Planning for Sustainability:
Multiple Technologies for Different Care Models

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***Abstract*—The integration of eHealth into the routine delivery of care is an important element in the maintenance of health care costs. This paper reports on the findings from a series of projects assessing the effectiveness of several eHealth technologies to both contain costs and aid in the provision of care to individuals with Intellectual and Developmental Disabilities or Severe and Persistent Mental Illness. Data were collected from 11 different locations in order to determine if the technologies resulted in an improvement in living conditions and to judge the acceptance of the technologies by both the staff and individuals. Findings indicate that the technologies have exceeded expectations resulting in plans to expand to other facilities and to build a new residence in which all of the technologies will be installed.**

Keywords—telecare; eHealth, multiple technologies; demonstration project; intellectual and developmental disabilities; severe and persistent mental illness

I. INTRODUCTION

The need to contain health care costs has seen the development of new technologies, as well as the innovative use of existing technologies, in an ever enlarging number of care models. Thus, it is not surprising that new and reconfigured eHealth technologies are increasingly being used to provide care and services to individuals with Intellectual and Developmental Disabilities (IDD) and those with Severe and Persistent Mental Illness (SMI) [1][2]. As in the use of new technologies, in each and every care model there are challenges to using innovative technologies in addressing the needs of these two populations, but the necessity to contain, and if possible, reduce the cost of providing care to these populations, makes the use of technology, in some form, inevitable. However, three different trends intersect in such a way that result in the urgency to develop more efficient care models for the IDD and SMI populations: the cost of care; the aging of the two populations and a reduction in the number of qualified staff providing care to the IDD and SMI populations.

First, deinstitutionalization, in both the United States and Europe took place from the mid-1960's through the 1970's, had a dramatic impact on the care models used for both populations [3][4]. Prior to the deinstitutionalization, the majority of care was provided for individuals with IDD and SMI in large institutions which were often dehumanizing. The impact of deinstitutionalization on the cost of care varied significantly, but the impact on the care model was significant as most individuals with IDD and SMI moved into the community, many living in some form of group home. The number of individuals living in any particular group home varies based upon the needs of the individuals. The most common number of residents is four with some group homes having as many as eight to ten residents. In the most severe cases, an individual lives alone in a residence with 24 hour supervision. Although costs of providing care to the residents in group homes vary based upon the needs and location, the average cost is between $40-50,000 per year per resident and if an individual needs to live alone, the cost can top $150,000 per year [5][6].

Second, the rapidly increasing number of such individuals brought about by the same demographic factors as for the general population is adding even greater cost to the care of IDD and SMI populations [7]. As individuals with IDD or SMI age, they are as susceptible to chronic illnesses as the general population, but the cost of caring for them is much greater. For example, care for an individual with IDD who has congestive heart failure costs approximately eight times more than for a person without IDD [5]. The ratios for other chronic diseases and individuals with IDD versus SMI vary somewhat, but the reasons are consistent. Many individuals with IDD and SMI make poor lifestyle decisions—use tobacco products and abuse alcohol and drugs. In addition, many are unable to self-manage disease, e.g., adhere to complicated medication regimes and follow complex health care instructions. Thus, greater cost of care for individuals with IDD and SMI when combined with the cost of residential care in general, results in a compelling reason for attempting to use technology to contain costs.

A third reason is that there is an increasing imbalance between the growing needs of the IDD and SMI populations and the number of qualified staff available to provide care. Projections from the federal government suggest that the need for trained staff will increase by over 30% in the next decade, while the supply of individuals who traditionally have filled these jobs is expected to increase only by 7% [8]. In addition, the high turnover rate for individuals caring for these populations adds another dimension to the staffing challenges. It is estimated that turnover for direct support professionals (DSPs) ranges between 50-70% depending on the specific jobs undertaken, e.g., residential care versus in-home care. This high turnover rate adds at least $2,500 in direct expenses plus a minimum of an additional $1,000 of indirect expenditures

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for an organization to replace a single DSP, thus adding to the ever increasing cost of providing care to these populations [9].

In the next section, a brief discussion of attempts at using technology to provide care for these populations is presented, while in the third section the overall Project is described including a short description of the organization undertaking the Projects, as well as the overall goals and objectives to be achieved by the introduction of the new technologies. In Section IV, the different Projects undertaken are described along with the care models employed and the technologies introduced. The next section discusses the methodologies employed in gathering data on the individuals with disabilities and mental illness and staff in order to assess the effectiveness of the technologies in care delivery, while Section VI offers a discussion of preliminary findings. What has been learned from the analysis is summarized in the Discussion Section, while plans for the roll out of the technologies to other facilities and the financial model to pay for this roll out comprise the concluding section.

II. RELATED WORK

It became apparent from the earliest discussions about the use of technology in the provision of care to individuals with disabilities, that there had been few other attempts to utilize technologies in a similar matter. This was the case, even though what little research was available that the increase in the use of technology benefits the quality of life for people with disabilities and that, "(m)ore often than not, people with intellectual and developmental disabilities (IDD) end up on the side of the divide with others who do not have access to or use technology" [10]. The vast majority of studies that exist focus on children within the context of school [11][12], rather than adults living in the community Those studies that do focus on similar populations are either, not helpful because of advances in technology since being undertaken, or are not residential based [13][14]. Thus, the effort to use a series of technologies within the NHS care system became more than just a localized demonstration; it became a test of the resolve to make these technologies widely available within the larger IDD community [15].

III. PROJECT

NHS Human Services, through its subsidiaries, is one of the United States' leading non-profit providers of community-based human and special education services. With nationally recognized programs in multiple states, NHS offers a full range of integrated services to children and adults in the areas of mental health, addictive diseases, autism, intellectual and developmental disabilities, juvenile justice, foster care treatment, education and other specialized programs. In particular, NHS is a leader in developing treatment plans for people with dual diagnoses and other multiple challenges and is in the forefront of the use of innovative technologies.

A. The Strategic Plan

In 2012, in order to accomplish the objectives outlined in the NHS Mission and Strategic Plan, the organization embarked on an assistive technology Project. This was partly in response to the growing IDD and SMI populations, partly based on the financial realities faced by the organization in providing care to these populations and partly in response to The Rights of People with Cognitive Disabilities to Technology and Information Access [16].

The planning process was inclusive and there was a recognition that in order to "do it right" it would take time to put everything in place. The first step was to form a committee led by an upper administrator, and employees were encouraged to review the current state of technology use in the delivery of care to the IDD and SMI populations and to propose sites at which new technologies could be used. Members of the committee attended several professional meetings in the United States and met with representatives of companies and organizations that used and produced various technologies in order to determine what technologies were available for use.

During the remainder of 2012, proposals were received and evaluated based upon specific criteria: administrative and staff buy-in; existence of suitable technology; evidence that technology would enhance care provision; evidence that, if successful, the technology could be used at a large number of other care facilities within the organization; and a financial model showing that the technology was sustainable—the organization would be reimbursed for its use. Finally, there was an attempt to achieve a rough balance among the different care models employed throughout the organization. This process took over a year which afforded a thorough evaluation of the resources available at each of the selected sites. The final decision was confirmed at an all-day meeting of administrators and representatives from each of the chosen sites in the fall of 2013.

B. The Project Goals

As planning progressed, three main goals emerged: 1) to determine which, if any, of the technologies being tested can allow for an improvement in living conditions and the care being delivered in the selected facilities; 2) to judge the acceptance of the technologies by both the staff and individuals with disabilities and mental illness; and 3) to assess whether the technologies should be rolled out to other facilities with similar care models. In order for any of the technology Projects to be deemed successful, it was necessary to determine if the new technologies allowed for an improvement in living conditions and the care being delivered in that the individuals with disabilities and mental illness express that their lives are better after the introduction of the technologies than before. It was also necessary to determine if care delivered is more timely, efficient and cost effective than the care delivered without the technologies.

It also became apparent that it was essential to ascertain if staff could properly use the new technology, that they believed

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in its effectiveness and accepted that the technology would require that they did their jobs differently. If staff did not accept the changes that would be brought about by the introduction of the technology, there was no reason to go forward with a roll out to additional facilities. Likewise, it was necessary to determine if the individuals with disabilities and mental illness accepted the use of the new technologies in the care that they received, if they were intimidated or not by the technologies and if they would willingly comply with requirements for the use of the technologies. Finally, even if it was determined that the new technologies provided improved care, were accepted by staff and individuals with disabilities and mental illness, it was still vital to find out if the care provided with the new technology was reimbursable as a billable expense. Consequently, the locations, the care models and the technologies had to be carefully selected in order to ensure that all three goals were achievable.

IV. THE TECHNOLOGIES AND LOCATIONS

During the planning process, the Assistive Technology Executive Steering Committee received proposals from local management teams which had assessed individual needs, staff interest and available dollars. The Executive Committee narrowed the proposals to three that were to be part of the first phase of the Project: Communication Technologies Project (CTB); the Smarthome Project (SHP); and the Biometrics Project (BMP). Although the initial goal was to have all three of the Projects begin simultaneously, issues, e.g., renovation delays, equipment problems, made this impossible. As a result, the CTP has advanced at a faster rate than the other two Projects. Also, as each of the Projects has progressed, sites have been added and subtracted, once again resulting in different timelines for the three Projects.

A. The Communication Technologies Project (CTP)

The CTP began in the spring of 2014 with the selection of sites and upgrading of wireless routers. Work continued during that summer with the focus of training staff in the use of AbleLink software [17] that had been selected for use and during the fall of 2014, staff and individuals with disabilities were surveyed and the Glasgow Depression Scale (GDS) administered to all individuals with disabilities participating in the Project [18] [19]. The main goals of the CTP was fourfold: to enable individuals with disabilities to stay in touch with family and friends; to allow a greater ability for them to communicate with members of the support services team; to encourage them to acquire basic computer skills; and to permit safe and secure access to the internet in order for them to pursue their particular interests. Seven sites were selected for inclusion in the CTP. Five of the sites are group homes and two program centers, all in Western Pennsylvania. The group homes are single sex residences for between three and six individuals. In contrast, the two program centers serve between 90 and 130 individuals on any given day.

The hardware introduced into the five group homes was iPads and laptops while at the day programs all-in-one desktop computers, laptops, tablets and iPads were made available. The hardware was customized to meet the needs of the IDD population, e.g., large keyboards, headphones. After much research a software package designed specially for individuals with cognitive disabilities—AbleLink—was purchased and installed. AbleLink allowed individuals to experience a more self-determined and fulfilled life through an empowering technology characterized by a person-centered design philosophy. Several AbleLink applications were installed that allowed individuals to use email (voice activated), Skype and webcam broadcasts, along with providing prompts for tasks that increased independence. The personalized laptops in the homes allowed the individuals to utilize the skills learned at the day program in their own homes.

B. Smarthome Project (SHP)

The SHP required a remodeling of a residential unit which faced construction problems delaying the start of the Project several months. However, by the summer of 2014, the four residents were able to move into the remodeled facility and be administered surveys and the GDS. The main objectives of the SHP were to increase the independence of the four IDD residents and to conserve energy through the use of "green" appliances and more efficient heating and air conditioning systems (HVAC). To achieve the goal of increasing the independence of residents, a Smart TV was installed, iPads and remote controls for lighting and window blinds were made available to the residents. Additionally, motorized cabinetry and cook tops and sinks were installed in a lowered position to allow wheelchair access. Finally, to reduce the amount of energy consumed, remote control HVAC systems and smaller and more easily accessible dishwashers and refrigerators were installed.

C Biometric Project (BMP)

The BMP began in the summer of 2014 with the development of protocols, the installation of the technology, training of staff, retrospective data collection, the creation of event and error forms and administering surveys to residents and staff and the GDS to the residents. The main goal of the Project was to use technology to reduce the number of emergency room visits and hospitalizations and thus, by doing so curtail costs by delivering care in a more timely manner and at a lower level of care [20]. Two group homes with four residents each were selected for inclusion along with a Long Term Structured Residence (LTSR), a locked facility that served eight male individuals with SMI with serious and persistent mental illness. The technology installed was a basic vital signs monitoring system including a digital scale, blood pressure cuff and pulse oximeters. The software included with the system allowed data to be sent to an external location and was configured to send alerts when the data collected went outside preconfigured parameters. Planning to expand this

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Project to include the large Delaware County Adult Behavioral Health Outpatient Clinic is currently underway.

V. METHODS

There were several challenges to the selection of the methods to use to collect data on the three Projects. First, the Projects were not a test of the technologies themselves, as it was already known that they worked. Instead, the objective of the Projects was to determine how the selected technologies could be used to enhance the provision of care, while at the same time curtailing the cost of that care. Thus, the methods had to capture specific data on various components of care delivery. This entailed collecting data on the staff at each of the sites, both the way they used the technologies and their level of acceptance and willingness to change how they did their jobs. Data also had to be collected on the level of acceptance of the technologies by individuals at each of the sites. If individuals were uncomfortable with the use of the new technologies it would not be possible to roll out the technologies to other facilities. Secondly, although ideally the same methods of data collection would be used at each of the sites, this proved impossible because of the differences in the nature of the sites and the care models employed.

A. Communication Technologies Project

The main challenge was to develop questions that could be answered by individuals with disabilities and would, at the same time, provide the data necessary on which to make future decisions [21] [22]. Achieving these twin goals necessitated the development of a project-specific questionnaire for the CTP, which included simple straightforward questions and took no more than 15 minutes to administer. The questions asked included:

- Which of the following electronic devices do you use to communicate with friends, family or other people?
- How much help do you need to use these devices?
- When you want to communicate with friends, family or other people, how often is the device available?
- What devices do you use to play games or watch movies?
- How much help do you need to use these devices to play games or watch movies?
- When you want to play games or watch movies, how often is the device available?

The main goal of asking these questions was to determine the amount of change that took place in both device use and amount of help needed by individuals with disabilities during the length of the Project. Staff was trained to administer the questionnaire to individuals with disabilities at each of the sites with the goal being that the same staff member at each of the sites would administer the questionnaire at initiation of the Project and at three, six and 12 month intervals. However, this proved not to be possible because of the high rate of staff turnover. The staff questionnaire was self-administered and, similar to the questionnaire for individuals with disabilities, was repeated at three, six and 12 month intervals. The GDS was administered by staff members at the inception of the Project and six and 12 month intervals. Once again, staff turnover prevented the same staff member from administering the Scale at each of the intervals.

B. Smarthome Project

The methods used for the SHP were closely matched to those used for the CTP: Project specific questionnaires were given to the residents at the initiation of the Project and three, six and 12 month intervals; likewise the GDS was administered at the initiation of the Project and six and 12 month intervals. Questions focused on the ability of the residents to undertake basic tasks within the home, e.g., meal preparation, putting away groceries, controlling the lighting and blinds in their rooms, using computers and other electronic devices, using email to communicate with family and friends. Thus, it was possible to determine changes in both the residents' ability to use the new technologies and the impact on the technology of residents' well-being.

C. Biometric Project

The methods employed for the BMP, to a large extent, mirrored those for the other two Projects with a couple of exceptions. Staff was surveyed at the beginning of the Project and after six and 12 months. Questions for the staff focused on:

- The comfort level of staff members in the use of the biometric devices;
- The reliability of the devices;
- The acceptance of the devices by individuals with disabilities; and
- The perceived change in the quality of care with the use of the biometric devices;

Similarly residents at the three facilities were administered questionnaires and the GDS at the inception of the Project and at six and 12 month intervals. In addition to these instruments, event and error forms were developed for use. The event forms were used to record each event triggered by a biomedical alert, the actions taken by staff in response to the event and the outcome, e.g., a visit by a nurse, emergency room visit or hospitalization. The error forms were used to record problems with the various devices comprising the vital signs array, steps taken to correct the problem, the potential risk to the health/safety of the residents and how the problem was resolved.

D. Limitations of the Methods

There were several factors which limited the effectiveness of the data collection and the quality of the data. First, as stated previously, the fact that individuals at all the sites had either developmental and intellectual disabilities or were diagnosed with severe mental illness limited, to a certain

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extent, the type of questions that could be asked and often required prompting by the staff member administering the instrument Secondly, although not optimal from a research perspective, given the scope of the three Projects, it was necessary for staff to administer the questionnaires and GDS. These staff members were para-professional whose main responsibility was not research, but instead, was the delivery of care. In addition, staff turnover was also an issue because in many cases the same staff member was not available to re-administer the questionnaires and scales at the designated intervals. Finally, and perhaps most importantly, the Projects were not research per se, but a real world evaluation of the effectiveness of technology within challenging care models. In other words, the information collected was that which could help NHS determine whether the technology installed in the sites should be rolled out to other facilities, rather than what would necessarily be collected in a controlled research project.

VI. PRELIMINARY FINDINGS

At this stage, the findings from all three Projects are preliminary and some are more preliminary than others. The CTP started before the other two Projects and as a result the data collected is more complete and comprehensive. However, there is sufficient data from the other two to allow for initial analysis that can provide useful information to NHS on what works and what doesn't and to allow informed decisions about the future use of technology within the organization. Data collection will continue at all three Projects until, at least, September 2016. CTP eHealth technologies were installed at three additional sites in August 2015 and data will be collected at these three sites, at least, through September 2016. At this time, a comparative analysis of data from all sites will be undertaken and a decision whether to continue data collection will be made. There are preliminary plans to include an outpatient clinic as part of the BMP, but delays in finding an eHealth technology that would allow the collection and integration of vital signs information has put the project on hold.

A. Community Technology Project

As stated in the previous section, data were collected on both individuals with disabilities and staff at the five group homes and two day programs: questionnaires and the GDS for the individuals with disabilities; and questionnaires for the staff. In order to track changes in the activities and well-being of the individuals with disabilities, questionnaires were administered at the initiation of the Project and at three, six and 12 month intervals. The findings from a comparison of the data collected from these four sets of questionnaires are, from an organization perspective, very encouraging. Questions were asked about the use of electronic devices, both the number of devices used and the purpose for the use of the device. Answers to these questions showed a distinct pattern of the increase in both device use and the number and type of applications used. Sixteen of the 35 individuals (44%) for which data on all four sets of questionnaires are available were using more devices after 12 months than at the initiation of the Project, while fifteen (43%) were using more applications than in the prior 12 months. For the majority of individuals, the added device was a laptop that was made available in their residences. The pattern that emerged was quite clear. Individuals learned to use new applications on the desk-top computers at the day programs and then used the applications on the laptop when they returned to their residences.

The findings for the amount of help that individuals required to use the new devices and applications are a bit more complicated to interpret. The raw findings are: 2 (6%) of the individuals did not need help throughout the twelve months; 11 (31%) of them had no change in the level of help needed to access the devices and applications; 12 (34%) increased the level of help needed to access the devices and applications; and 10 (29%) decreased the level of help needed to access the devices and applications. These data are confusing enough, but in addition, there is no distinct relationship between the individuals who increased their use of devices and applications and the need for help. The amount of staff time required to train staff in the use of the technologies and to help individuals with new devices and application is a key factor in the decision to expand this Project to other facilities and therefore, having more usable findings is extremely important. As a result, a better way of measuring the level of help needed by individuals is being considered for use in the newer sites that have been added to the CTP.

Similarly, the findings from the GDS are ambivalent. Although there is a slight overall decrease in the number of answers that reflect a depressive state for over one-third of the individuals with disabilities, there is no apparent relationship between an increase in the use of devices and applications and a decrease in a depressive state. Once again, a better way of measuring the change in wellbeing is being sought.

Although the main conclusion that can be drawn from the three staff surveys is that the staff believes strongly that the technologies introduced have been greatly beneficial, the findings did expose some problems. A full quarter of staff believed that the technology was not useful for all individuals with disabilities. In particular, those individuals who had problems with reading grew frustrated when attempting to use the various applications. Secondly, almost half of staff reported that there were problems with the applications periodically crashing and/or having difficulty in getting the applications to work properly. However, the data did indicate that over time, the technological problems decreased significantly. Finally, the data confirmed the high rate of staff turnover, as only 12 of the 50 staff who completed at least one survey completed all three. In fact, an equal number—12—of staff completed only the last survey as those who had completed all three. Although staff turnover is a major issue with providing care for IDD and SMI populations (see the Introduction), such turnover will increase the costs of rolling out the technologies to other facilities.

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B. Smarthome Project

There were no problems with data collection for the SHP. All four individuals with disabilities completed the three questionnaires and GDS administered upon initiation and three, six and 12 months into the Project. Nevertheless, the simple fact that there were only four residents in the study does limit the ability to generalize and reach firm conclusions about the wisdom of expanding the Project to other facilities.

The findings are largely positive as three out of the four residents expressed that over the twelve months of the Project their level of independence had increased: three out of the four residents expressed an increase in the ability to operate blinds and lights without help; two out of the four residents expressed an increase in the ability to undertake chores in the kitchen without help; and one out of the four residents recorded a greater ability to communicate with family. Answers on the GDS indicated that two of the four residents experienced a slight decrease in their level of depression. Staff also filled out the GDS for the residents and once again, it appeared that the same two residents experienced a decline in their level of depression.

In addition to the quantitative data collected, more informal interviews with both residents and staff revealed a very high level of satisfaction with the modifications made in the residence and the addition of the Smart TV, iPads and remote controls for blinds and lights. In particular, staff indicated that the mood of the residents had become more positive and that residents are much more active in the kitchen and taking pride in their increased independence.

C. Biometric Project

The findings for the BMP are the most preliminary of the three Projects, primarily because of equipment issues that delayed its start. Nevertheless, there are sufficient data to draw some conclusions that can be used as the Project is expanded to other facilities. For this analysis the two residential facilities serving IDD residents will be lumped together, while the findings for the LTSR are presented separately.

Staff surveys at the two IDD facilities showed that at the beginning of the Project over one-half of the staff did not know how to use at least one of the devices that was being installed. However, by the six month mark, all but one staff member, not only could use all of the devices, but were comfortable using them. The six month survey also indicated that, overall, staff were very positive about the use of the biometric equipment: a clear majority believed that care had improved with the use of the equipment; and all staff believed that residents had accepted the use of the equipment and were comfortable with its use. Over the first six months of the Project, there were 10 instances when one or more vital sign reading was beyond the safe range. In seven cases, a physician was contacted and in three cases, a nurse was contacted. Although in none of these cases was hospitalization necessary, four residents were put on outpatient observation in order to more carefully track their vital signs.

The only negative finding was the number of problems with the equipment recorded in 32 error logs. Just over 50% of the errors were a failure of the data to upload from the device to the iPad, which was used to record and forward the data to the nursing staff. In one-third of the error logs, the problem was with the devices not actually recording any data, e.g., the blood pressure cuff not indicating a reading. These findings have led to a reevaluation of the vital signs system being used.

All staff at the LTSR, when surveyed, expressed a high level of familiarity with all equipment used in the Project, both at the inception and six months later. Eight of the nine staff reported that the residents were comfortable with the use of the vital signs array, but one-third reported that the equipment was not as reliable as they would have liked. This unreliability was reflected in the nine error reports that indicated both problems with uploading data and the blood pressure and oximeter cuffs not generating a reading. Finally, there were eight events when one or more vital sign reading was beyond the safe range. In four of the cases, the nurse was contacted and the resident more closely monitored for the next 24 hours.

VII. DISCUSSION

As stated at the beginning of the previous section, the three Projects have been on different timelines with the result being that the extent of data collection and analysis varies. However, there are sufficient findings to reach preliminary conclusions for each of the Projects separately and when combined. In particular, it is possible to determine what has exceeded expectations, what has worked as hoped and what has not worked as well as hoped. Additionally, valuable lessons have been learned that can be used to help move the Projects to the next stage.

A. Successful Implementation

The CTP has been a tremendous success and has far exceeded expectations. The vast majority of individuals embraced the new technology and the applications made available through the Project. These individuals were able, in a relatively short period of time, to use the technology to communicate with family and friends, safely surf the internet in order to pursue their individual interests and to play games and watch movies—none of which they could do on their own before the Project. Although not all individuals at the seven facilities were able to utilize the technology, the vast majority could and they were able, over time, to do so with less and less staff help. Staff was equally pleased with the introduction of the technology and consistently reported that individuals were happy with their increased independence.

The SHP also exceeded expectations. Even though the numbers of residents impacted by the introduction was small, four, the findings clearly show that they benefitted from having the new technologies. Their independence increased over the duration of the Project because they were able to undertake tasks that they could not accomplish prior to the introduction of the new technology. The simple ability to control the lights and blinds in their own rooms, not only

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increased their level of independence, but staff reported that the residents' mood became increasingly positive over time.

B. Meeting Implementation Objectives

Although the BMP did not exceed expectations, it certainly succeeded in meeting the objectives set out at the beginning of the Project. The vital signs system is able to record, upload and send data to an external location as was hoped. In addition, the system was able to determine when readings are outside established norms and this information was used at all locations to take action, e.g., notify nurses, inform physicians. It is too early to determine if the use of the technology has reduced emergency room visits and hospitalizations, but staff believe that the system is able to allow more timely care and, as a result, the well-being of individuals has increased.

C. Hardware and Software Problems

Even though the CTP far exceeded expectation, there have been some issues surrounding the reliability of both the hardware and applications used. Most of these problems have been resolved during the course of the Project, but some problems still linger. The biggest issue with the technology occurred in the BMP. The number of error reports filed at the three facilities, confirm the overall impression that a different vital signs system needs to be used as the Project moves forward. The encouraging conclusion is that, even with the problems with the technology, the results were sufficiently encouraging to plan for the Project's expansion.

D. What Has Been Learned

In the last three and one-half years, many lessons have been learned about the process of incorporating new technologies into NHS's various care models. Some are more important than others, but some are absolutely essential to rolling out the technologies to additional facilities. Among the most important are: detailed planning is indispensable; there must be buy-in at all levels—board, ceo, upper administration, management and line personnel; one technology must be working before the next one is introduced; and everything takes longer than originally thought.

In the early stages of the Project, many individuals at NHS believed that things were moving too slowly; they were anxious to "get-on-with-it". This urge to move quickly is natural, especially from individuals who have been recruited because they are enthusiastic about the introduction of new technologies. Nevertheless, taking the time to plan every step of the Project was vital to success. Even with careful planning, mistakes were made and problems encountered. Likewise, there must be buy-in at every level of the organization and this also takes time. Without buy-in and commitment, there is the tendency to "cut the losses" when problems arise. The buy-in of the NHS Board, CEO and upper administrators was key to the continuation of the Project when things went wrong.

The incremental approach to the introduction of the technologies also proved to be a wise decision. Once again, there was a push to introduce "everything" at once, but the plan to make sure that one technology worked before installing a second, allowed staff and individuals with disabilities and severe mental illness to adjust to the first change before a second was introduced. Finally, although initially people involved with the Project were confident that the timeline for their slow and cautious approach was realistic, as the three Projects got underway there was a realization that the amount of time necessary to get 11 different sites up and running was going to take longer than anyone had anticipated. Fortunately, the fact that there was total buy-in at all levels of the organization allowed the Projects to proceed at the slower pace required.

VIII. CONCLUSION

When the Assistive Technology Project was being planned in 2012 there were doubts whether, because of its scale and complexity, it could achieve its objectives. Even as the first technologies were being installed and problems emerged, there were concerns that trying to evaluate three distinct technologies in 11 locations was just too ambitious. However, the Project leadership persevered and by the end of 2015, it is impossible to conclude otherwise than that the Project has been a success.

A. Improvements for Next Stage

Based on an analysis of the results from the three Projects, several adjustments have been made to both the technologies employed and the implementation protocols. First, continual problems with the biometric instruments have led to a search for more robust products from companies that offer greater technical support. Similarly, dissatisfaction on the part of staff and individuals with disabilities with several products in the SHP has resulted in the selection of more sophisticated equipment that incorporates more sensor technology. Third, results have indicated the greatest degree of success at the day centers. As a result, the plans are to include a greater number of these centers and fewer group homes in the next phase of the project. Finally, because the use of the GDS did not produce the level of meaningful information as anticipated, it's been replaced by satisfaction scales.

B. Expansion

The best measure of this success is that NHS has made the decision to extend all three technologies to additional locations. The CTP has already been expanded to three new locations bringing the total number of participants to just under 200 and there are plans to include more facilities during 2016. NHS is also working with AbleLink to develop new applications specifically targeting the IDD population, as well as working to refine and enhance existing applications. As indicated previously, the Delaware County Adult Behavioral Health Outpatient Clinic will be added to the BMP in the

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summer of 2016. The complexity of incorporating vital signs monitoring into an outpatient clinic is, from NHS's perspective, outweighed by the opportunity to effectively offer psychiatric services, primary care physicians and pharmacy services in one location along with an integrated medical record. If successful, there are plans to extend the BMP to other outpatient locations.

Perhaps the most significant indication of the success of the overall Project is that there are plans to build, ground up, a new facility in Western Pennsylvania which will include technologies from all three Projects. This $650,000 residence will house six individuals and incorporate the green appliances, design features—lower sinks and cabinets—and remote control features from the SHP, with the AbleLink applications from the CTP and the vital signs array from the BMP. It is hoped that this new facility will be the model for the necessary replenishment of the aging housing stock that is currently in use.

C. Financial Model

From the inception, one of the key components of the Project was to construct a financial model that would allow NHS to be reimbursed for the care delivered by the use of the new technologies. The Project itself, costing over $200,000 in real money and much more when the amount of staff time expended is included, has been financed by grants. Although grant funding is absolutely satisfactory for a project whose goal is to evaluate the appropriateness of new technologies in the delivery of care, it is not a satisfactory means for developing a sustainable financial model. A sustainable financial model can only exist if the care delivered with the use of the new technologies is reimburseable by Medicare (the health insurance program for people in the United States who are 65 or older. Medicare Part B covers certain doctors' services, outpatient care, medical supplies, and preventive services.) and, especially, Medicaid (the U.S. government program, financed by federal, state, and local funds, of hospitalization and medical insurance for low income persons of all ages.) as billable services. The problem is that, currently, most of the care delivered in the three Projects is not billable and thus, not reimburseable, but this is changing. Virginia and Pennsylvania have granted Medicaid waivers that could allow reimbursement for care delivered with the new technologies as soon as mid-2016. Individuals from NHS are presently developing proposals for both states that would allow the services to be reimburseable.

If the three Projects have done nothing else, they have confirmed that the use of technology to aid in the delivery of care to individuals with IDD and SMI is inevitable. The increasing numbers, along with the aging of the IDD and SMI populations, is increasing the cost of care exponentially at the same time as the number of people available to deliver the care is stagnating. The only way to maintain, let alone enhance, the level of care to these populations is through the innovative use of technology and the only way to make this happen is to develop a means of reimbursing this care. This must and will occur; the only question remaining is when?

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