warrant further discussion but are beyond the scope of this paper.

4. Implications for technology design: The previous section gave a broad overview of the work of the community nurse. In this section, some of the issues that arose in the course of their work is drawn out in more detail and the implications for technology design to enable better quality community health care is considered. Initially, the issue of external communication and the possible use of e-mail is discussed. The paper-based client chart is then discussed and various issues for its conversion to an electronic client chart are explored. Mobile devices are then explored in the next 2 sections.

Communication with care providers: At times nurses needed to contact doctors, for example, to clarify difficult to read hand written referrals, to check a medication order, or to ask for a wound review. In many cases, multiple attempts to phone the doctor were required before the nurse could make contact. In the case of wound reviews, sometimes the nurse could not get the doctor to see the wound in a timely manner.

Similarly, there were significant delays in being able to get an Occupational Therapist (OT) to come and assess a home. This is an important issue, as additional care support can't be brought in until the OT assessment is made thereby increasing the nurse's workload. One nurse stated that they used to be able to give a sketch to the OT for assessment but indicated that they are no longer able to do so.

These problems with synchronous contact highlight the potential of alternate communication methods. For contact with other care providers, the greatest benefit will probably be gained through better support of asynchronous communication. While the benefits of video conferencing are becoming widely accepted, such technology is likely to suffer from the same simultaneous access problems as the telephone. For community nurses an asynchronous communication tool such as e-mail is a readily available, lightweight solution that can be useful for both internal and external communication and could save significant time making repeated phone calls. It can also be useful for exchanging other forms of information, e.g. digital photos of a bathroom could be sent by e-mail

to an occupational therapist, reducing delays in OT assessments. Also digital photos of wounds could be sent to doctors for review, thereby reducing delays and as a staff member indicated “you don't have to disturb a client” as he/she would not need to visit the doctor. One centre occasionally uses a digital camera to take photos of wounds and e-mail them to doctors. Such visualisation and communication technologies have great potential for enhancing communication and the management of care across health care providers, thereby improving the quality of care delivered. Furthermore, if an electronic record were developed, digital photographs could be stored electronically as part of the client chart.

Client Chart: One of the main sources of paperwork was the client chart. According to the nurses, approximately 60% of the paper-based charts are stored in the homes rather than the community centre. There are advantages and disadvantages to having the chart in the client's home. According to a nurse, the advantages are: “you don't have to carry as much around” and “other health practitioners can write in the charts”. The chart acts as a collaboration tool that other health care providers can read and write in. Another nurse noted that if one is out in the field and discovers they have too many clients and needs to shift a client onto someone else via the phone, then that nurse can go straight to the house as the client information is already there.

However, there are disadvantages: “... back in the centre you may need some information from the chart in the home ... but you have to wait for the next visit for this.... it's very annoying”; and being unable to read the chart until they were in the home, when the clients often want to talk. When nurses visited new or unfamiliar clients they needed access to the clients chart to familiarise themselves with the care regime. If they had access to the client chart they were observed reading it in the car before entering the home. Otherwise they would have to quickly familiarise themselves on entering the client's home thereby possibly interrupting the flow of the visit.

So, access to the client chart is often needed in other locations such as the car and office. To compensate for the lack of information back in the centre, extra work was required. Paper duplicates of parts of the chart were often made and distributed appropriately. The front-sheet of client charts, containing client demographics and other ‘at-hand’ information, was photocopied and kept in a plastic sleeve, providing nurses with easy access to basic client information at all times. An electronic form of the client chart, with appropriate devices for access to the chart regardless of location may solve many of these issues. This may lead to better management of care across visits, particularly when different care providers are visiting the same client. Furthermore, nurses could be given instant access to a broad range of unanticipated information sources that may be relevant to a client during a visit, such as drugs databases, community services e.g. Meals-on-Wheels, respite centres.

Colour was used to indicate and separate various sections of the paper-based client chart by way of coloured dividers and bands on the forms. This allowed for quick and easy access to the various sections. The paper-based system provided flexibility for nurses to include less formal working documentation such as using post-it notes for alerts or reminders. Nurses also created informal to-do lists associated with clients, for tasks that needed to be carried out after the visit. An electronic version of this feature was available on the Apple Newton MessagePad that the organisation previously used (discussed further in the next section). Nurses commented that they found the ‘Memo’ function very useful for taking notes and electronically associating it with a client. This concurs with the ‘pliant’ approach to computing (Harris and Henderson, 1999), which proposes that information systems should be able to ‘honour particularities’ of the job at hand by recognising that

not every situation can be explicitly planned and designed for. Harris and Henderson (1999) provide suggestions for making systems more pliant by simply allowing electronic forms to be annotated and allowing for more flexible input.

There are advantages to electronic based systems that will help improve health care, however a number of subtle and important work practices, revealed in this study, need to be taken into consideration in moving from a paper-based system to an electronic system. For example, external care providers may find that if the client chart becomes electronic and is no longer stored in the home, it will not be as conveniently accessible as when it was paper-based. Some form of record would still need to be available in the home. Furthermore access times to parts of an electronic client chart would need to match those of a paper-based chart, to ensure documentation time does not increase. Also, software solutions that take into account the more informal documentation (a more 'pliant' approach) would be useful for nurses.

5. Understanding past experiences with mobile devices: As stated previously, understanding how community care work happens 'on the ground' can provide useful insights for the design of solutions that better fit into that work. A complementary input to the design process is understanding the lessons from past experiences, in this case with Apple Newton MessagePads. In this section we discuss information gleaned from our discussions with nurses who used the Newtons.

"It was capable of doing so much but couldn't do it all."
(a nurse's comment from the interview)

Apple Newton MessagePads were trialed by the community care organisation from 1995 to 1999 at several centres. The device was a personal digital assistant (PDA) that had a stylus for input using handwriting recognition. Their function was to provide schedules of client visits for a nurse over the course of a week, to allow nurses to time their visits with clients and to make short notes for actions associated with the client. The Newtons also included details about the client and basic information about interventions. Given their primary role as a scheduling tool, Newtons remained in the car for the duration of client visits. Client notes continued to be made in the paper-based client charts that typically remained in the home.

Screen: As the Apple Newtons were mainly used in the car, the clarity and brightness of a mobile device's display was an important factor. Nurses commented that in the glare of sunlight, it was often hard to read the information on the screen. They also commented that at times they had to tap the stylus very precisely on parts of the screen in order to access the appropriate information. This raises questions about the size of a screen and the amount of information that can reasonably be displayed on a screen.

Robustness: The Apple Newtons were sometimes dropped. One nurse commented that the battery cover had been broken and that it had to be taped up in order to ensure the batteries did not fall out. They were also left in the car for the duration of the client visit and often overheated, requiring the cool air from the car's air conditioner to "revive" it. Battery life was commented to be 2-3 weeks, and did not seem to be a major concern with some nurses. However, one nurse expressed frustration about losing information, when the battery went flat. This happened to this nurse on 3 occasions during the trial period.

Information synchronisation: Information about clients visited for the previous week was uploaded to the central information system from the Newton MessagePad at the end of the week and the information about clients for the next week was also downloaded to the Newton at the same time. It was commented that this was too infrequent as information would change during the week and remain out-of-date on the central information system. For example the roster for client visits could change on the Newton but this would not be reflected on the central system. New clients would be issued with a unique identifier and problems would arise when nurses were unsure as to which identifiers had already been allocated without their knowledge. This raises questions about the type of connection that such devices should have with the central information system.

The semi-structured interview served to illustrate many important points regarding the organisation's past experience with the mobile device. These will be discussed further in the following section.

6. Mobile devices: While there are benefits in having electronic systems as highlighted previously, in this community care environment it is essential that an appropriate mobile information device is provided for access to that information. Mobile information and communication devices are converging and the wireless infrastructure to support them is rapidly improving (Schrope, 2000; Graham-Rowe, 2000). These devices are incorporating mature and more usable technologies such as wireless networking, voice and handwriting recognition, with an aim to be suitable for all types of mobile workers. The overall goal is for the device and software to match the needs and capabilities of the nurse and to fit in with the way they carry out their work and the locations in which they carry out the work.

The use of a mobile information device in a homecare setting will need to be carefully planned and managed in order to minimise potential disruptions to the social interactions between nurse and client. Studies by Greatbatch et al. (1995) confirmed that desktop computers adversely affected doctor-patient interactions in general practices. They suggest that training in the use of the device and "priming" the client about the potential for the device to distract the user, could minimise and manage the disruptions.

A complaint with the Apple Newtons was that "they seemed to be getting slower and slower" over time. This problem sometimes led to nurses tapping one too many times on the touch sensitive screen, advancing them too far forward to an undesired form. When considering a mobile system for nurses, response time is a critical factor to take into consideration.

In comparison with desktop computer usage, Greatbatch et al. (1995) also noted that the 'ecological mobility' of pen and paper allowed the doctor to orient the paper card so that concentration could easily be shifted between the patient and the paper card. The ecological mobility of mobile information devices also needs to be considered in order to allow the nurse to orient herself for efficient interaction with the client and chart at the same time. Some factors influencing a device's ecological mobility are: form factor (size, weight, volume), the human-computer interface (graphical user interface or a speech interface), whether or not it was tethered by cables (wired or wireless), and so on.

Ecological mobility must also be considered in the context of the different roles and jobs that a community care nurse performs often within the same day. For example, home visits can be broadly categorised either as admissions or ongoing care. Admissions take approximately 90 minutes with

extensive information input, while ongoing care is on average 15 to 30 minutes with less extensive interactions with the client chart. For admissions, a laptop computer with a display, keyboard and mouse would be the most efficient device for information gathering and extensive form input. For less information intensive interactions, a hand-held or palm-sized device would be more appropriate for reviewing and updating care plans or progress notes. Laptop computers are much heavier and more awkward to handle compared to hand-held devices and would be less appropriate for a mobile nurse who has many of the less information intensive visits. There are also cross-infection concerns for ongoing care, which limits the number of items that a nurse can carry into the clients' homes and so ideally only one device should be used during a visit.

Hosono et al. (1999) undertook a survey-based study to gauge the relative importance of mobile information device factors for nurses in a hospital setting. The study found that screen-size, the display type, robustness and adequate storage were the most important considerations. The retrospective recount of the Apple Newton MessagePads also revealed similar points.

As nurses found it difficult to read the Apple Newton MessagePads in glare, the screen visibility in a mobile device is important to ensure that the device can be viewed in different lighting conditions. For nurses using handheld devices, the size of the screen and the amount of information that can be reasonably displayed on a screen is significant. Appropriate design of these aspects may help to minimise the need for nurses to tap very precisely on parts of the screen when using the interface.

In addition, nurses expressed frustration at losing information when batteries went flat, so local storage is an important design consideration. Mobile information devices also need to be robust enough to resist damage from impact and heat.

Ideally mobile devices should have a constant online connection, independent of location. The ability for nurses to access the network and synchronise information while in the field, occasionally during the day, would probably be attainable. While this may be difficult given current wireless telecommunications technology (for example in rural settings where the infrastructure is less established than urban settings), nurses would need to synchronise information at least once a day. By ensuring that information on the central information system is more up-to-date problems such as issuing unique identifiers for new clients can be alleviated.

7. Conclusions and future work: To realise quality health care, systems need to take advantage of what future technologies have to offer, but also to adapt the beneficial work practices observed from existing and past systems.

This study has revealed a number of subtle work practices that are an integral part of the daily working life of a community care nurse. Many of these were not obvious before carrying out the study. With a greater understanding of how the work is achieved 'on the ground' it is apparent how technology might be able to fit into and enhance work practices. These understandings can have a large impact on the design choices that are made.

For contact with other care providers, the benefits will be gained through better support of asynchronous communication, such as the use of e-mail and digital cameras. When moving from a paper-based system to an electronic system, maintaining the client chart's functionality as a collaboration tool with external health care providers, access times and allowing for informal documentation (a more 'pliant' approach) all need to be addressed.

The study has revealed significant points relating to mobile information devices such as the need for ecological mobility, robustness, adequate screen size, visibility and storage space, and a preference for online connectivity.

At this point in time there does not appear to be an ideal mobile information device on the market that would match the different types and locations of work undertaken by the community health care worker. To practically approach this complex problem, initially one location and one type of visit could be considered when selecting a device and implementing a software solution. However it is worthwhile bearing in mind the impact these choices will have on future integration of the other locations and type of work.

Future work will build on these findings. The intention is to move from user studies to developing and testing solutions through an iterative design approach incorporating brainstorming and prototyping techniques. This will include further studies such as these, to better understand and learn from experiences in practice.

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