



How to Create a Digital Human Health Coach

A focus on co-design as a means to understand health illiteracy and its impact on machine learning

Selected Extracts from Draft eBook

Authors:

Marie Johnson
Managing Director
Centre for Digital Business

Allan Johnson
Patient # 1 Digital Human Cardiac Coach
Centre for Digital Business

Disclaimer

The Centre for Digital Business (Australia) Pty Ltd, its officers and employees, do not guarantee, and accept no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any material contained in this presentation, on any linked or referenced site, or in the supplementary materials posted on GitHub (overall, the 'Information').

We make no representations as to the compliance of the information with the laws, regulations, standards and policies governing health and technology globally or in any jurisdiction.

We recommend you exercise your own skill and care with respect to the use of this information and that you carefully evaluate the accuracy, currency, completeness and relevance of the information for your purposes.

The information is not a substitute for independent professional advice, and you should obtain any appropriate professional advice relevant to your particular circumstances.

The information may include the views or recommendations of third parties, which do not necessarily reflect the views of the Centre for Digital Business or indicate our commitment to a particular course of action.

Photographs contained in the information have been licensed for our use only and cannot be used by any third party.

The Centre for Digital Business is providing the information free of charge for use by organisations developing or researching digital humans for health care.

The Centre for Digital Business reserves the right to be recognized as the creators of the information.

© Centre for Digital Business Pty Ltd (ACN 162 122 072)

1	Introduction.....	1
2	What is a Cardiac Coach?	2
2.1	Human Cardiac Coach	2
2.2	Digital Human Cardiac Coach	3
3	Qualification	4
4	Why Patients Don't Ask their Doctor, Pharmacist or other Health Expert?	4
5	Our Priorities and Conventions	5
5.1	Our Starting Point	5
5.2	Health System vs Patients	6
5.3	Is it for All Patients – and their Families?	6
5.4	Omni-Channel Approach	7
5.5	Broad Objectives	7
5.6	Conversation Conventions.....	8
5.6.1	The Challenge of Medications Conversations.....	8
5.6.2	Lifestyle Conversations	9
5.6.3	Transitional Conversations	9
5.6.4	Exceptions to the Conventions	10
5.6.5	Family and Carers	10
5.6.6	Dean Ornish Program	10
5.7	Applicability to Other Diseases.....	10
5.7.1	Content	10
5.7.2	Language.....	11
5.7.3	Codesign Methodology.....	11
6	Development Notes on Co-Design	11
6.1	Part One: An Introduction to Co-Design	11
6.1.1	“An Introduction to Co-Design” by Ingrid Burkett.....	11
6.1.2	The Western Australian Council of Social Service.	12
6.1.3	NSW Council of Social Services	12
6.2	Part Two: Co-Design and AI Powered Digital Humans.....	13
6.2.1	Human Conversations and Digital Humans ~ Not Just a Pretty Face.....	13
7	Content Development	18
7.1	Content Development Options.....	18
7.2	Automated Creation	18
7.3	Empathy.....	20
7.4	Constrained Domains - Health.....	21

7.5	More on Guided Conversations vs Q&A	21
8	Developing Q&A for the AI Corpus	22
8.1	Where to Start	22
8.2	Sentence Structure Variations	24
8.3	Word Variations (Synonyms)	24
8.4	Other Sources of Variation	26
9	Developing Guided Conversations	27
9.1	General Principles	27
9.2	The Use of Video	27
10	Technology	28
10.1	Starting Point	28
10.2	Can this be SaaS (Software as a Service)	29
11	Operational Model	29
12	Design Guidelines	30
12.1	'Effort' Matrix	30
12.2	Generic Design Principles	32
13	Table of Provided Documents	37

1 Introduction

We have been working towards the Digital Human Cardiac Coach for many years.

My husband Allan first studied expert systems, the predecessors of artificial intelligence, back in the 90s when he was as an aeronautical engineer officer in the Royal Australian Air Force (RAAF). He has extensive international technology experience, including systems integration, consulting and ERP – including in health in Australia and internationally. You will see that he is a qualified fitness instructor, speaker, lecturer and advocate on cardiac rehabilitation and health. He has undergone 4 heart surgeries, including 2 bypass surgeries – all up, 8 cardiac bypass grafts and 4 stents – in surgeries in the US and Australia.

His first open heart surgery was in 2006. Early on he was frustrated by the lack of support for heart patients throughout their journey – in the hospital, during cardiac rehabilitation and afterwards. His first answer to that frustration was to throw himself into volunteerism and self-education.

Eventually he came to realise that there were systemic problems that couldn't be overcome by local action and started searching for ways to overcome the problems of health illiteracy and accessibility.

My own experience covers the public and private sectors in Australia and internationally, in roles including large scale government service delivery operations; leading Microsoft's worldwide public services and egovernment business in Seattle; Chief Information Officer; Chief Technology Architect; and Technology Authority.

My experience included delivering health and human services systems. I have been researching and developing "eBusiness" solutions for decades, culminating in my writing of the technology business case for the National Disability Insurance Agency and then, as Head of the Technology Authority, assembling an amazing team of people with disability and entrepreneurs to create Nadia, the world's first AI powered digital human for service delivery.

In my early career, I worked in intelligence - and so throughout this presentation, you will see reference to "common patterns" – we have combined this intelligence concept with concepts of expert systems Allan developed – and other aspects of our professional and lived experience to develop this digital human body of knowledge for health.

We do our best thinking and talking when walking around Lake Burley Griffin in Canberra and early on we saw the potential for digital humans, as part of an omni-channel approach, to help tackle some of the problems heart patients experience.

Getting to this point has been a lot of hard work. Also, Allan's health is often fragile and there have been many times when he has had to 'down tools' on his part of the project whilst he is in hospital and then recovering. As his carer my focus also has to change during these difficult times.

The current COVID-19 pandemic has prematurely ended the lives of many heart patients; I wrote about this recently ([Telehealth and the Tale of Two Pandemics" in InnovationAus](#)). We would have liked to continue our development work, but we started the project to help others and there is a dire need right now.

Around the world heart patients are being denied cardiac rehabilitation or, at best, offered hastily pulled together telehealth based on video software that patients can't install and health teams can't use. The Digital Human Cardiac Coach can be an important part of the solution.

There has been a massive increase in the number of companies offering avatars and AI, and the big software companies are starting to look at providing integrated solutions. Virtual assistants are being written into government health strategies and are an important consideration for hospitals and insurers.

We hope that we can accelerate this process by democratising the codesigned content we have developed so far to implement in-patient guided conversations and lifetime patient support via integrating guided conversations with a rich AI corpus.

For the first time, this is a body of knowledge that describes a way to address the impact of health illiteracy on machine learning.

Thank you for taking up the challenge.

2 What is a Cardiac Coach?

2.1 Human Cardiac Coach

A Cardiac Coach helps heart patients (often called ‘consumers’) navigate their journey from first ‘at risk’ diagnosis through primary prevention and then heart events, heart surgeries, recovery, rehabilitation and secondary prevention should these be required.

There are currently no lifelong cardiac coaches, that we are aware of, that provide continuous support for heart patients on their heart health journeys. General practitioners, specialists, allied health professionals such as dietitians and exercise physiologists, perform diagnosis and recommend treatments and lifestyle changes. This staccato approach becomes a series of appointments where advice and information are provided to the patient. The gap is the implementation of this advice and information by the heart patient, that occurs between appointments.

A dietitian might advise eating more of certain foods, but many heart patients can’t cook let alone do meal plans. An exercise physiologist might advise doing resistance training alongside walking, but is there a gym nearby? Can the patient afford a personal trainer? Tellingly, a large percentage of heart patients lack the literacy skills required to read and understand the printed information they are given; socio-economic disadvantage and psych-social problems share a larger burden of illiteracy and heart disease.

Perhaps most importantly of all, heart disease impacts the lonely and can create loneliness even in patients with families and friends around them. Men tend to be stoic, and not want to burden those around them with their problems. Women often have to go back to running the household; no time for sharing what is happening to them with friends. Many people simply live alone in big cities or remote areas. The links between heart disease and depression and anxiety are well documented. A cardiac coach understands what the heart patient is dealing with and can show empathy when discussing issues and providing advice and information; a sympathetic and informed listener.

A heart patient could hold conversations with their cardiac coach about what has and is happening to them, about the lifestyle changes they have been told to make, about their progress and failures, about how they are feeling. These conversations can occur whenever the heart patient needs help, at home, when travelling, in fact anywhere and anytime that help is needed.

If only lifelong cardiac coaches actually existed!

There have been various approaches to providing coaching. For example, some health funds and heart interest groups have telephone services that patients can call and there are also patient forums (e.g. British

Heart Foundation) where patients can discuss with each other their concerns and questions. The American Heart Association and others provide moderated patient forums where health professionals answer patient questions.

There are two that have been important in my husband's heart journey that are worth mentioning here.

My husband discovered Dr Dean Ornish's 'Reversing Heart Disease' program in a paperback book not long after this first surgery, a five-way bypass. This became his guide and his subsequent surgeries (four stents and a three-way bypass) were attributed by his surgeons to problems with the endoscopic harvesting of his saphenous vein in 2006, not his lifestyle. In fact, after his three-way bypass in 2017 the surgeon commented that his mammary artery, used as a graft in 2006, was still in pristine condition and that it was the grafts that had collapsed. Dr Ornish's program can be paid for by Medicare and some insurance companies and is offered by some hospitals as an alternative to traditional rehab. We look forward to one day seeing a virtual Dr Ornish offering his program in Australia.

In early 2019 my husband participated in The COACH Program:

The COACH Program is a standardised structured coaching program delivered by highly trained health professionals ("coaches") to people already diagnosed with a chronic disease or who are at high risk of developing chronic disease.

The COACH Program is delivered by telephone and mail-outs over a period of 6 months. The Program is focused on closing the "evidence-practice gap" – the gap between guideline-recommended care and the care patients actually receive.

Developed in Australia in 1995, The COACH Program has been rated the most evidence-based cardiovascular disease prevention program in the world on clinical and cost-effectiveness, by the British Heart Foundation and Public Health England's "International Cardiovascular Disease Prevention case studies report – October 2018".

This amazing program resulted in changes to my husband's medications that should have been advised years ago. Secondly, he made positive changes to all of his risk factors over the course of the program. The cost of the program was covered by our health fund.

Both are fantastic programs in their own way. What we are looking for though is a companion that you meet in hospital and is there every step of the way throughout life.

2.2 Digital Human Cardiac Coach

A Digital Human Cardiac Coach helps heart patients navigate their heart health journeys in an empathic way. It will provide information, education and advice relevant to the various stages of a heart patient's journey. The required materials are contained in a corpus in various formats including dialogues, text, video, and images.

The primary means of communication between the Digital Human Cardiac Coach and the patient is via a 'face to face' conversational dialogue. This conversation can occur on a PC, tablet device or mobile phone. The Digital Human Cardiac Coach can use text, video and images in the corpus to deliver information and education where appropriate to a particular interaction. Conversations can be held in multiple languages where the corpus content has been translated.

An interaction between a Digital Human Cardiac Coach and patient can also be conducted through other channels such as social media (e.g. Twitter, Facebook), telephone and text message. Whilst ‘face to face’ enables full empathic delivery, the use of these other channels can provide fast access to information and answers to questions ‘on the fly’ (e.g. text message when out to dinner with others and not sure if a menu item is suitable).

The Digital Human Cardiac Coach would direct patients to other sources of information and advice where appropriate. For example, the various national heart foundations and associations often offer information, and social interactions such as walking programs and events, that are important to awareness, prevention and recovery. Also, the websites of these foundations are an important part of their fundraising to support heart health research. Similarly, the Digital Human Cardiac Coach could point to third party eating and exercise programs that are suitable for primary prevention. This is an important part of the navigation role of the Digital Human Cardiac Coach.

The Digital Human Cardiac Coach would also directly provide curated and created content that is held in the corpus. Curated content would be provided by arrangement with third party organisations that offer heart health relevant content. This would be supplemented by created content that bridges the gap between what is already available and what is necessary for Digital Human Cardiac Coach service delivery. Created content would, by definition, be developed by the organization delivering the Digital Human Cardiac Coach to heart patients or by the organization developing and managing the Digital Human Cardiac Coach on behalf of that delivery organisation. The various options for sourcing and paying for content such as licensing, subscription and non-financial arrangements will be discussed in the Investment section of this document.

The most important role of the Digital Human Cardiac Coach would be to advise a heart patient to immediately call for paramedics when they are experiencing certain symptoms. People die every day because they experience symptoms but don’t seek medical help.

3 Qualification

The digital human cardiac coach we have developed is not intended for diagnosis and treatment. A digital human could be used for that purpose subject to meeting all of the mandated regulatory and safety requirements.

Wherever appropriate the answers we have developed to critical patient concerns recommend talking to a doctor or pharmacist because we are not doing diagnosis or treatment. This might seem counter intuitive because the popularity of patient forums and research shows that many patients don’t talk to their doctors or pharmacists. The following section explains.

4 Why Patients Don’t Ask their Doctor, Pharmacist or other Health Expert?

The answer to this question was derived from own research and experience, published research, polling health students and various seminars and conferences. The major reasons identified include:

- Health illiteracy including not knowing to ask
- Accessibility issues including cost, location, physical disability, psycho-social disability
- Language
- Gender

- Fear of bad news
- Hope that things will resolve by themselves
- Lack of trust in health system
- Lack of trust in individual practitioners
- Lack of empathic delivery by practitioners
- Difficulty in getting appointments
- Don't want to hear the answer (e.g. you can't drink when on this med)
- Peer or family pressure
- Fear of consequence (e.g. lose life insurance, can't drive etc)
- Anonymity
- Embarrassment
- Cultural mores

Interestingly, in many countries, patients can walk into a pharmacy without an appointment and ask questions about their medications for no cost and yet medication questions are one of the most common on patient forums.

Peer reviewed research by SimCoach found that the anonymity of talking to a virtual assistant increased rapport leading to trust and increased disclosure. SimCoach also addresses many of the other barriers listed above and has been found to be highly effective.

This is why psychologist input to codesign is critical. Multiple interactions with the digital human cardiac coach on concerns and questions that can be directly answered will build rapport and trust so that when the digital human cardiac coach says 'go see your doctor or pharmacist' its recommendations might be more compelling.

5 Our Priorities and Conventions

5.1 Our Starting Point

Cardiac rehab varies across the world in terms of scope, length, delivery approach and so on but there are strong core similarities. In general, rehab includes education sessions on:

- Understanding of heart conditions and the surgeries (where relevant)
- Medications
- Nutrition
- Exercise
- Stress management (including relaxation and sleep)
- Quitting smoking

These also form an important part of primary and secondary prevention of heart disease. Rehab also includes a supervised exercise program.

Peer reviewed research has shown that attendance at a cardiac rehabilitation program improves patient outcomes. This makes sense because many patients are ignorant of the essential components of prevention.

Poor medication adherence is a global issue that adversely impacts recovery and secondary prevention and we have made that one of our priorities. Anecdotally, medications are like the seat belts and air bags in a

car. They can save a bad drivers life. Similarly, a heart patient that doesn't always adhere to the exercise and nutrition recommendations has at least some coverage from their meds if taken.

Leaving hospital (discharge) has a big impact on patient outcomes simply because of the high risks in the early days following a heart surgery or event. Getting home safely from hospital, safety in the home, care in the home, wound care and so on are critical in the early days of recovery.

Finally, heart failure patients have specific risks that require management. Fluid management is one of those.

We have focussed our development efforts on these four Themes because of their importance to early patient outcomes and because of their financial impact on hospitals (especially in the USA) in terms of ACA readmission penalties and patient litigation. All of the other things are important, but this was our starting point.

5.2 Health System vs Patients

We have spoken and written many times about a fundamental problem with patient use of technology and it doesn't matter if it is a website, app, virtual world or virtual assistant. Patients, especially if health illiterate, don't know what they don't know.

This doesn't diminish the value of Q&A using an AI corpus; patients have lots of questions. A lot of our research has been finding these questions and their common threads so as to develop answers. What more could a patient want? I have a question and I can get it answered now, for free, and can understand the answer.

The health system also benefits from Q&A. Staff are diverted from primary duties to answer the same patient questions over and over and over. This results in staff burnout and reduced staff utilisation. My husband once asked the ward orderly wheeling him to radiology what was going to happen. The orderly, a very large Pacific Islander good naturedly told my husband that if he knew the answer to that he'd be making a doctor's salary! They spent the rest of the journey talking about football.

Every patient is different, and there are batteries of tests to build up individual patient profiles to maximise treatment effectiveness and minimise medical risk. But where is the effort to truly understand a patient's health risk when they return home. Will they take their medications? Will they eat the right foods? Will they exercise? Cardiac rehabilitation aims to address these questions and peer reviewed research has shown that it is effective. But around the world the majority of patients do not attend cardiac rehabilitation.

We developed some simple guided conversations to start winding back this problem by:

- Assessing each patient's key risks before they get to discharge (we call this ASK)
- Providing some early education before patient discharge (we call this TELL).

A patient (or their carer) can have a few simple and short guided conversations (preferably before surgery) with the Digital Human Cardiac Coach and hospital review of the transcripts can identify priorities for each patient; what are their risks, what will they need help with, do they need more information?

5.3 Is it for All Patients – and their Families?

Simple answer, no:

- Some patients enter the hospital system as an emergency and following surgery are unable to interact with a digital human.
- Some patients cannot use technology or are uncomfortable with it.
- Some patients can't afford any form of technology after discharge.
- Some patients live on the street.

As we said at the start the approach needs to be omni-channel. By diverting patients that are comfortable with technology into this channel we free up face to face human interaction for those that require this deeper level of care.

Of course, many patients can be supported in using technology by family members and this needs to be a design consideration.

5.4 Omni-Channel Approach

The guided conversations and Q&A are intended to be omni-channel.

For example, they could be run:

- by a chat bot on a website,
- on an app as a text conversation,
- in a virtual world environment
- by a digital human or other virtual assistant.

Interestingly, there is nothing to prevent them being used face to face. For example, in the absence of technology the guided conversation on leaving hospital could be between a hospital staff member and a patient.

This brings up an important point. The various channels, face to face included, address various accessibility barriers but do not inherently address health illiteracy. It is codesign, not channel technologies, that creates content that can be understood by health illiterate patients.

5.5 Broad Objectives

Guided conversations and Q&A exist for all three phases of a patient's admission to secondary prevention journey with the following broad objectives:

- Inpatient:
 - assist risk assessment of patients prior to discharge
 - inform discharge planning
 - assist patient education
 - reduce hospital staff workload answering repetitive patient questions
 - encourage patient participation in cardiac rehabilitation
- Outpatient:
 - support cardiac rehabilitation patient education
 - encourage patients to continue cardiac rehabilitation when the face barriers to participation
 - reduce rehab staff workload answering repetitive patient questions
- Home:
 - repeat inpatient conversations for reinforcement
 - provide structured responses to patient concerns and questions

- adherence to treatments, therapies and medications

Achieving these objectives – risk assessment, education, participation and compliance – contributes to health system business objectives of improving patient health outcomes including reducing patient readmissions and reducing costs.

5.6 Conversation Conventions

We have adopted three broad classes of conversations to facilitate creation and review by the appropriately qualified and skilled authorities:

1. Therapeutic - we define therapeutic conversations as those that cover treatment, therapy or medications and are tightly managed from a medical standpoint.
2. Lifestyle – we define lifestyle conversations as those that cover advice and activities that, whilst important to recovery and secondary prevention, are managed by the broader health and wellness professional community.
3. Transitional – we define transitional conversations as those that cover advice and activities that start out as therapeutic but that, following recovery, become lifestyle conversations.

All of the conversations we have identified under the various Themes and Topics we have developed for the digital human cardiac coach fall into one of these classifications.

5.6.1 The Challenge of Medications Conversations

Medications adherence is a huge problem for heart patients and many of the questions on patient forums are about medications; we need to address this need. However, medications are firmly part of ‘diagnosis and treatment’ and we have positioned the digital human cardiac coach as just that, a coach, and not a doctor.

The following describes how we have balanced these two objectives.

When deciding how to classify a conversation we have erred on the side of caution. For example, conversations on how to remember to take medications and travelling with medications could be classed as ‘lifestyle’ but, given the massive global problem with medication adherence we have kept these with the purely therapeutic medications conversations.

Interestingly, many patient concerns and questions about medications don’t arise until after the inpatient and outpatient phases and the early focus is driven by the needs of the hospital and rehab teams. Once at home though many patients start to experience medication fatigue, encounter other barriers to adherence (forgetfulness, peer pressure, cost etc) or experience real or imagined side effects. This is why we see medications guided conversations being triggered at any time by patient Q&A.

We have deliberately avoided going down the ‘diagnosis and treatment’ path therefore, we wanted to be able to address patient concerns and questions about their medications but in a way that emphasised the importance of professional advice. To do this we identified as many patient concerns and questions as we could and analysed the different ways in which these questions are asked. Some patients on forums will refer to their medications as my meds/drugs/pills whilst others will refer to them in the most exacting detail – trade name, scientific name, dosage etc.

This diversity does not represent an equally wide range of health illiteracy. In most cases the actual question represents a fundamental misunderstanding of their medication and its importance based on ignorance,

family pressure, media articles (positive and negative about the med) and limited understanding of what the medication is treating and any side effects.

Therefore, we believe it is important to capture all questions about medications, and to provide an authoritative answer, but one that pushes the patient back to the relevant professional. It doesn't matter whether this is about side effects or pill boxes, referral to doctors and pharmacists is important.

In short, answering questions about meds needs to:

- Check if a patient is experiencing the type of problems that require urgent medical treatment – chest pain, shortness of breath and so on and get them to take urgent medical action if recommended. You would be surprised how many patient questions on forums start with “I’ve been experiencing chest pain/shortness of breath etc for several days now ... what should I do’.
- Emphasise the need to not stop medications without discussing it with a doctor and don’t take anyone else’s meds or share yours.
- Refer the patient to a doctor or pharmacist.

We cannot emphasise enough the need for localisation of medications conversations. Each health jurisdiction and organisation have their own triggers (e.g. symptoms/side effects) and actions for emergencies (call paramedics/go to hospital/see doctor).

Similarly, the choice between doctor and pharmacist can vary based on policy and practice issues. Pharmacists are generally free of charge and freely available for advice so there are few barriers to having non-emergency questions answered and they are best placed to advise on how to remember to take medications and interactions between medications and foods. However, this approach means that the doctor remains ignorant of any adherence or low-level side effects their patient is experiencing.

5.6.2 Lifestyle Conversations

At this time, we have not focussed on pure lifestyle conversations that might occur after recovery and rehabilitation, although (as an example) we have developed some Q&A about returning to sports. Patient forums often have questions about various sports, travel, eating out and everything that would fall under living a normal life. Guided conversations and Q&A on these are important but were not our priority at this time.

5.6.3 Transitional Conversations

Some conversations transition from being largely therapeutic to be more lifestyle focussed; examples include:

- Movement: First few weeks at home starts with clearing the lungs, avoiding sternum injuries and avoiding joint stiffening. The focus gradually transitions to increasing cardiovascular exercise for cardiac health and increasing stamina, strength and suppleness for functional fitness. Ideally this process is managed through cardiac rehabilitation. Eventually patients might return to community exercise and sports.
- Eating: First few weeks at home starts with obtaining sufficient nutrition for surgical recovery and avoiding foods and drinks that are of immediate risk such as high sodium for heart failure patients, or foods that interact with common heart medications. An early transition to overall healthy eating is a key focus and is ideally managed through cardiac rehabilitation.

5.6.4 Exceptions to the Conventions

Every patient is different, and some are very different. Heart failure patients have lifelong restrictions that make lifestyle conversations therapeutic. The ‘every day’ CVD patient, if there is such a thing, can follow the general community guidelines on healthy eating, including reducing dietary sodium and drinking plenty of water, once recovered and if they are taking their medications. Heart patients always have to strictly control their sodium and fluid intake and therefore need variants to the Q&A and guided conversations.

5.6.5 Family and Carers

Guided conversations are written as a dialogue between the digital human and the patient using the first-person point of view. A family member or caregiver can answer on behalf of the patient if they are unable to do so themselves. Specific conversations could be written to educate family members or caregivers however education alone can also be achieved with video content as data capture is not an objective.

5.6.6 Dean Ornish Program

Allan Johnson, Patient Number 1 from the Centre for Digital Business, started following the Dean Ornish program after his first bypass in the USA in 2006. He used a copy of Dr Ornish’s book ‘Reversing Heart Disease’. He achieved excellent results and it has guided his life for many years now.

The Ornish Program is offered as a rehab program at some hospitals and guides secondary prevention beyond rehab. Guided conversations and Q&A could be developed for the Ornish program but we have not done so because it is proprietary to Dr Ornish.

5.7 Applicability to Other Diseases

As mentioned above, the concept of ‘common patterns’ has been one of our key design guides. Common patterns can be realised in several ways when designing a digital human health coach:

1. Content (information, advice, questions, answers)
2. Language (lexicon and syntax)
3. Codesign Methodology including templates and accelerators

5.7.1 Content

Cardiovascular disease (CVD) is a collective term for diseases of the heart and blood vessels. The term commonly includes diseases such as coronary heart disease (CHD), heart failure, cardiomyopathy, congenital heart disease, peripheral vascular disease and stroke.

My husband Allan has CHD and so that was our research and development starting point. A lot of content is shared by the CVD diseases but there are also some very important variations in some of the guided conversations and Q&A, heart failure for example.

Some chronic diseases, but especially diabetes, COPD and cancers, ‘share’ lifestyle recommendations. Not smoking is an obvious one but across diet, exercise, stress management and others there are strong content similarities although obviously each also, like heart failure, has important variations.

Of course, there is absolute commonality between all on the therapeutic importance of medication adherence and all suffer from the same causes of poor medication adherence. Only the details of the medications are different.

The design principles described in this document maximise re-use of content by other diseases. For example, except where specifically necessary (e.g. ‘as a heart failure patient’) we avoid mentioning a patient’s specific disease in conversations and Q&A.

5.7.2 Language

Common patterns also drive lexicon and syntax. Health illiteracy does not discriminate between diseases and so language, especially lexicon, should be common in all conversations and Q&A. As for syntax, the design principles described in this document apply equally to all diseases. Short sentences, modularity, use of video etc. are universal requirements. Video (and images) are important because the content differences can be embedded in these with the conversation introducing the video, checking understanding and referral to a health professional can be common.

5.7.3 Codesign Methodology

The codesign methodology is the same for all diseases, only the content and some of the participants will change. The concepts we use (themes, topics, guided conversations and Q&A) and the various tables we use (risks, asks, tells etc) don’t require ‘re-engineering’ before use.

Codesign simplification and commonality were major objectives for us. Both Allan and I have worked at various ‘big box’ consulting firms and have been their clients, including in the health sector. We understand that their associated activities, costs and schedules do not sit comfortably with health staff whose every minute and every dollar (both scarce) is focussed on safe and effective patient care. By democratising the codesign methodology and our IP we hope that these overheads can at least be significantly reduced.

6 Development Notes on Co-Design

The Development Notes commentary on co-design and digital humans is provided in two parts.

The first part provides detailed references and quotes from world-leading practitioners in the practice of co-design. I encourage people to read these references closely for the phenomenal insights these provide – particularly on culture, assumptions and change.

The second part covers my application and adaptation of co-design to the creation of digital humans – in this space, I refer to co-design not just as a practice but as an emerging science. My application of co-design to the creation of digital humans is based in human rights, and I describe this in detail.

6.1 Part One: An Introduction to Co-Design

6.1.1 “An Introduction to Co-Design” by Ingrid Burkett

<https://www.yacwa.org.au/wp-content/uploads/2016/09/An-Introduction-to-Co-Design-by-Ingrid-Burkett.pdf>

“Participatory experience is not simply a method or set of methodologies, it is a mindset and an attitude about people. It is the belief that all people have something to offer to the design process and that they can

be both articulate and creative when given appropriate tools with which to express themselves” (Liz Sanders, MakeTools, 2002).

“Co-design is about engaging consumers and users of products and services in the design process, with the idea that this will ultimately lead to improvements and innovation.”

“In the design profession there is a growing interest in the ideas of co-design - that is, engaging customers and consumers in the design process and harnessing their ‘expertise’ as users of products and services. This is said to create benefits both for consumers but also for companies.”

“Co-design literally means collaboratively designing services, products or processes.”

“Either way, co-design involves a shift in the locus of responsibility and control so that ‘clients’ or users of services become active partners in designing, shaping and resourcing services, rather than being passive recipients of pre-determined services.”

“Co-design is not just a set of new methods and approaches to add to our toolboxes. In my experience it potentially represents a cultural shift in service provision - that is, it changes what we mean by ‘service’, and it changes the roles and relationships between providers and users. Any radical conceptions of co-design are built around a fundamental belief in the potential for positive change in even the most dire situations, and an equal faith that people have the capacity to participate in and direct change in their lives.”

“Is our organisational culture reflective of the principles of co-design? “

6.1.2 The Western Australian Council of Social Service.

<http://www.wacoss.org.au/wp-content/uploads/2017/06/WACOSS-Co-Design-Discussion-Paper-Revised-20160919.pdf>

“Co-design involves coming alongside people who experience vulnerabilities, to work with them in creating interventions, services and programs which will work in the context of their lives and will reflect their own values and goals. This involves letting go of professional assumptions about a group’s perspectives and experiences and actively learning from what people say and do.”

6.1.3 NSW Council of Social Services

<https://www.ncoss.org.au/sites/default/files/public/resources/Codesign%20principles.pdf>

“Co-design can be used to create, redevelop and evaluate a product, service or system. It can be applied to anything from an app to improve people’s accessibility, to major community service reform processes. It is not the answer for everything but can be effective when responding to complex issues .”

“It is not a linear process and cannot be rushed. There are no step-by-step procedures or checklists. The process is as variable as the problems it aims to address, reflecting the issues and the needs of the people it involves. It requires a commitment to create change.”

“It is more than a consultation process. Everyone is seen as an expert in their domain and as such has something to offer in the design of products and solutions.”

“Principles of Co-design

- *Inclusive*. The process includes representatives from critical stakeholder groups who are involved in the co-design project from framing the issue to developing and testing solutions. It utilises feedback, advice and decisions from people with lived or work experience, and the knowledge, experience and skills of experts in the field.
- *Respectful*. All participants are seen as experts and their input is valued and has equal standing. Strategies are used to remove potential or perceived inequality. Partners manage their own and others' feelings in the interest of the process. Co-design requires everyone to negotiate personal and practical understandings at the expense of differences.
- *Participative*. The process itself is open, empathetic and responsive. Co-design uses a series of conversations and activities where dialogue and engagement generate new, shared meanings based on expert knowledge and lived experience. Major themes can be extracted and used as the basis for co-designed solutions. All participants are responsible for the effectiveness of the process.
- *Iterative*. Ideas and solutions are continually tested and evaluated with the participants. Changes and adaptations are a natural part of the process, trialling possibilities and insights as they emerge, taking risks and allowing for failure. This process is also used to fine-tune potential outcomes or solutions as it reaches fruition and can later be used to evaluate its effectiveness.
- *Outcomes focused*. The process can be used to create, redesign or evaluate services, systems or products. It is designed to achieve an outcome or series of outcomes, where the potential solutions can be rapidly tested, effectiveness measured and where the spreading or scaling of these solutions can be developed with stakeholders and in context."

(The Co-Design Principles came out of the Fair Deal Forum in November 2016 with input from the participants and Dr Ingrid Burkett, The Australian Centre for Social Innovation) <https://www.tacsi.org.au>

6.2 Part Two: Co-Design and AI Powered Digital Humans

As stated above, my application of co-design to the creation of digital humans is deeply based in human rights, and I describe this in detail. Based on my experience, I strongly believe that it is an emerging science.

6.2.1 Human Conversations and Digital Humans ~ Not Just a Pretty Face

<https://medium.com/@mariehjohnson/human-conversations-and-digital-humans-not-just-a-pretty-face-d5abfaaa2c5f>

There is much hype about digital humans. But what are they and what do they do? How are they created? And why the current prevalence of female personas? The article (link) explores these questions and more through the human need for conversation, the essential role of co-design and human rights as a design determinant.

What do these digital humans actually do? And what are they...actually?

Having led the "[Nadia](#)" project, the world's first AI powered digital human for service delivery co-created by with people with disability (2016) and the AI powered [Digital Human Cardiac Coach](#) (2019, following 14 years of research and lived experience), I know this landscape deeply.

Digital humans exist to converse with humans. To ask and answer questions, to provide information, even to give comfort. Not in the staccato short format of the current crop of personal assistants but in real conversations, nuanced with context and expression.

What is largely missing from the commentary is the central role of co-design and ethics. Also wanting, is a deep exploration of the previously unimaginable and unreachable human potential and the unique support for human agency that AI powered digital humans enable.

One clear goal in support of the human rights of people with disability: to achieve natural empathetic embodied conversations regardless of ability or language.

Instead of the industrialised online automation driven model where people had to adapt to channels, this was a vision to have the interface, the language, the channel and the technology adapt and respond to the person.

And we achieved this through radically inclusive co-design grounded in human rights and ethics. “Nothing About Me, Without Me”



The emerging science of co-design has proven fundamental to the creation of systems that are like people.

And with the digital human cardiac coach, it was our experience that if we struggled, how could anyone survive physically and mentally? And it occurred to us, that our experience struggling with bureaucratic health information, not understanding it — and with no one to talk to when we were most vulnerable — was in many ways the same isolating traumatising experience suffered by people with disability in accessing services.

Again, one clear goal. What if we could find a way for people to access and understand cardiac health information — and ask questions without fear of judgment or stigma — in simple language, in their own words, at any time.

As with Nadia, this was an endeavour of co-design but we took it further.

We adapted the application of co-design to the creation of the digital human health coach, to develop a scalable body of knowledge and practice: the Digital Human Body of Knowledge — Health Variant © for the strategy, design, planning and implementation of AI powered digital humans in health care.

From the human experience across the patient journey, we have documented common themes that only co-design can reveal, to build a corpus and conversation topics which is 80% common across health domains. And the explanation for this commonality, is that a heart patient is more than a heart patient: they are

people seeking information and reassurance, and this is conveyed through repeated reinforcing empathetic conversations whenever the person needs it.

6.2.1.1 Defining Digital Humans through Co-Design

There are two fundamental question that are asked: what is a digital human and how is it created?

In short, a digital human is composed of three capability domains: an avatar platform; a cognitive / AI platform; and the digital human co-design capability that determines the servicing model, corpus and context. A digital human requires all three to fulfil its purpose and potential.

A complete digital human is more than an avatar, a CGI replica, or a human-realistic face with digital nervous system. And it is more than AI. These are phenomenal technologies with different trajectories and approaches to R&D on emotionally responsive embodied systems. These technologies have existed for some time but separately are not sufficient to constitute a digital human.

The creation of the digital human is dependent on co-design. Many mistake consultation for co-design — it is not!

Co-design is fundamental to the articulation of the purpose and role of the digital human, the consideration of ethics, and development of the corpus and operating model: all dimensions necessary to transform the avatar to life as a digital human. Co-design creates the rich conversations and knowledge that breathe life into the otherwise dormant avatars and AI technologies.

And by this I don't mean text chat-bot conversations which are inherently inaccessible. Co-design produces natural contextual human-like embodied conversations: the ebb-and-flow of natural conversational interactions that are impacted by illiteracy, disadvantage, and bureaucratic and technical language.

Some commentators have stated that it is a fairly straight-forward process to “point” an avatar at a brochure or FAQ, and that this can be done in a few days.

From my experience, this is not the case, and there is method and effort in how this should be done. A digital human is not a talking brochure ... with a pretty face.

Co-design is a strategic function that considers the relationship between an organisation's brand, purpose and risk profile and how they will use the avatar and AI to converse/inform and emote/connect to influence behaviours. These behaviours might be as commercial as selling a product or service, or as altruistic as medication adherence and adopting a healthy lifestyle.

The co-design process also determines the purpose, role, personality and operating model supporting the particular digital human. The operating model is necessary to sustain operations, scale, agility and quality. Digital humans need to be able evolve to meet the societal changes that impact organisational to human conversations.

There is also much commentary regarding autonomously responsive emotional systems. Once again, my perspective is always “for what purpose”. Whilst the scientific and R&D efforts on these emotionally responsive systems is phenomenal, that does not mean that such systems are appropriate in every setting. Take for example in the service delivery setting of health or disability services. When dealing with people who are traumatised, illiterate, disadvantaged or with impaired cognitive function, emotional systems must respond and exhibit behaviours within a range defined by co-design, not left to an algorithm.

Even real humans involved in service delivery do not act “autonomously” as they like. If a customer or patient screams at them, the person delivering that service is trained to remain calm and neutral with managed escalation procedures, not reflect and react with a response that might otherwise be fight or flight. And so it is with AI digital humans in service delivery: they need to be designed and trained for context.

This doesn't mean that emotional systems operating within co-designed boundaries are not powerful. Quite the opposite. Co-designed emotional systems achieve highly contextual intelligent conversations in specific domains such as cardiac health or disability. A careful distinction needs to be made between roles and relationships during co-design; this is why a psychologist was part of the co-design team for Nadia.

6.2.1.2 The Importance of Educationalists and Psychologists

Most people are already aware of how difficult web sites can be to navigate and understand. Many heart health applications running on mobile devices are no better. They still contain text that the health illiterate cannot understand, well above a Grade 5 reading level. Many also require patients to make detailed entries every day and week to ensure they are 'on track'. Yes, there are some people that respond well to diary systems such as our Patient Number 1 who is an engineer and retired military officer. But there are many, the majority, that don't. A friend or caring family member will occasionally ask how you are going and if you are having any difficulties. They don't ring you every morning at 8am demanding that you enter today's weight!

The US allows telehealth consults to capture and review physiologic measurements from patients. This allows for conversations about the importance of these and can identify causes for non-compliance – scales broke, don't have a BP monitor, been too much to take measurements and so on. Not all non-compliance is poor patient attitude and no amount of daily prompting will resolve the deeper issues.

Educationalist and psychologists have an important role to play in the design of the digital human cardiac coach to ensure that understanding and willing participation (not grudging compliance) are the norm.

6.2.1.3 Co-Designing Digital Human Personas

Another contentious question is: why the prevalence of young female digital human personas?

Commentators have quite rightly asked questions about this, suggesting bias and even sexism. There might be some truth to this in some instances.

From my experience, the issues of gender selection, appearance, mannerisms, voice and so on are extremely complex, once again involving issues of ethics and co-design.

Take for example Nadia. As the first AI powered digital human, Nadia was grounded in human rights and inclusion. So, how is the Nadia female persona explained?

Nadia was grounded in human rights and we used that to prise open design processes that for a long time had effectively excluded people with disability. Nadia's personality, look, mannerisms and role were all determined through co-design, led by people with disability.

A phenomenal entrepreneur, a quadriplegic, running an assistive technology business; a deafblind colleague doing a PhD in haptic communication; a disability advocate running a social media platform; a young man with cerebral palsy an Apple ambassador; people with intellectual disability supported by university psychology faculty. And many hundreds of other people with disability and their families. Nadia looks how they wanted her to look.

Nadia was not a curiosity being paraded by tech companies: Nadia did not exist as such a product. Nadia was first and foremost, the creation and imagination of people with disability. And significantly, the co-design process was not just about the embodiment of Nadia, but the experience that people with disability wanted and needed, with accessibility across all disabilities a key design determinant.

Co-design revealed insights not otherwise discernible. For example, her lip colour supports lip reading by those with hearing impairment. Her short hair reduces distractions that affect some with cognitive disability. Her calm manner and use of only positive expressions — smiles, head gestures etc — are designed to not startle. Even her voice was carefully designed. Her words had to be clearly enunciated and pace not too fast. A job for an actress and one that Cate Blanchett, who volunteered her time, fitted to perfection.

We explored and were inspired by what was happening in the gaming world and virtual worlds such as Second Life where virtual beings and avatars engaged in conversations. Many people with disability are avid gamers: they say they can be whoever they want to be and are not judged. From this insight, Nadia was to have a presence in Second Life to be where the people are. In addition to Nadia, it was also envisaged that in this Second Life environment, people would have their own avatars taking on roles such as mentor and connector. The power of these conversations and peer guidance was seen as an important and new way to build capacity.

But we all knew that as a young fair skinned female persona, Nadia would not reflect all the communities served. There were plans for a male and female Indigenous persona, co-design to be led by the Indigenous community as an authentic natural interface. Communicating men's business and women's business, passing knowledge through conversations and yarns.

Co-design and ethics go hand-in-hand. The principle “nothing about me, without me”, encapsulates the [UN Convention on the Rights of Persons with Disabilities](#).

In practice, this principle is universal: it's fundamental to co-design and is a core principle underpinning the ethics of the design and operation of digital humans as emotionally responsive systems.

I am of the view that in the field of AI, much commentary about ethics is paternalistic and mostly by vested interests. Co-designed AI powered digital human conversations break through barriers of illiteracy and disadvantage unlocking immense human potential. Far more inclusive commentary and research is needed that encompasses AI and the ethics of opportunity enabling human agency in new ways.

So Nadia was a phenomenal example of co-design. Nadia, the female persona, was to be just the starting point.

Similarly, the work on Hanna, the Digital Human Cardiac Coach involves co-design and localisation reflecting the expressions and customs of the community of North Carolina served by NHRMC. At the [Cucalorus Film Festival, we wondered if Michael Jordan](#) would step up to be the persona or digital human cardiac coach ambassador for North Carolina to raise awareness through digital human conversations of the humanitarian cause of cardiac health amongst disadvantaged communities.

Clearly, sports brands and cosmetic brands for example, might want a digital human persona and personality to reflect their brand and values. Perhaps a new face not seen elsewhere: an “energetic” digital human influencer perhaps more fully utilising autonomous emotionally responsive systems as an engagement mechanism for their followers.

This goes to the purpose and role of the particular digital human, and the strategic importance of co-design.

The digital human cardiac coach, focussed on health illiteracy, establishes a new model for access to cardiac health information and services, and in fact for all health domains.

Digital humans such as [SimCoach](#) (referred to as a virtual human) have been used for a number of years in mental health settings, monitoring for signs of PTSD in veterans and service personnel.

Avatars operating within a [virtual world such as Second Life](#), are being used in the rehabilitation of service veteran amputees.

Digital humans as companions for the elderly and supporting people with dementia.

But this has been far more than a journey of science and technology advancement and the world of start-ups. It has been the human experience, suffering and disadvantage with the yearning visceral human need for conversations, that helped forge this from imagination to reality.

The conversation services economy has started, shaped by the emerging science of co-design.

7 Content Development

7.1 Content Development Options

There are several major options for creating AI corpus content but some of them are ineffective, at least for now, for a digital human health coach:

- Automated creation which relies on machines to do the ‘heavy lifting’:
 - Web scraping
 - Machine learning
- Manual creation:
 - Codesign (which we recommend)
 - ‘Best efforts’ which might include a multi-disciplinary team but doesn’t use codesign

7.2 Automated Creation

Automated creation, especially web scraping, can be attractive to tech companies, especially start-ups, because it doesn’t rely on domain expertise, is relatively fast and cheap (because it is less labour intensive). Machine learning uses computer programs to access this data and use it to learn what questions might be asked and what the answers to these questions could be.

There are fundamental problems for this approach in health:

- The majority of the global patient population is health illiterate and don’t understand much of the health information that is already online.
- Many health organisations and professionals are unable to communicate with health illiterate patients at an appropriate education level.
- The web is full of information and advice that is contrary to current best practice.
- There are unmoderated patient forums where health illiterate patients answer each other’s questions, often with information that ranges from simply incorrect to possibly dangerous.

- There are moderated patient forums where health professionals answer patient questions with long winded obscure answers that, whilst factually correct, don't address the underlying patient concern or are simply unintelligible.

There are exceptions to these concerns; websites with accurate and useful information, skilled health professionals (especially nurses) who can communicate with patients at the right level, even forums that provide patients with some social support without veering into dangerous or unintelligible advice. But, and it is a big but, how do machines tell the good from the bad?

Machine learning is a game of numbers. To put it simplistically, if the machine sees the same answers to similar questions over and over it will assign a high probability to that being the correct answer no matter how incorrect it might be. Secondly, the machine won't actually rewrite this answer so that health illiterate patients can understand it.

So, in AI systems development, there is a lot of focus on the development of large sets of questions and answers.

This is not enough. What if a patient doesn't know what question to ask? Or doesn't even understand or have knowledge about key concepts? And this is highly likely given the extent of health illiteracy.

This is common in any service delivery setting. Machine learning cannot learn what the patient doesn't know.

Or what if there is additional context? A point answer to a point question will not be sufficient:

- In the Empathy section below, we talk about two patients having totally opposite emotional reactions to the same answer; the businessperson pleased that they won't be able to fly for several weeks after their surgery so they can be with their family and the parent distraught at missing a daughter's wedding.
- Heart failure patients have stricter constraints on what they consume compared to many other heart patients.
- Co-morbidities (cancers, IBS, neurological etc) require answers to be adjusted.

The patient journey might consist of several interactions with the health system and periods at home in between these. Patient admission processes can capture contextual information for the inpatient (e.g. surgery) and outpatient (e.g. cardiac rehab) processes, but this information is largely focussed on that required for diagnosis and treatment. It doesn't capture situational and emotional context that would help select the right answer to a patient question and the right way of delivering that answer.

Our experience is that there is a presumption of attendance at cardiac rehab, despite statistics showing that the majority do not attend. The problem is 'kicked down the road'. Questions about driving, flying, getting back to work, returning to sports – getting back to a normal life – are left for 'later'.

So, you have patients with many legitimate concerns and questions who don't know where to turn.

Some will go to rehab. Some will seek solace in patient forums. Some will ask their doctor. Some will ask their family or friends. And in the brave new world, some will ask an AI. And if that AI simply matches an answer to a question, without context, disaster awaits.

Conversations, not simple Q&A, enable situational and emotional context to be captured and answers adjusted to fit the context.

This is why we have developed the approach of using ‘guided conversations’ that takes away the need for patients to know what questions to ask and for the AI to identify what the patient needs to know.

Guided conversations work with Q&A to capture additional context to select the right answer, and to deliver that answer with empathy.

7.3 Empathy

Heart events and surgeries are traumatic for patients, their carers, families and friends. Guided conversations and answers to questions must adopt a mix of emotions, expressions and gestures that convey interest and sympathy with perhaps a touch of humour where appropriate to lighten mood.

Done well, a digital human might over time transition from roles to relationships, just as SimCoach builds rapport that translates to trust and disclosure. This is where psychologist input is very important to codesign.

Consider this simple example. A patient asks the digital human when they will be able to fly again after their bypass surgery. The factual answer is fairly simple. There are medical recommendations AND some airlines have their own no fly periods for heart patients. All up, it will be around several weeks in most countries but longer for patients with complications such as heart failure.

How will the patient react? It depends.

- ‘Bruce’ is a businessman and is happy that his company can’t make him fly for a while so he can spend time with his family.
- ‘Louise’ is upset because she won’t be able to fly to her daughter’s wedding next week.

The same answer but two totally opposite reactions. Inserting a question from the digital human can help in answering with the appropriate emotional overlay.

“Are you planning on flying somewhere important soon?”

If the patient then asks if exceptions can be made the digital human would recommend they talk to their doctor as the answer to this varies based on the patient’s condition, country laws and so on. The doctor could help navigate these parameters.

Selecting the emotional state of a patient before answering is possible using one or more of a four basic approaches:

1. Assume a default emotional state and provide a ‘least harm’ answer. So, for heart patients and their carers, unless the answer is one that is ALWAYS positive (and accurate) it is safer to answer with empathy. This means a fairly neutral expression and words rather than a broad smile and ‘I’ve got great news for you’!
2. Assess patient emotional state based on phrasing. If a digital human asks a patient ‘how are you feeling this morning’ and the patient answers ‘okay, I guess’ then this qualification indicates that there might be a problem.
3. Voice recognition.
4. Facial recognition.

One thing we strongly recommend against is allowing the digital human to display negative emotions or to use autonomous reactions. A positive calm delivery is required, not judgement or anger.

7.4 Constrained Domains - Health

Almost everyone has had an experience where a digital assistant on a phone or computer has provided a nonsense answer to their question. These assistants might be asked anything so is it any wonder that they often don't know the answer.

The digital human cardiac coach is designed to operate in a constrained domain which means that:

- Questions outside that domain, such as 'how long would it take to drive from A to B', can be answered with 'that is not part of my role'.
- Context is easier to infer; we can assume that the question is being asked by a patient or carer and that the answer will lie within a certain small subset and that empathic delivery is required.
- It is easier for the digital human to ask clarification questions as part of a conversation to determine context.

So, if a digital human cardiac coach is asked 'when am I able to fly again', it can clarify by asking 'is there somewhere you need to fly to when you leave hospital' and answer accordingly (as part of Q&A) or it can start a guided conversation:

Most patients have to wait at least several weeks before they can fly again but this depends on what has happened to them and how they are recovering. If you need to fly soon you should talk to your doctor and get their advice before booking any travel.

A lot depends on the variability in the answer. Returning to driving is based on laws in the local jurisdiction with commercial drivers subject to longer constraint periods than private drivers.

In the absence of situational context, either from a patient registration process or conversation, the simple answer is:

Most heart patients are not allowed by law to drive for a time after their surgery. You must check with your local authority and insurer before driving.

Within the health domain the answer at this level is unlikely to change, there will always be a driver constraint. However, the time and process changes from jurisdiction to jurisdiction so answering with specifics would add unnecessary complication to the AI corpus.

7.5 More on Guided Conversations vs Q&A

Q&A driven by a codesigned AI corpus can be a valuable tool for patients on their recovery, rehabilitation and secondary prevention journeys. It is certainly a major component of the digital human cardiac coach. However, the fundamental problem of health illiteracy requires a complementary approach.

Many heart patients simply don't know what questions to ask; and if they don't ask the questions, they don't learn what to do. What is needed is for the digital human to control the initial interactions, what we have called 'guided conversations', to develop sufficient patient awareness and understanding to later trigger meaningful questions.

This PUSH approach (guided conversations) balances the PULL approach (Q&A).

Guided conversations are especially useful in the inpatient setting. The digital human cardiac coach can initiate simple short conversations with a patient that consist of:

ASKS: identifying potential risks for this patient when they are discharged – safety when travelling and at home, medications, non-attendance at rehab and smoking. For a heart failure patient this is where their fluid management risk is assessed by asking about sodium intake etc. Transcripts of the conversations are reviewed by the hospital well ahead of discharge so that meetings can occur (say with a dietician) before discharge and appropriate appointments and care arrangements made well in advance for after discharge.

TELLS: this is where the digital human gives the patient and carers information that will address questions they already have or are likely to arise during confinement.

One of the major benefits of the guided conversation is the potential to reduce staff workload and burnout. Another is reducing the risk of readmission. The third is providing a transcript of conversations that can prove that a patient was informed of a requirement and that they acknowledged that they understand it.

Guided conversations can trigger Q&A (when switched on and allowed) and Q&A can trigger guided conversations. For example, after discharge a patient might ask about their meds and rerunning a meds guided conversation might be more effective than a simple short answer in achieving medication adherence.

8 Developing Q&A for the AI Corpus

8.1 Where to Start

We based our initial development around IBM Watson and their recommendations:

- *Intents are purposes or goals that are expressed in a customer's input, such as answering a question By recognizing the intent expressed in a customer's input, the Watson Assistant service can choose the correct dialog flow for responding to it.*
- *Ideally, find real-world user utterance examples that you can extract from existing business processes. The user examples should be tailored to your specific business.*
- *The examples that you provide are used by your assistant to build a machine learning model that can recognize the same and similar types of utterances and map them to the appropriate intent.*
- *If you already have chat transcripts from a call centre or customer inquiries that you collected from an online application, put that data to work for you.*
- *For each business goal, you must provide at least 5 examples of utterances that your customers typically use to indicate their goal.*

A lot has been written about the size of datasets and their impact on machine learning and algorithms. Our approach was to develop a large dataset that spans the cardiac health domain. A small dataset would limit the initial usefulness of the digital human cardiac coach and potentially lead to wrong answers that have adverse effects. There is a risk with intents that are too similar to each other causing confusion and this can be addressed by reviewing your dataset with an expert for the AI product you select.

Also, we have developed the approach of using 'guided conversation' (see section below) that takes away the need for patients to know what questions to ask and for the AI to identify what the patient needs to know.

We sampled tens of thousands of utterances (patient concerns and questions) from multiple sources over a number of years including:

- Patient forums in Australia, UK and USA
- Patient education development with cardiac rehab nurses, exercise physiologists, dieticians, psychologists and pharmacists
- Participation in National Heart Foundation Ambassador Program
- Completion of Rehab Training and courses on exercise training of older adults and women
- Speaking at multiple patient rehab sessions
- Coaching of individual heart patients
- Own attendance at cardiac rehab in the USA and Australia
- Websites of heart health industry advocacy bodies
- Analysis of multiple peer reviewed research articles
- Multiple hospital websites providing rehab services
- Speaking at university and industry body health courses and seminars
- Provider websites for pharmaceuticals etc

We created an initial set of ‘intents’ based on similar ‘utterances’, for example:

What is cardiac rehab	Where can I do cardiac rehab	What are the benefits of cardiac rehab	When do I do cardiac rehab
What is cardiac rehab	Where can I do cardiac rehab	What are the benefits of cardiac rehab	When do I do cardiac rehab
What happens in cardiac rehab	Do I do cardiac rehab at the hospital	Do I have to do rehab to get better	Can I do rehab later
What happens at cardiac rehab	Can I do cardiac rehab at home	Will rehab help me get better	Can I stop and restart cardiac rehab
What should I expect during cardiac rehab	What other options are there besides rehab	Will rehab help me get back to where I was before surgery	When will I do cardiac rehab
Does cardiac rehab cover diet (eating)	I can't get to rehab	Will I be able to play sport again after cardiac rehab	When will I start cardiac rehab
Does cardiac rehab cover exercise	How do I choose the right rehab program	Will I be able to run again after cardiac rehab	How soon can I start rehab
Does cardiac rehab cover stress	Can I do rehab at my local gym	Will rehab stop me having another heart attack	When should I start cardiac rehab
Does cardiac rehab cover quitting smoking	Where can I get cardiac rehab	Will I need surgery again if I do cardiac rehab	
Will cardiac rehab help me understand what happened to me	Where do you do rehab	Will I be able to swim again after cardiac rehab	

Note that IBM Watson and other AI products can handle simple grammatic variations out of the box and utterances such as “What happens in cardiac rehab” and “What happens at cardiac rehab” and would treat these as the same intent.

8.2 Sentence Structure Variations

More complex sentence structure variations need to be learned or taught. For example, it would not be immediately obvious that “will I exercise on my own at cardiac rehab” and “I’m too embarrassed to exercise in front of others” could have the same or opposite intents. “Will I exercise on my own ...” might indicate that the patient would prefer others to be there for safety and social needs or they might want to be alone. The second would indicate a strong preference for exercising alone based on gender, cultural or other factors.

Fortunately, they can have the same answer:

Cardiac rehab has two parts. One part is exercise sessions and the other is classroom education sessions. Both have small groups of patients in them who support each other. Many even go for a coffee together after the session. You can talk to the rehab coordinator if you are worried about exercising or learning in a group so that they can help you.

Note that the answer doesn’t promise single patient sessions; these might not be possible at some rehab facilities. What it does do is direct the patient to talk to the rehab coordinator who can better understand their concerns and possibly resolve them over the phone or face to face. Note also that the answer doesn’t repeat the types of concerns patients might have as this is not necessary and adds complexity to maintaining the corpus (see design principles in this document). Many patients find patient support and having an opportunity to talk to someone other than their family/carer a benefit of rehab and mentioning this in the answer can help convince patients to attend group rehab classes.

8.3 Word Variations (Synonyms)

Sentence variations and grammar aren’t the only variations. Patients often use different words to mean the same thing either as synonyms (house, home, condo) or as variations in specificity (drugs/meds/pills vs statins/beta blockers vs Lipitor/Cresta/Bisoprolol/Metoprolol).

We have accommodated word variations by using synonyms and have developed hundreds of these specific to cardiac health questions. Our convention has been to indicate word (or phrase) variations as <synonyms>. As mentioned above, Watson and other AI products don’t need synonyms for words like in, at and so on.

For example, a common concern is that a medication is giving a patient a symptom or side effect.

The sentence variations might include:

- I think my <medications> are giving me <side_effects>
- I’ve got a <side_effects> from my <medications>
- Can <medications> cause <side_effects>
- One of my friends got a <side_effects> from <medications>

In Excel spreadsheets we have used the ‘concatenation’ feature to develop the synonym variants as per the example below:

Populate cells in columns using copy/paste etc

I think my	<medications>	is giving me	<side_effects>
<i>Copy down</i>	<i>List synonyms</i>	<i>Copy down</i>	<i>List synonyms</i>

I think my	Medications	Is giving me	
I think my	Drugs	Is giving me	
I think my	Pills	Is giving me	
I think my	etc	Is giving me	
I think my	Statin	Is giving me	
I think my	Lipitor	Is giving me	
I think my	Crestor	Is giving me	
I think my	etc	Is giving me	
I think my	Beta Blocker	Is giving me	slow heart rate
I think my	Beta Blocker	Is giving me	diarrhea
I think my	Beta Blocker	I think my	weakness
I think my	Beta Blocker	I think my	tiredness
I think my	Beta Blocker	I think my	dizziness
I think my	Beta Blocker	I think my	anxiety
I think my	Beta Blocker	I think my	nausea
I think my	Bisoprolol	I think my	slow heart rate
I think my	Bisoprolol	Is giving me	diarrhea
I think my	Bisoprolol	Is giving me	weakness
I think my	Bisoprolol	Is giving me	tiredness
I think my	Bisoprolol	Is giving me	dizziness
I think my	Bisoprolol	Is giving me	anxiety
I think my	Bisoprolol	Is giving me	nausea
I think my	Zebeta	Is giving me	slow heart rate
I think my	Zebeta	Is giving me	diarrhea
I think my	Zebeta	Is giving me	weakness
I think my	Zebeta	Is giving me	tiredness
I think my	Zebeta	Is giving me	dizziness
I think my	Zebeta	Is giving me	anxiety
I think my	Zebeta	Is giving me	nausea
I think my	Ziac	Is giving me	slow heart rate
I think my	Ziac	Is giving me	diarrhea
I think my	Ziac	Is giving me	weakness
I think my	Ziac	Is giving me	tiredness
I think my	Ziac	Is giving me	dizziness
I think my	Ziac	Is giving me	anxiety
I think my	Ziac	Is giving me	nausea
I think my	Toprol	Is giving me	
I think my	Lopressor	Is giving me	
I think my	Metroprolol	Is giving me	
I think my	etc	Is giving me	

Use concatenate function to create candidate intents for AI corpus:

I think my Beta Blocker Is giving me slow heart rate
 I think my Beta Blocker Is giving me diarrhea
 I think my Beta Blocker I think my weakness
 I think my Beta Blocker I think my tiredness
 I think my Beta Blocker I think my dizziness
 I think my Beta Blocker I think my anxiety
 I think my Beta Blocker I think my nausea

I think my Bisoprolol Is giving me slow heart rate
I think my Bisoprolol Is giving me diarrhea
I think my Bisoprolol Is giving me weakness
I think my Bisoprolol Is giving me tiredness
I think my Bisoprolol Is giving me dizziness
I think my Bisoprolol Is giving me anxiety
I think my Bisoprolol Is giving me nausea
I think my Zebeta Is giving me slow heart rate
I think my Zebeta Is giving me diarrhea
I think my Zebeta Is giving me weakness
I think my Zebeta Is giving me tiredness
I think my Zebeta Is giving me dizziness
I think my Zebeta Is giving me anxiety
I think my Zebeta Is giving me nausea
I think my Ziac Is giving me slow heart rate
I think my Ziac Is giving me diarrhea
I think my Ziac Is giving me weakness
I think my Ziac Is giving me tiredness
I think my Ziac Is giving me dizziness
I think my Ziac Is giving me anxiety
I think my Ziac Is giving me nausea

We used Excel because it was expedient but other spreadsheets, database products etc could be used.

Note that the initial dataset would need to be reviewed by a pharmacist and the Operating Model would need to include update procedures for all of the synonyms.

Various medical and hospital authorities will have their own preferences for answering these questions but using the design principles the single answer for all could be:

This is a side effect that patients can experience from this medication and you should talk to your doctor or pharmacist as soon as possible. If you are very worried or have chest pain, shortness of breath, blurred vision, uncontrollable diarrhea or vomiting you should call for a paramedic.

Note that by using the design principles we have maximised the use of this answer across all meds including those for many other chronic conditions and have simplified future changes to the Ai corpus.

Again, because we are not doing diagnosis and treatment, we don't single out specific side effects and suggest things like drinking more fluids for the diarrhea (not possible for a heart failure patient), taking OTC anti-nausea or anti-diarrheal formulations (possible dangerous side effects).

Note that in the USA (and other countries) a telehealth consult can be recommended to avoid delays resulting from making appointments to see a doctor.

8.4 Other Sources of Variation

Sentence structure and use of synonyms aren't the only source of intent variations and answers. For example:

- Gender can result in Q&A variations (not just binary gender) and these need to be addressed. Patients won't always express their questions in terms of their gender therefore identifying gender when setting up a digital human cardiac coach for a patient can be important.
- Localisations (cultural, administrative and logistical) are also important. Cultural mores, foods and expressions can be localised within large countries such as the USA. Also, every hospital, insurer and so on has different contact and ordering processes (amongst others) that will need to be considered (see the design principles).

Language is obviously a major source of variation. ESL speakers (patients and carers) in large US communities might be able to converse with the digital human cardiac coach when it is designed to handle health illiteracy (reading level of grade 5 and below) and pre-existing language specific features and content (e.g. Hispanic food pyramids) can be used instead of the English language ones.

9 Developing Guided Conversations

9.1 General Principles

The principles we have used to develop the guided conversations are:

- Guided conversations should be conducted before surgery and short – 5 to 10 minutes max – to accommodate patient attention span and improve answer accuracy.
- Focus on more immediate high-risk areas of going home, meds, attending rehab and heart failure.
- Limit branching, this is not a Q&A session driven by the patient. For example, even if a patient says they don't smoke we simply acknowledge that they have answered rather than say well done. The next step is usually the same regardless of the patient answer. Simplicity is the key.
- Limit avatar expressions and emotions to positive interest. Nodding occasionally, the odd wink and broad smile where appropriate. Never angry, negative, uninterested.
- Be able to handle interruptions – toilet breaks, nurses dispensing meds, meals and so on.
- Conversations make sense if conducted by a carer rather than the patient.
- Avatar face and voice need to promote rapport and match the brand of the organisation. Several might be required where the patient population is very diverse across cultural, age and gender divides.
- Templates for use by hospital staff are very simple – list important TELLS and ASKS – can be in a document or spreadsheet or even captured on paper. Hospital staff are busy helping patients,

9.2 The Use of Video

There are many heart health videos out there. Some are very useful, and many are not; at least for the health illiterate. Problematically, most videos are buried deep in websites where they are very difficult to find. This means that patients and carers who might benefit from them will never find or see them.

In the design principles section, we talk about how describing our overseas holiday to a friend without missing any important details would require considerable pre-planning. We use photos and maps to communicate detail without the need for preparing a lengthy speech and the use of these greatly increases interest. And, let's face it, a long monologue would be boring!

A guided conversation or corpus answer to a question can include short relevant videos (and of course images) to convey information in a way that is easier for patients and carers to understand and to maintain

interest. This approach, rather than dumping videos onto websites, allows videos to be presented with context whether that be as part of an inpatient discussion or response to an at home concern.

The digital human can introduce the video, explain its relevance and then at the end of the video reinforce key messages and actions:

Hi – one of the most important things to do at home every day as a heart failure patient is cut down salt in your diet. This short video shows you what to do. {shows video}. As you saw you can do a lot just by not adding salt to your food. If you eat a lot of processed foods or take out you might also eat too much salt. Would you like the hospital dietician to give you some ideas for healthy take out?

Lancaster General Health (and others) use video content from Healthwise.Org and this could be a good starting point if you don't have your own videos.

One final point. Try and avoid 'talking head' videos. Embedding a conversation within a conversation without simple and engaging graphics won't help overcome health illiteracy.

Important Note: although reducing readmission penalties and litigation costs are important benefits of this approach DO NOT let the accountants and lawyers design the guided conversations and Q&A!

10 Technology

10.1 Starting Point

Codesign creates content and that content resides in the AI corpus.

There are a number of AI vendors that can support the corpus for a digital human health coach but there are differences between them.

These differences become more pronounced if you want to scale to operate different versions of your digital human health coach across geographies and languages. This requires the ability to implement specialisation and localisation without losing standardisation.

It is important to remember that everything else technology is about accessing the corpus and interacting with the patient. It doesn't have to be limited to a digital human and an avatar. It can be a text based chatbot or app.

Our emphasis has been on codesign of Q&A and guided conversations that are technology neutral and the proliferation of avatars in the market means that there is wide choice.

Price is obviously a consideration. This is one of the reasons why we have provided our IP for free, to remove that cost component for those who want to help patients.

The other major issue is integration of the avatar to the AI. The general consensus in business is that you don't want to bear the responsibility for building and maintaining the integration between multiple software vendors unless you have a competent IT capability.

There is a lot of activity in this space and it is accelerating. It is no stretch for the major AI vendors to add avatars and eliminate the major integration point. They might also have the advantage of offering existing

integration to electronic health record (EHR) systems (patient administration and management) and other capabilities such as machine vision, telehealth and so on.

Alternatively, you can go with a local provider (maybe a university) and start small (and fast) with the essential guided conversations.

10.2 Can this be SaaS (Software as a Service)

As with anything these days people get excited about a single global design one size fits all software as a service (SaaS) model that can make a start-up and its investors lots of money. The fact is that the digital human cardiac coach is a health capability and as such is bound by the laws and policies extant in each jurisdiction no matter how common the subject matter. Localisation is required to comply with these and to also localise for culture, administrative and logistics processes. The digital human starts its journey with each patient in the inpatient setting with guided conversations and needs to be managed accordingly.

We like to think that the big accelerator here is CaaS or Content as a Service, and not SaaS. Codesigned content can maximise standardisation whilst enabling specialisation and localisation where required or value adding.

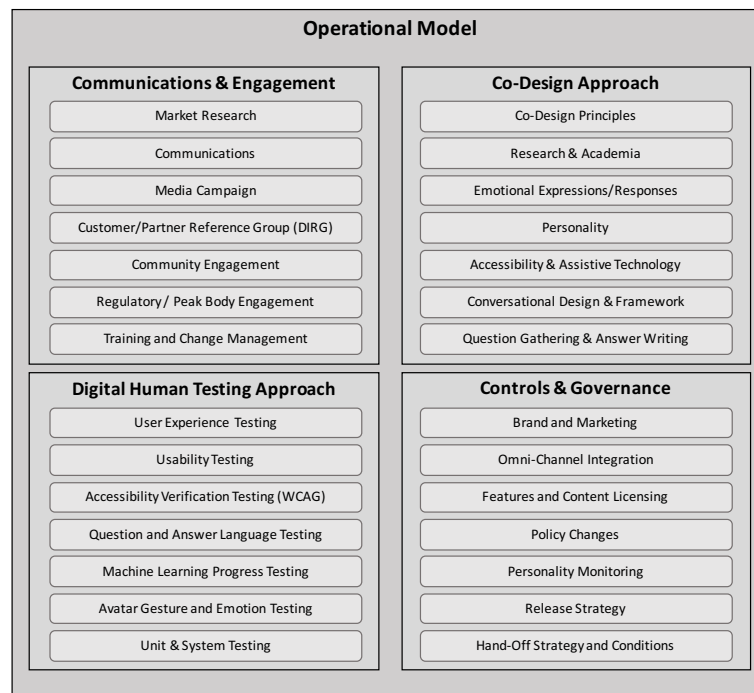
If you think of a digital human as a humanitarian and not a technology project, opportunities for efficiency and reducing cost become obvious.

11 Operational Model

An Operational Model will be needed, even for a PoC, as this will affect the success or otherwise of the digital human initiative:

- Communications and engagement for the PoC is required to:
 - gain and maintain executive support
 - inform and excite investors
 - build patient and carer support
 - inform regulatory bodies
 - manage vendor communications
 - when ready, controlled information flow to the public
- Co-Design Approach for the PoC is required to:
 - Ensure patient barriers such as health illiteracy and accessibility are addressed
 - Start with the approach that will be used throughout the project
 - Avoid hardware/software technical and commercial dead-ends
 - Facilitate progressive buildout of the team to ensure continuity of knowledge and purpose; this is essential to support a development roadmap of evolution and innovation.
- Controls and Governance for the PoC is required to:
 - Orchestrate activities across the functional areas, to achieve the layers of embodiment and context that define the unique attributes of personality and brand.
 - Ensure that the solution is omni-channel capable
 - Initiate licensing and commercials
 - Safeguard brand/cause
 - Manage PoC testing and viability evaluation including entry/exit criteria
- Testing Approach for the PoC is required to:
 - Ensure all relevant aspects are evaluated – content, conversations, expressions and emotions, machine learning, user experience
 - Comply with regulatory requirements for progressing to patient testing

- Meet regulatory and other requirements for use of the hardware device and associated software and communications in the hospital



It is important to remember that the digital human cardiac coach is NOT a technology project, and the Operational Model must have a clear focus on the non-technical components and capabilities. Equally, the technology components need to be sourced and managed with the same rigour that would be applied to a technology project and the Operational Model should also reflect this aspect.

Because the guided conversations and corpus content and Q&A are omni-channel they can be delivered to patients in a number of ways. For example, the guided conversations can be tested in the PoC by a human practitioner conversing face to face with a patient without technology. It could then be tested human to human via a telephone conversation. This sort of evaluation is important to complete before handing over a conversation to a Natural Language Programmer to code. The same approach can be applied to the Q&A. Human to human testing will quickly identify if a conversation is too long or the phrasing awkward. Human to human testing can also show the videos that might be later embedded in the digital human cardiac coach.

Some of the roles required to implement the Operational Model are not typically part of a hospital's staff and might need to be sourced from organisations such as universities and media production companies.

12 Design Guidelines

12.1 'Effort' Matrix

The following table is a very rough guide to assessing digital human cardiac coach difficulty for various patient cohorts and regions. Note that we have assessed western culture/English language as easier because that was our starting point.

Parameter	Easier < > Harder					Notes
External Regulation	No guidelines or regulations	General industry guidelines or AS/ISO - not enforceable	General industry guidelines relevant to license to operate and mandatory AS/ISO	Single regulation such as product approval (FDA/TGA) or Privacy	Multiple regulations such as product approval (FDA/TGA) and Privacy	Common, commercial and trade laws apply in all cases
Internal Policy	No guidelines or policy	Advisory policy or procedures - discretionary	Advisory policy or procedures - mandatory	Policy approvals required separate from process	Policy approvals embedded in process	Process redesign is desirable but not always possible
Spoken Language	Non-colloquial English - USA, UK, Australia, New Zealand, Canada	Colloquial English - USA, UK, Australia, New Zealand, Canada	European Union countries foreign language but strong English usage	Asian languages with little resemblance to English and population non-English speaking	Non-English with strong regional variations	Language impact amplified by use case system and process variability
System/Process Commonality	Globally common with UN or other standard	Globally common with national standards	Globally common with variants within nations	Differs from country to country but with some common roots	Differs between countries and even regions with few or no common roots	Rehab education and exercise have high global commonality but are currently highly regionalised
Culture	Monoculture largely based on western values e.g. USA, Australia, UK, NZ, Canada	European Union countries	Large common non-western culture	Blended cultures with a strong indigenous element e.g. Malaysia	High cultural diversity within a single country	Western monoculture has regional variations (e.g. foods) that can be achieved though 'localisation'
Gender	Male – youth to middle aged	Female – youth to middle aged	Older males	Older females	Gender fluid	Gender fluidity can require specific forms of address, some different questions and answers
Digital human role	Concierge - Meet and greet in controlled environment	Assistant – answer questions within small controlled question set and guided conversations	Advisor – able to support heart health conversations and Q&A without patient specificity	Coach – able to support heart health conversations with recall of previous conversations with this patient	Influencer – free form conversations on a range of topics with autonomous reactions	DHCC likely to start as Assistant then move to Advisor during early deployment.
Digital Human added features	Features and content such as text, images, video	Integration to electronic health records	Integration with physiologic devices	Integration to email, messaging, schedules etc	Integration with health ecosystems (e.g. Apple, Google)	Text, images and video essential to avoid long winded conversations
Embodiment	Small set of standard emotions and expressions (happy, interested – smile, nod) for guided conversations	Add contextual empathy to Q&A – “don’t worry, a lot of patients experience that ... “	Initiate conversation with appropriate empathy – “hi, we haven’t spoken for a few days, is everything ok?”	Infer patient mood from language and/or visuals within context	Autonomous reactions	Autonomous reactions are not suitable for health digital humans
Voice recognition	Understand health domain words within context	Understand words or language	Understand health domain words not	Identity words outside of health domain	General language recognition (e.g. similar to	Critical action response required for any digital human

		requiring critical action	expected within context	but within context	current voice assistants such as Siri)	health coach used unsupervised
Object Recognition	No object recognition	Common standard items with clear labelling (e.g. Statin meds box)	Standard text or numbers on device screens	More complex health information – nutrition label	Recognise and interpret information on a health brochure	Recognition of meds labelling and device data useful for meds adherence and physiologic measurement

12.2 Generic Design Principles

Postponement	
<i>Definition</i>	Only add variation as close as possible to the customer
<i>Rationale</i>	Variation imbedded in the middle of a process or capability reduces re-use and adds time and cost to enhancements and modifications
<i>Analogy</i>	Printer companies build one printer for all countries and the country specific cable is added under a separate flap in the packaging just before shipping in response to a specific sales order.
<i>Example - Health</i>	Build a generic conversation capability for machine reading of a medicine box that can be used for all chronic diseases. Variations for cardiac health, oncology etc are added using images and text for each disease that can be inserted into the patient interaction without having to redo the conversation. Images and text for each disease are only developed and added when a customer exists for that variation.

Reduce Interaction Complexity	
<i>Definition</i>	Natural empathic conversations are supported by features (video, images, maps, text and soon) that are less complex to produce.
<i>Rationale</i>	Natural empathic conversations are the most complex interaction capability to produce so the use of imbedded features reduces time and cost of development. The use of features also enhances customer interest and understanding.
<i>Analogy</i>	Describing our overseas holiday to a friend without missing any important details would require considerable pre-planning. We use photos and maps to communicate detail without the need for preparing a lengthy speech and the use of these greatly increases interest.
<i>Example - Health</i>	A medications interaction could replay a rehab introductory video (see HealthWise), use images to show what the medication looks like, use a map to show how to get to the drug store, and weave conversation around these to tell a story and check understanding.

Increase Ease of Modification	
<i>Definition</i>	Choose conversational and feature elements that support simple modification for frequent content changes.
<i>Rationale</i>	Content changes over time with research and development, policy and regulation changes and so on. Overuse of long videos can be problematic if small but important content changes require reshooting a whole imbedded video. Where content changes are frequent the use of shorter videos, images, text or other features might be appropriate. In some cases, conversation might also be the preferred option if small conversation changes are supported by modular design.

<i>Analogy</i>	Printed textbooks require an entire new print run for a change whereas eBooks can be easily modified by section.
<i>Example - Health</i>	A typical cardiac rehab education session with a human presenter using a slide deck and answering questions takes anywhere from 45 minutes to an hour. A single video of an entire rehab education session on say, your medications, would be costly to reshoot and would not accommodate Q&A. A blend of guided digital human conversations that introduce and link shorter video segments, accompanied by Q&A conversation, would provide the right mix of ease of modification and interest.

Emphasise Conversation Attributes	
<i>Definition</i>	Choose conversation over other features in an interaction where understanding and empathy are critical.
<i>Rationale</i>	Features such as text, video, maps and images are unidirectional – to the patient – and cannot dynamically change with context. A digital human can interpret mood, check understanding and so on and adjust delivery style or content to suit.
<i>Analogy</i>	Whilst videos can be used to demonstrate skills required of a sport a coach can assess how well a player has understood the demonstration and detect any learning frustrations that might require mentoring.
<i>Example - Health</i>	Pre-recorded videos are available on many hospital web sites to inform patients about cardiac rehab, heart meds and so on but there is no way to check that a patient has understood the content or is distressed by it without a conversational element with a real human (not scalable) or a digital human (scalable).

Consider Exit and Re-entry Points	
<i>Definition</i>	All conversations need to plan for exit and entry points to facilitate interaction flow whilst also avoiding 'messy' branching.
<i>Rationale</i>	The flow of planned interactions will be interrupted temporarily or permanently. A temporary interruption might be when a customer says, 'can you repeat that, I didn't understand what you were saying'. The digital human would query if it was a volume/speed or content issue and respond appropriately by going back in the conversation and speaking louder or more slowly or defaulting to an alternative explanation. A permanent interruption would occur when the digital human cannot meet the customer's stated requirement and has to drop out to a human assistant or terminate the conversation.
<i>Analogy</i>	A call centre service representative will repeat a question or response if requested and will escalate or divert to management or another representative if required during the conversation. Often the call will return to the original representative for closure.
<i>Example - Health</i>	A patient might need a toilet break when talking to a clinician or someone might come into the ward to dress a wound etc. that needs urgent attention.

Differentiate Between Short and Long Cycle Interactions	
<i>Definition</i>	Over time repeated short cycle interactions can influence behaviours and turn digital human roles into relationships. Poor design can lead to unintended consequences. Psychologists and codesign are critical to achieving this design principle.
<i>Rationale</i>	Many conversations are continuous short cycle, with a specific purpose such as delivering information or answering a question. Some though are intermittent long cycle interactions spanning hours, days or even months. The digital human needs to

	be able to remember where it is in a long cycle interaction and use new and recurring short cycle conversations to meet specific longer-term goals.
<i>Analogy</i>	Managing staff, raising children, building friendships and so on all have behavioural and relationships elements that over time are built on short cycle interactions.
<i>Example - Health</i>	Telehealth applications often use daily reminders and data requests to try and achieve medication compliance and lifestyle behavioural changes. Patients can find these distressing, seeing them as 'machines policing what they do' and recording 'holidays' often lead to permanent non-compliance. The digital human in health aims to gradually remove the barriers to compliance and develop rapport, trust and disclosure until patients achieve autonomous action.

Codesign should Balance Forward and Reverse Engineering	
<i>Definition</i>	Forward engineering builds from a conceptual model to the detailed application. Reverse engineering builds from a detailed application to infer a conceptual model.
<i>Rationale</i>	Forward engineering in codesign ensures common starting points against which other design principles such as modularity, postponement and ease of modification can be achieved using the unique features of digital humans. Reverse engineering looks at the existing conversations that customers have with advisors, service providers and so on to build a conceptual model of what works now to inform the conceptual model.
<i>Analogy</i>	Designers of electric vehicles start with a conceptual model that maximises the use of its unique features but examining existing vehicles and their design will show that facing the direction of travel has been implemented as the norm for drivers and passengers. Codesign brings everyone together to challenge both concepts and current implementations to determine an optimum design position. Psychologists aid this process by using research and heuristics to explain why some human preferences are not negotiable.
<i>Example - Health</i>	Forward engineering could be used to conceptually design a fully automated discharge process with digital human interactions, robot dispensing of meds, bandages etc. however working backwards from the manual discharge process (reverse engineering) would identify wide variations in patient physical ability, emotional state, cognitive ability and so on that would require a multi-channel approach that includes a human to human process for certain patient cohorts.

'Chunkories of Memory'	
<i>Definition</i>	Conceptually humans can only hold 3-5 (at most 7) ideas in their head at the one time when processing information. In practice, most patients, especially if in a physically or emotionally stressed state would struggle to retain 3 ideas.
<i>Rationale</i>	G.B.Davis – Information and Science Quarterly. Implication is that the digital human shouldn't present lists with too many items in them at the one time or concepts that have more than a few components. This is especially important where health illiteracy is a factor.
<i>Analogy</i>	Similar to concept of span of control where humans can only effectively manage 3-7 subordinates.
<i>Example - Health</i>	Many problems occur after discharge because patients are hit with lots of information about medications, would care, diet, exercise, next appointments and so on and each of these will contain many concepts. Providing printed information is not enough as a reminder because of health illiteracy. Patient's need explanations for each small chunk of information so that it can be absorbed.

Bounded Rationality

<i>Definition</i>	We find it difficult to believe what we are told if the very concept is foreign to us because it is well outside our education and experience.
<i>Rationale</i>	Exposure to people, to ideas and so on builds trust. In the absence of any exposure there is less reason to trust what we are told to do.
<i>Analogy</i>	Orson Welles radio play about an alien invasion of earth caused panic because the concept was unfamiliar to most citizens and they trusted the radio as their main source of instant news. These days most of us have seen or heard of alien invasion movies and are more familiar with the scientific view that travel between the stars is almost impossible. Therefore, we would have some understanding that it might be fictitious if we heard it and not panic.
<i>Example - Health</i>	Early patient experience with medications is often simple painkillers or maybe a course of antibiotics for an infection that have short term effects. They have no concept of drugs like statins that have longer term effects and patients often take 'medication holidays' or stop them altogether and when there are no ill effects never take them again.

Nothing About Me without Me	
<i>Definition</i>	Users need to be included in all aspects of design and development, not just occasionally consulted.
<i>Rationale</i>	This is a humanitarian principle and is critical to usability and acceptance. This codesign principle is a critical component of the 'chain of proof' for reducing negligence claims in that a digital human to patient interaction in a transcript or recording can be proven to be fit for purpose because illiteracy, accessibility needs etc have been met.
<i>Analogy</i>	A homeowner might be able to claim negligence against an architect for a flawed design by claiming they didn't understand what the architect was presenting but if the homeowner was an active part of the design process it is more likely to meet their needs but, if it doesn't, a case against the architect would be harder to prove..
<i>Example - Health</i>	Technical and medical staff might think they know how a patient feels when they are discharged from reading research, but every community and patient cohort has its own challenges and broad inclusion in codesign is critical to uncovering the real challenges patients face and discussing with them what will help. Patient 1's meal didn't arrive one night in hospital just before surgery and the nursing staff said 'order Uber Eats' and the hospital will pay for it. Patient 1 had never ordered food online before, was already stressed and didn't know what to do. The younger nursing staff offered what to them was an easy solution, to the patient it created further anxiety.

Digital Humans need a Life Cycle Operating Model	
<i>Definition</i>	Ongoing and integrated management, governance and evolution of the knowledge and interaction base with the underlying technology.
<i>Rationale</i>	Businesspeople would understand that software has upgrade cycles, might be modified etc but digital humans are more complex in that there are behavioural/psychological elements often coupled with complex regulatory environments and ongoing research and development into the core knowledge base of each digital human's industry/domain/use case. This is on top of any of the usual software and hardware changes.
<i>Analogy</i>	Aircraft design uses a life cycle concept that includes regular minor, medium and major maintenance, fault funding and rectification, life cycle costs including operations, maintenance and administration, governance of design and so on. These are all developed before production of the first aircraft.

<i>Example - Health</i>	R&D into prevention, procedures, treatments and medications is ongoing and the results need to be incorporated into health digital humans. Likewise, avatar and AI technologies are constantly evolving. Finally, telehealth as a whole is rapidly expanding. The LCOM enables effective and timely incorporation into the health digital human capability.
-------------------------	---

Standardisation	
<i>Definition</i>	Standardisation is the practice of designing to ensure the widest possible use of a good or service without the need for modification.
<i>Rationale</i>	Standardisation reduces costs and speeds up deployment.
<i>Analogy</i>	Many auto manufacturers have merged and created a small number of standard chassis complete with electronics from which multiple models can be created.
<i>Example - Health</i>	The guided conversations and corpus content of the digital human cardiac coach have been designed so as to be useable across multiple chronic conditions.

Localisation	
<i>Definition</i>	Localisation is the practice of making minor changes to a standard to meet regional variations that cannot be easily removed: <u>Cultural</u> variations can include language, foods and customs. For example, favourite foods enjoyed by patients can vary between regions in the USA. <u>Administrative</u> variations can result from regional laws and regulations or practices. Examples include who to call in an emergency, how to make an appointment etc. <u>Logistics</u> (or process) variations can include how to obtain a shower chair for use at home after discharge, resupply of medications and so on.
<i>Rationale</i>	Localisation is an important part of codesign because it makes sensible adjustments to the standard to maximise patient participation and comply with mandatory regulations or practices.
<i>Analogy</i>	Auto manufacturers make small local changes in each country to standard models to accommodate variations such as emission regulations. Major changes such as swapping from left hand drive to right hand drive are specialisations (see next section).
<i>Example - Health</i>	A regional hospital adopting a digital human cardiac coach would seek localisations for patient dietary needs, administrative processes such as requesting home care or patient transport and attending cardiac rehab.

Specialisation	
<i>Definition</i>	Specialisation is the process of creating a variation to a standard that itself becomes a new standard.
<i>Rationale</i>	Specialisation builds on the benefits of an existing standard but broadens the use of that standard to new requirements.
<i>Analogy</i>	Auto manufacturers in the USA or Europe will create a left hand drive version of a standard automobile for use in the Australian, British and New Zealand markets.
<i>Example - Health</i>	The guided conversations and corpus Q&A for the digital human cardiac coach can have, for example, oncology specific medications and side effects added to the existing conversation patterns without the need to create entirely new AI intents.

13 Table of Provided Documents

The following list of documents published on GitHub accompanying this explanatory guide on “How to Create a Digital Human Health Coach” together are not presented as a textbook or training course; these are our working documents that we have been developing and using over many years.

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
READ THIS FIRST – HOW TO CREATE A DHHC		READTHISFIRST - How to Create A Digital Human Health Coach	This document provides selected extracts from an ebook which we will publish in due course. It is a detailed explanation of the background, co-design process, and our approach to the development of the corpus which we believe is necessary to overcome the impact of health illiteracy on machine learning in all health domains. Together with the webinar presentation, people should read this document first to assist with the navigation of the documents published on GitHub.
Webinar Presentation			This can be viewed via YouTube https://youtu.be/i5ny_S2slyk (too large for GitHub)
Composite Deck		CompDeck (Pt1, Pt2, Pt3) - Digital Human Body of Knowledge - Composite Deck	This is a large document broken into 3 parts to meet GitHub size requirements, a compilation of the various frameworks and methodologies. This has been put together so that people get a sense of the extent of the IP development process that can be leveraged. This document does not include the corpus (or key elements such as the frameworks, guided conversations, Q&A, questions, synonyms).
Capability Blueprint			Capability Blueprint describes the overall capability architecture, capability and roadmap of the DHCC
	Capability – Interactions – Machine Vision		Describes the machine vision capability; how this supports priority target interactions; and a roadmap.
		CB - CIMV - Capability Prioritisation Tool	Describes the business, language, domain and technology factors to be considered in prioritising a DH use case capability.
		CB - CIMV - Potential MVP Timeline Capability Phasing	Describes MVP capability phasings across 30-60-90 days – and aligned to CMS Codes – see business case documents for analysis.
		CB – CIMV - Reuse and Modularity Capability	Describes using modularity and Identifying commonality to prioritise capability development and maximise reuse opportunities.
		CB - CIMV - Target Interactions and Machine Vision	Describes how machine vision, screen capture, and the use of the camera can be used to capture physiologic measurement in a guided conversation. Maps machine vision capability to the Apple Health ecosystem. Maps to CMS codes across 30-60-90 day use case.
	DH Architecture		Digital Human Conceptual Architecture
		CB - DHA - Digital Human Architecture	This is the digital human health coach – omni channel conceptual architecture. Shaped by co-design. This is a strategic document.
	DH Deconstructed		

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
		CB - DHD - DH Health Coach - Deconstructed	This diagram deconstructs the components of the digital human health coach across the Centre for Digital Business Digital Human Health Coach model; avatar platforms; and AI platforms. Demonstrating that without the Digital human health coach model, the avatar is an empty shell.
	Ecosystem and Telehealth		
		CB - ET - Augmented Healthcare and Hierarchy	Diagrammatic representation of health illiteracy and other barriers impacting access and outcomes – across legacy health; websites and patient forums; apps and wearables; health ecosystems; virtual worlds; and AI digital humans. This is a strategic diagram.
		CB - ET - Ecosystem and Telehealth	Series of models illustrating the Apple Health ecosystem as a “one-stop shop” in telehealth. Conceptual mapping of Apple Health ecosystem against new US telehealth codes – this would in general apply to other telehealth codes in other countries. To be read in conjunction with the business case documents.
Co-Design			Co-Design: Contains detailed tools and frameworks to be applied in the co-design of a digital human health coach. These tools and frameworks can be applied to the co-design of digital humans in other domains and there are a number of non-health use cases provided.
	Complexity Framework – Use Cases		Framework to determine use case complexity. The objective is to avoid unnecessary bespoke development that cannot be re-used or scaled.
		CD - CFUC - Digital Human Cardiac Coach – Complexity Framework.	Frameworks to determine use case complexity, and how different digital human cardiac coach use cases – across the patient journey and for different demographics – involve different levels of complexity, and risk.
	Context and Embodiment		Framework for considering digital human personality and brand.
		CD - CE - Context and Embodiment for Personality and Brand	Up front consideration of brand and personality is essential and this is done through co-design. The layers of embodiment (domain knowledge, what she looked like, her mannerisms, voice etc) and the layers of context (this is about the community, industry, policy settings, use case etc) - combined to reflect the personality and the brand. Understanding the combined elements of context and embodiment is necessary to risk management and brand management.
	Evolution and Flow Model		Model that represents the evolution of a digital human capability and the operating model necessary to support it.
		CD - EFM - Digital Human Evolution Flow Model	Model that represents the evolution of a digital human over time – across the lifecycle from initial proof of concept to sustainment. Illustrates the role of the operating model, and the governance required to maintain and update the digital human body of knowledge (corpus etc) through analytics.
	Lexicon		Digital Human Lexicon – Work-in-Progress
		CD - L - Digital Human Lexicon	The purpose of this document is to capture and explain key words and concepts used through our various documents and articles. This list is not exhaustive nor definitive, and is a work-in-progress as thinking evolves.
	Pathways		Model that represents the four pathways to a digital human.

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
		CD - P - Digital Human Pathways	The four pathways are: creating ab initio (a digital human); copying (a digital human); evolving (a digital human); and digitally cloning (a REAL human). What is the right one for your organisation or purpose? To be determined through co-design, applying the framework for “Context and Embodiment
	Specialisation – Localisation - Standardisation		Design principles and patterns for replication and scaling. The objective is to avoid unnecessary bespoke development that cannot be re-used or scaled.
		CD - SLS - Specialisation – Localisation - Standardisation	Core to the co-design process and planning for scale, is understanding standardisation, specialisation and localisation. This framework applies to the digital human persona, guided conversations, and the use and re-use of other assets such as videos and maps.
	Use Cases and Personas		Frameworks and sample use cases and personas to assist designing for modularity and reuse. The objective is to avoid unnecessary bespoke development that cannot be re-used or scaled.
		CD – UCP - Designing for Re-Use	Describes using modularity and Identifying commonality to prioritise capability development and maximise reuse opportunities. Refer to Blueprint Capability topic, repeated here to emphasise patterns of re-use across use cases.
		CD – UCP - Health and Engineering	Framework to illustrate the intersection between health and engineering use cases and solutions.
		CD – UCP - Cardiac Rehab Use Case Persona Example	Framework to illustrate how personas are an essential design component in designing digital human guided conversations, including optimising for re-use. Digital human cardiac coach patient #1 is the “example” persona.
		CD – UCP – Utilities Use Case and Persona Examples	Personas framework applied to the designing of digital humans in the utilities sector. Based on Al Johnson’s global experience in the utilities sector, this illustrates three different personas and common conversation patterns in utilities.
Strategy – Business Case – Operating Model			Strategy – Business Case – Operating Model: Contains reference documents, market statistics, frameworks and CMS revenue and other benefits modelling, as components for potential business cases.
	CMS Codes - References		The US Government Centers for Medicare and Medicaid Services (CMS) is responsible for billing codes for reimbursement for the cost of healthcare services in the US. In 2018, CMS announced several new billing codes to incentivize the use of technology to engage with patients at home. The decision to expand reimbursement for providers for the use of communication technology-based services recognizes the important role these services play in increasing patient engagement and reducing unnecessary costs. These policy updates signal that CMS is moving quickly to incentivize the integration of innovative technologies as it pushes for the transition to value-based care. https://www.cms.gov
		SBCOM – CMSCR - <files>	Ten reference documents providing information and FAQs about the new US CMS codes and opportunities for telehealth.

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
	CMS Codes and Revenue Modelling		Contains documents that together describe how the new US CMS codes might map to DHCC use cases, revenue potential and other benefits than could be built into a business case.
		SBCOM - CMSCRM - Analysis of CMS Codes for DHCC Use Cases	This document provides a “narrative” of a DHCC use case and how the CMS codes might apply when specific DHCC capabilities are initiated. Note: whilst the component technologies exist and are in common use generally, these have not been “built” into a DHCC offering. This is to demonstrate for priority capability planning purposes.
		SBCOM - CMSCRM - DHCC Capability – CMS Code Mapping to Revenue	This spreadsheet models the above “narrative” DHCC use case, to CMS revenue reimbursements over 30-60-90 days. Illustrates that the common patterns of these processes – and revenue flows – might also apply to other health domains. Note: this is a high level analysis and would need to be further validated by experts in CMS code analysis.
		SBCOM - CMSCRM - Modelling of Revenue from New CMS Codes on a 90 Day Use Case – Including Telehealth Ecosystem	This document illustrates the DHCC capability mapping to CMS codes across the patient journey; the potential revenue flow every 30 days; and other hard financial benefits that could be built into a business case. Also represented is how the DHCC design mapping to the new CMS codes can also be part of and leverage health ecosystems (such as the Apple health ecosystem) and telehealth processes.
	Heart Disease Lifecycle and Health Illiteracy		The purpose of including a lifecycle cost perspective as part of the “Strategy – Business Case – Operating Model”, is to provide multiple perspectives to a business case and potential economic model.
		SBCOM - HDLHL - Heart Disease Lifecycle and Health Illiteracy	This document illustrates the impact of health illiteracy on the heart disease lifecycle – and what needs to change from the perspective of the individual citizen, government and commercial providers. Health illiteracy is impacting outcomes, costs and operational performance system wide.
	Key Market Statistics		The purpose in providing this global perspective, is that a business case pattern, once developed, can be applied to other markets.
		SBCOM - KMS - Market Analysis and Research	Summary of market research globally: impact and cost of CVD on economies; impact and cost of health illiteracy – including estimate of cost of health illiteracy on CVD; research on impact of health illiteracy on medical liabilities; costs and impact of non-adherence; and costs and penalties of readmissions.
		SBCOM - KMS - Stats and Research references	Reference and raw stats by country. References on the use of avatars in clinical settings: SimCoach; discharge processes. Note: analysis and commentary in “READTHISFIRST - How to Create A Digital Human Health Coach”, in webinar and in composite deck – on the accessibility and other limitations including health illiteracy, of apps and simplistic text-based chatbots.
	Operating Model		The reason why “Operating Model” is included in the business case / strategy section – is that there are always costs associated with an operating model – and costs associated with the absence of an operating mode. “Software as a Service” in healthcare does not overcome the need for an Operating Model. Determining the operating Model is a

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
			critical success factor for the digital human health coach – and for any digital endeavour.
		SBCOM - OM - Operating Model	Model for the operations and sustainment of a digital human. This needs to be thought about up-front, even for a proof-of-concept as this is a key governance and risk management framework. Also refer to: “How to Create a Digital Human Health Coach”, in webinar and in composite deck.
	Prioritisation and Functional Deployment Model – Revenue		How do you know where to start, what capabilities to deploy in what sequence, in order to achieve benefits?
		SBCOM - PFDMR - Prioritisation and Functional Deployment Model – Revenue	This framework assists with the filtering and prioritisation of use cases, capabilities, corpus development and guided conversations – with different capabilities driving different benefit areas. Used to support planning and business case development.
Corpus – Q&A – Guided Conversations			Corpus – Q&A – Guided Conversations. Contains assets which can be immediately applied to the development of a digital human health coach. <i>Important:</i> Refer to “ READTHISFIRST - How to Create A Digital Human Health Coach ”. The document “ CQAGC - DHCM - Corpus - Guided Conversation Methodology ” outlines in detail the process by which Q&A, intents, and guided conversations are developed – emphasising the focus on health illiteracy. Emphasis on structuring the approach to the development of the corpus to address the impact of health illiteracy on conversation design and machine learning. <i>Note:</i> disclaimer statement on due diligence and governance required by organisations.
	Corpus - Content Primacy		Is all content the same? How do you know what content to use /re-use?
		CQAGC - CP - Content Primacy Strategy	A framework that maps categories of content – “created” content; “collated” content; and “curated” content” – to the development of common patterns of conversations across health domains. Applies the concepts of “Specialisation – Localisation – Standardisation” described earlier to maximise re-use. Framework to be applied in co-design activities, and specifically to filter out content that has not been designed for health illiteracy.
	Corpus - Guided Conversations		10 ready-to-go guided conversations as a core to get started. These will require further refinement though co-design and initial proof-of-concept.
		CQAGC - GC - Inpatient Guided Conversations - WIP	Repository of 10 WIP guided conversations, which have been developed through research and co-design. Priority determined by benefit areas. Note: these conversations will need to be coded into an NLP, to include the various dialogue handlers and navigators, and digital human gestures (such as nodding etc).
	Corpus – Q&A – Heart Failure		Heart failure questions, intents, answers and training phrases. Note: more work required to build out the corpus to support Q&A interaction.
		CQAGC - CQAHF - Common HF	A working draft of specific questions about heart failure. To be read in conjunction with the heart failure guided conversation.

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
		Questions and Answers	
		CQAGC - CQAHF - Heart Failure Intents Spreadsheet	A spreadsheet model of heart failure questions, intents, answers and training phrases. To be read in conjunction with the heart failure guided conversation.
	Corpus – Q&A - Meds		Meds questions, intents, answers and training phrases. Note: more work required to build out the corpus to support Q&A interaction.
		CQAGC - CQAM - Corpus – Common Meds Questions and Answers	A repository of common meds questions and answers – an extensive list resourced from “Reference Organisations” described in the document “CQAGC - DHCM - Corpus - Guided Conversation Methodology”
		CQAGC - CQAM - Corpus – Meds Raw Data	A spreadsheet of meds questions; synonyms by category and common usage; and concatenation.
		CQAGC - CQAM - Corpus – Meds Working Document	A spreadsheet of meds Entities and Synonyms; Intents and Answers; and guided conversation objectives.
	Corpus – Q&A – Leaving Hospital		Leaving Hospital questions, intents, answers and training phrases. Note: more work required to build out the corpus to support Q&A interaction.
		CQAGC - CQALH - Corpus – Common Leaving Hospital Questions and Answers	A repository of common “leaving hospital” questions and answers – an extensive list resourced from “Reference Organisations” described in the document “CQAGC - DHCM - Corpus - Guided Conversation Methodology”.
		CQAGC - CQALH - Corpus – Leaving Hospital Raw Data	A spreadsheet of leaving hospital questions; intents; answers; and training phrases.
		CQAGC - CQALH - Corpus – Leaving Hospital Working Document	A spreadsheet of leaving hospital questions; intents and answers (all); intents and answers (HF); intents and answers (women); answers; training phrases; and guided conversation objectives.
		CQAGC - CQALH - Corpus – Sample Templates – Leaving Hospital	Template used for the development of guided conversations on specific themes/topics to incorporate objectives, risks, enablers, awareness goals, and data capture. This sample template has been pre-populated as the core of the “leaving hospital” guided conversation.
	Corpus – Q&A – Rehab		Rehab questions, intents, answers and training phrases. Note: more work required to build out the corpus to support Q&A interaction.
		CQAGC - CQAR - Corpus – Common Rehab Questions and Answers	A repository of common “rehab” questions and answers – an extensive list resourced from “Reference Organisations” described in the document “CQAGC - DHCM - Corpus - Guided Conversation Methodology”.
		CQAGC - CQAR - Corpus – Rehab Raw Data	A spreadsheet of rehab questions; intents; answers; and training phrases.
	Corpus Development		An illustrative framework showing the process from research through to the development of the corpus on a specific topic, incorporating both Q&A patterns and guided conversations.
		CQAGC - CD - Corpus Development –	A framework that illustrates the corpus development from Q&A patterns and guided conversations. Using Meds as the example. Shows how synonyms are applied to common patterns of questions / intents. Shows how a Q&A interaction

MAIN TOPIC	SUB-TOPIC	DOCUMENT NAME	PURPOSE
		Sample Q&A Intents – Meds	can also trigger a guided conversation to provide a more contextual response beyond a specific question and answer pair.
	Design Principles		Design principles are critical governance tool underpinning operational integrity. These need to be maintained and reviewed.
		CQAGC - DP - Corpus – SME Design Principles and Approach	A framework that illustrates the application of design principles throughout the co-design process, including the development of the themes and topics, Q&A, guided conversations, and the determination of scope for a proof of concept. Incorporates the design methodology “Specialisation – Localisation – Standardisation”.
	Digital Human Conversation Methodology		A series of artefacts that establish the Digital Human Conversation Design Methodology. Emphasis on structuring the approach to the development of the corpus to address the impact of health illiteracy on conversation design and machine learning.
		CQAGC - DHCM - Corpus – Examples of Poorly Worded Responses from Moderated Forums	Questions and responses taken from moderated patient forums. Questions from patients. Responses provided by health professionals. Most responses very technical in nature, assuming that people understand concepts and language – responses written for a different audience. Illustrates that even on authoritative forums, the impact of health illiteracy is not understood.
		CQAGC - DHCM - Corpus – Guided Conversation Methodology	Detailed design methodology for the creation of digital human guided conversations.
		CQAGC - DHCM - Corpus – DHCC Conversation Templates	Worksheets and templates to be used in the development of new / updated digital human guided conversations. For detailed instructions, refer to the document: “CQAGC - DHCM - Corpus - Guided Conversation Methodology” and to “How to Create a Digital Human Health Coach”.
		CQAGC - DHCM - Corpus – Risk Summary - WIP	A WIP checklist of risks to assist with the development of guided conversations – to be used in conjunction with the worksheets and templates and instructions in the documents: “CQAGC - DHCM - Corpus - Guided Conversation Methodology” and to “READTHISFIRST - How to Create A Digital Human Health Coach”. The risk summary is to be maintained through update and review.
Research Documents			Extensive repository of research documents covering health illiteracy; CVD population research; women and minorities; Presidential Advisories; the application of artificial intelligence, virtual assistants, virtual worlds etc in clinical, review, education and rehabilitation settings.
	General Research	RD - <files>	Multiple research files from various sources
	SimCoach	RD – SC - <files>	Two research files on SimCoach
	Software Devices Regulation	RD – SDRI - <files>	Two research files on software devices regulation
END			