Impact case study (REF3)

REF2021

Institution: Ulster University

Unit of Assessment: Computer Science and Informatics (11)

Title of case study: ICS4 The translation of digital reminding solutions into connected health products for caregivers

Period when the underpinning research was undertaken: 2000 - 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof Chris Nugent	Prof in Biomedical Engineering	1998 - Present
Dr Ian Cleland	Lecturer in Data Analytics	2012 - Present
Prof Cristiano Paggetti	Prof in Digital Health	2020 - Present
Dr Jonathan Synnott	Research Fellow	2013 - Present

Period when the claimed impact occurred: 2014 - 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Ulster's research in reminding solutions has contributed novel findings in medication management workflow, mobile-based video reminders for people with dementia and online training platforms for caregivers. This research underpins the following impacts:

I1 – Internet based product for managing the logging and dispensing of medication leading to 8 jobs, uptake by 150 users across 5 care homes and annual revenue of GBP1,200,000.

I2 – Online training platform for carers of people with dementia with 80 individual licences and 13 group sales in 6 EU countries.

I3 – Establishment of new policy guidelines for 45,000 Social Care Council staff in Northern Ireland and impacting the life and health sciences sector in Northern Ireland.

2. Underpinning research

The increase in the number of people suffering from long term health conditions coupled with the rapid decline in the working population has led to predictions of a decrease in the number of healthcare professionals who will be available to offer healthcare provision in the future. Taking this into consideration, new models of care delivery are required, in addition to the up-skilling of untrained informal caregivers and volunteers who will be expected to deliver healthcare, in order to ensure that a continuum of care is provided to those in need.

Research led by Nugent within the Pervasive Computing Research Centre (PCRC) has had a focus on developing solutions to support stakeholders within a Connected Health environment for over 20 years. The research and main application areas have related to reminding technologies for medication management and supporting people with dementia and their caregivers which are linked to research **R1-R6,** linked to impacts **I1-I3** and evidenced in **[C1-C7]**.

R1-R2 Reminding technologies for medication management
The initial work in this area stemmed from the EU FP5 MEDICATE Project (2000-2004), where Ulster were Project co-ordinators. The MEDICATE Project assessed stakeholder needs in the process of reminding technologies and established an Internet-based care model to support all those involved in the supply-to-intake chain of personal medication management [**R1**]. The MEDICATE solution was subsequently extended to a mobile-based reminding application which

inspired the concept of video-based reminders for persons with dementia [**R2**]. Through over 400 days of evaluations, the results from this research demonstrated the utility of the solution from both caregiver and patient perspectives. Two key areas were identified for future work: improving education for stakeholders using the technology, and challenges with technology adoption.

R3-R4 - Training for both formal and informal caregivers of persons with dementia
Involvement in the EU LLP STAR Project (2010-2014) permitted the PCRC to investigate the most appropriate digital strategies to support training for both formal and informal caregivers of persons with dementia (Nugent and Paggetti). A multilingual e-learning tool was designed and developed, taking into consideration varying levels of training content, gamification and user interaction strategies for engagement. The portal was evaluated in a randomized controlled trial with both informal caregivers and professional caregivers (n=142) in the Netherlands and the UK over a period of 4 months. The results demonstrated a significant positive impact of the STAR training course on maintaining feelings of empathy among informal caregivers and volunteers. It was also found that for professional caregivers, there was an improvement in empathy amongst those who followed the course. In terms of usefulness and user friendliness, the tool was rated positively by all user groups [**R3**].

Research within the EU MSCA REMIND Project (2017-2020), for which the PCRC are the project co-ordinators (Nugent and Cleland), has permitted work to continue on how reminding technologies can be embedded within smart environments. This research has led to training initiatives for caregivers [**R4**] (Synnott and Nugent) in addition to the delivery of 4 annual summer schools for early career researchers [**C4**] (Nugent, Paggetti and Cleland).

R5-R6 – Technology adoption models for persons with dementia
To assist with engagement strategies and technology adoption, research was undertaken to develop a suite of technology adoption models [**R5**] (Nugent and Cleland). Such models have been developed to predict the likelihood of a person with dementia adopting the technology. This work has been further extended to produce a set of recommendations to assist in the update of technology-based solutions both for persons with dementia and their caregivers [**R6**].

3. References to the research

[**R1**] CD Nugent, D Finlay, RJ Davies, MD Mulvenna, JG Wallace, C Paggetti, E Tamburini, ND Black (2007). The Next Generation of Mobile Medication Management Solutions, *International Journal of Electronic Healthcare*, vol. 3, no. 1, pp. 7-31.
[**R2**] MP Donnelly, CD Nugent, S Mason, SI McClean, BW Scotney, AP Passmore & D Craig (2010). A Mobile Multimedia Technology to Aid Those with Alzheimer's Disease. *IEEE Multimedia*, 17 (2), 42-51. doi: 10.1109/MMUL.2010.25
[**R3**] B Hattink, F Meiland, H van der Roest, P Kevern, F Abiuso, J Bengtsson, A Giuliano, A Duca, J Sanders, F Basnett, C Nugent, Paul K, R-M Dröes (2015). Web-Based STAR E-Learning Course Increases Empathy and Understanding in Dementia Caregivers: Results from a Randomized Controlled Trial in the Netherlands and the United Kingdom, *Journal of Medical Internet Research* (http://www.jmir.org), 30.10.2015.
[**R4**] J Synnott, M Harkin, B Horgan, A McKeown, D Hamilton, D McAllister, C Trainor, CD Nugent, The Digital Skills, Experiences and Attitudes of the Northern Ireland Social Care Workforce towards Technology for Learning and Development: Survey Study, (2020) *JMIR Medical Education*, vol. 6, no. 2. doi: 10.2196/15936
[**R5**] P Chaurasia, SI McClean, CD Nugent, I Cleland, S Zhang, M Donnelly, B Scotney, C Sanders, K Smith, M Norton, J Tschanz (2016). Modelling Assistive Technology Adoption for People with Dementia, *IEEE Journal of Biomedical and Health Informatics*, vol. 63, pp. 235-24.
[**R6**] J. M. Robillard, I. Cleland, J. Hoey, CD Nugent (2018). Ethical adoption: A new imperative in the development of technology for dementia, *Alzheimer's and Dementia*, vol. 14, no. 9, pp. 1104-113.

[**R1- R6**] have been subject to peer review by internationally based editorial boards.
Grants:

- MEDICATE: The control, Identification and Delivery of Prescribed Medication, EU FP5 (IST-2000-27618) GBP417,267 (to Ulster), (Black, Nugent) Nov 2001 – Jan 2006
- STAR: Skills Training and Re-Skilling for Carers of People with Dementia, CEC - Leonardo da Vinci, GBP37,900, (Nugent, Liu, Donnelly, Wang) Dec 2010 - Feb 2014.
- TAUT: Technology Adoption and Prediction Tools for Everyday Technologies, Alzheimer's Association (ETAC-12-242841), GBP128,205 (to Ulster), (Nugent, Donnelly, Scotney, McClean) Nov 2012 - Oct 2015.
- REMIND: The use of computational techniques to improve compliance to reminders within smart environments, CEC-H2020-MSCA-RISE, GBP192,439. (Nugent, Charles, Cleland, Galway, Donnelly, McCullagh, Zhang, Morrow) Jan 2017 - Dec 2020.

4. Details of the impact

I1 Internet-based product for managing the logging and dispensing of medication leading to 8 jobs, uptake by 150 users across 5 care homes and annual revenue of GBP1,200,000. [R1, R2, R5]

███████, a pharmacy automation business based in ████████, Northern Ireland (NI), has taken the findings from our research and created a new internet-based product for the management of their medication provision in care home settings. In 2016 the company wished to expand its operations into the domiciliary care market, but did not have the experience nor the technology expertise to do so [**C1**]. Through its engagement with the PCRC, the research findings and workflow management through an internet care model from the MEDICATE Project [**R1**] and mobile medication solution [**R2**] were used to create the design of a new mobile internet-based solution for tracking and managing medication sachets within care home settings. Findings from the digitisation of workflow management in the medication process [**R1, R2**] in addition to approaches to improve technology adoption [**R5**] were incorporated into the solution. ███████ subsequently leveraged funding to realise the product and in 2019 launched its new product offering, ████████. This is now being used in 5 care homes across NI to support approximately 150 users. Since engaging with PCRC, ███████ has grown its team from █ to █ (representing an increase in headcount of █). The company has since entered a new market of medication management in care homes and has increased its annual revenue from ████████ in 2016 to ████████ in 2020 [**C2**]. Improvements have been found from both patient and healthcare professional perspectives as evidenced in documented testimonials [**C7**]. The manager of Inspire Supported Living Care Home said that in using the automated processes of ████████ "*it is a simplistic system*" which has "*drastically reduced our timeframe*" for managing medication within the care home [**C7**]. Families using the solution have advocated that it assists with managing complex medication regimes and that "*there is absolutely no confusion as to what that medication is*". Users of the solution who previously had been challenged with the complexity of their medication regime have reported that "*it has given me peace of mind*" [**C7**].

I2 Online training platform for carers of people with dementia with 80 individual licences and 13 group sales in 6 EU countries. [R3]

Through involvement in the EU STAR Project and evaluation of the findings from the randomised control trial conducted by the consortium [**R3**], PCRC joined with members of the consortium to develop a multi-lingual online training portal, the 'STAR Training Portal'. Since 2015, the portal has generated 13 group sales and 80 individual licences in 6 EU countries UK, Netherlands, Romania, Italy, Malta and Sweden. The ambition was to deliver a low cost and affordable solution to support carers of people with dementia (EUR25 per user). Profits are split between partners within the original STAR consortium on a pro-rata basis aligned with the original Project funding and in accordance with a Joint Ownership and Collaboration Agreement [**C3**].

I3 Establishment of new policy guidelines for 45,000 Social Care Council staff in Northern Ireland and impacting the life and health sciences sector in Northern Ireland. [**R2, R4, R6**]

Through extensive research on caring solutions and technology driven care models the PCRC has engaged with a number of agencies and initiatives to deliver impact across a broad range of care based training, policy development and advisory initiatives that have informed roadmaps for delivering connected health products and services for caregivers including:-

- Northern Ireland Social Care Council (2018-2019)
- Connected Health Summer School (CHSS) (2016-2019)
- International Federation of Ageing
- MATRIX Life and Health Sciences NI
- The Health Innovation Research Alliance Northern Ireland (HIRANI)

The PCRC has worked with the **Northern Ireland Social Care Council** (2018-2019) to assist it in understanding and developing its digital capability for its 45,000 registered staff who deliver social work and social care services in Northern Ireland [**C5**]. The development of the council's digital skills for social care strategy has been based on the collection and analysis of staff feedback undertaken by PCRC [**R4**][**C6**]. This has resulted in an increase of 50% in users engaging with the council's online learning zone for the promotion of technology within the workplace [**C5**].

The PCRC has raised awareness of the use of technology for reminding purposes, to support persons with dementia and in general healthcare provision in a number of settings [**R2, R6**]. Through the **Connected Health Summer School (CHSS)**, which annually presents the research results from the REMIND consortium, the PCRC has co-organised and delivered the event over the last 4 years (2016-2019) to technologists, clinicians and industry practitioners [**C4**]. In a post event assessment to determine the benefits of the CHSS, all respondents stated that the summer school would have an impact on their future careers; and, that improvements in knowledge across technical, health and business domains were achieved [**C4**]. One industry participant stated the "*summer school has been an amazing experience. Both from a personal and from a professional development perspective. The direct contact with the problem owners offers a clear and full perspective of their needs and wishes. It also allows for direct, well-nuanced feedback of any solution direction that is being considered. The offer of both technical and health care oriented sessions show the full breadth of the potential solutions, allowing participants to look beyond their own discipline. Professionally, I have benefited greatly in my development. Hoping to contribute to the medical technology field, I am now organizing a boot camp in the Medical Device Regulation (MDR) for the second year in a row. In this boot camp, we bring medical technology companies, start-ups and students together to test specific use cases for compliance with the MDR.*"

Based on a general appreciation for the expertise acquired by the PCRC from research in the area of technology-based solutions for care provision, Prof Nugent was invited to join a panel of technology experts by the **International Federation of Ageing** to produce the 'Reablement and Older People' guidelines for the design and implementation of technology driven care models [**C8**].

Prof Nugent was also invited to join the MATRIX Northern Ireland Science Industry Panel, a business led expert panel, formed primarily to advise government, industry and academia on the commercial exploitation of R&D and science and technology in Northern Ireland. The Chair of the MATRIX Panel stated that Prof Nugent was appointed to the panel "*based on his research and academic track record and that he was a valuable member of the panel and that his research helped to inform the content of the report and shaped the recommendations*" [**C9**]. The expert panel published the **MATRIX Life and Health Sciences NI** 'Capability Assessment and Foresight Report' in 2015. MATRIX commissions research, analysis and studies to build an evidence base for future science and R&D policies in Northern Ireland. One of its objectives is

to 'identify, agree and oversee a programme of market led science and technology Foresight studies'. The report outlined recommendations to government highlighting the need (amongst others) for the further training of healthcare professionals and in terms of clear leadership and co-ordination the report highlighted *"the importance of building a committed, visible leadership and co-ordination capability for the sector. A facility whereby decision makers within industry, academia and government meet to make decisions for Northern Ireland would dramatically progress this issue"* **[C9]**. Following recommendations from the report in 2019 Invest Northern Ireland have funded the establishment of **The Health Innovation Research Alliance Northern Ireland (HIRANI)** an alliance of universities, health organisations and other industry bodies, established to drive and support ambitious growth in Northern Ireland's Life & Health Sciences sector. The Chair of the MATRIX Panel stated *"The recommendations from the Matrix report absolutely led to the establishment of HIRANI as a vehicle to coordinate and lead the life and health sciences sector in NI. Moreover, the recommendations also formed the basis of Invest NI's life science sector strategy informing areas of sectoral strength and approaches that might support business growth and expansion in the sector".* Research by the Fraser of Allander Institute in 2020 revealed that the life science sector in Northern Ireland is thriving, supporting 18,000 full-time jobs throughout Northern Ireland.

5. Sources to corroborate the impact

C1: Interview with Senior Pharmacist from ████████.
C2: Testimonial from ████████.
C3: Balance sheets for sales of STAR Training Portal.
C4: Connected Health Summer School Program assessment analysis.
C5: Testimonial from the Director of Registration and Corporate Services of the Northern Ireland Social Care Council.
C6: Technology for Learning and Development Survey, Northern Ireland Social Care Council.
C7: Testimonials from users of ████████.
C8: International Federation of Ageing, Report on Reablement and Older People.
C9: MATRIX Report, Life and Health Sciences Panel, statement from Chair of MATRIX Panel.