Training needs for future healthcare professionals using assistive robots in health and social care

Exploring the role of system users and staff in safety assurance in the real-world

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Assistive Robotics in Healthcare Demonstrator


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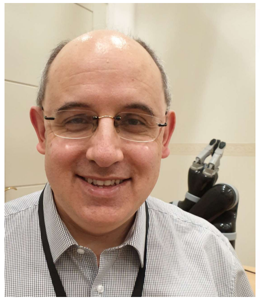
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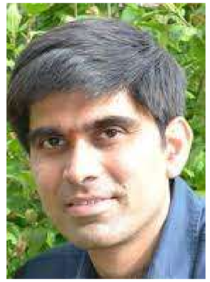
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Physically Assistive Robots

Example Applications:

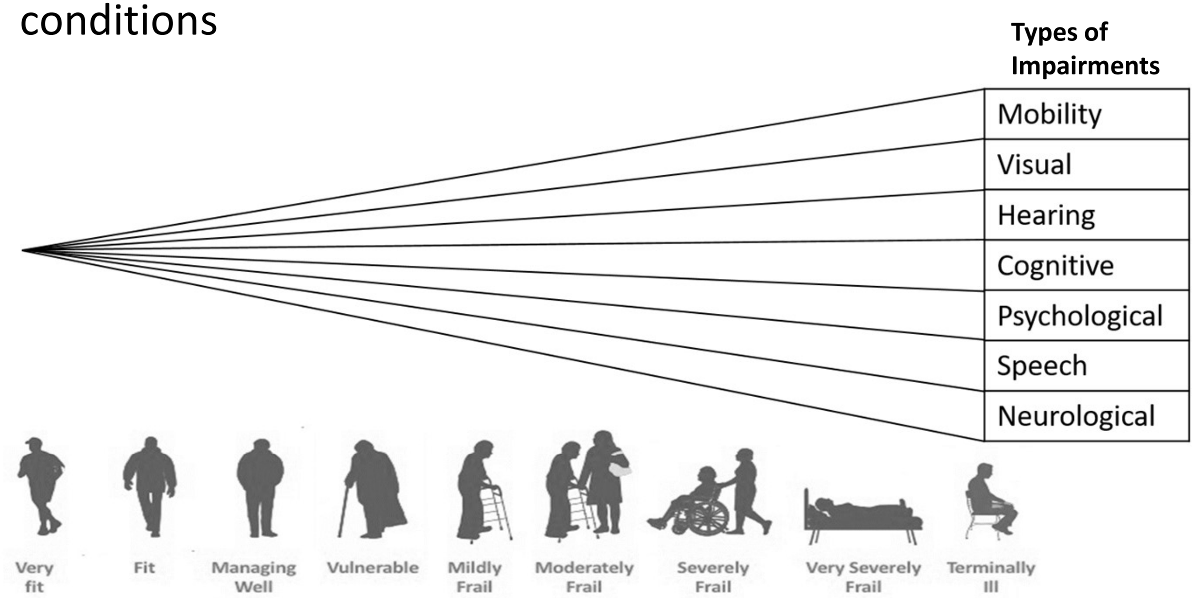
- ❑ Walking assistance
- ❑ Sit-to-stand and mobility assistance

Functional Support for:

Maintaining independence for ADLs	Physical support for tasks such as dressing, walking, food preparation
Enabling Rehabilitation	Supporting frequent and guided practice of exercises
Addressing care staff shortages	Reduction from two carers to one, or even zero for mundane tasks
Alleviation of physical workload for carers	Reduces injuries such as back strain, reduces sickness absence
Providing diagnostic information for carers	Sensor data recording, trend analysis, detection of emerging conditions

Challenges for Physically Assistive Robots

- Patients/users can have complex multiple co-morbidities and conditions

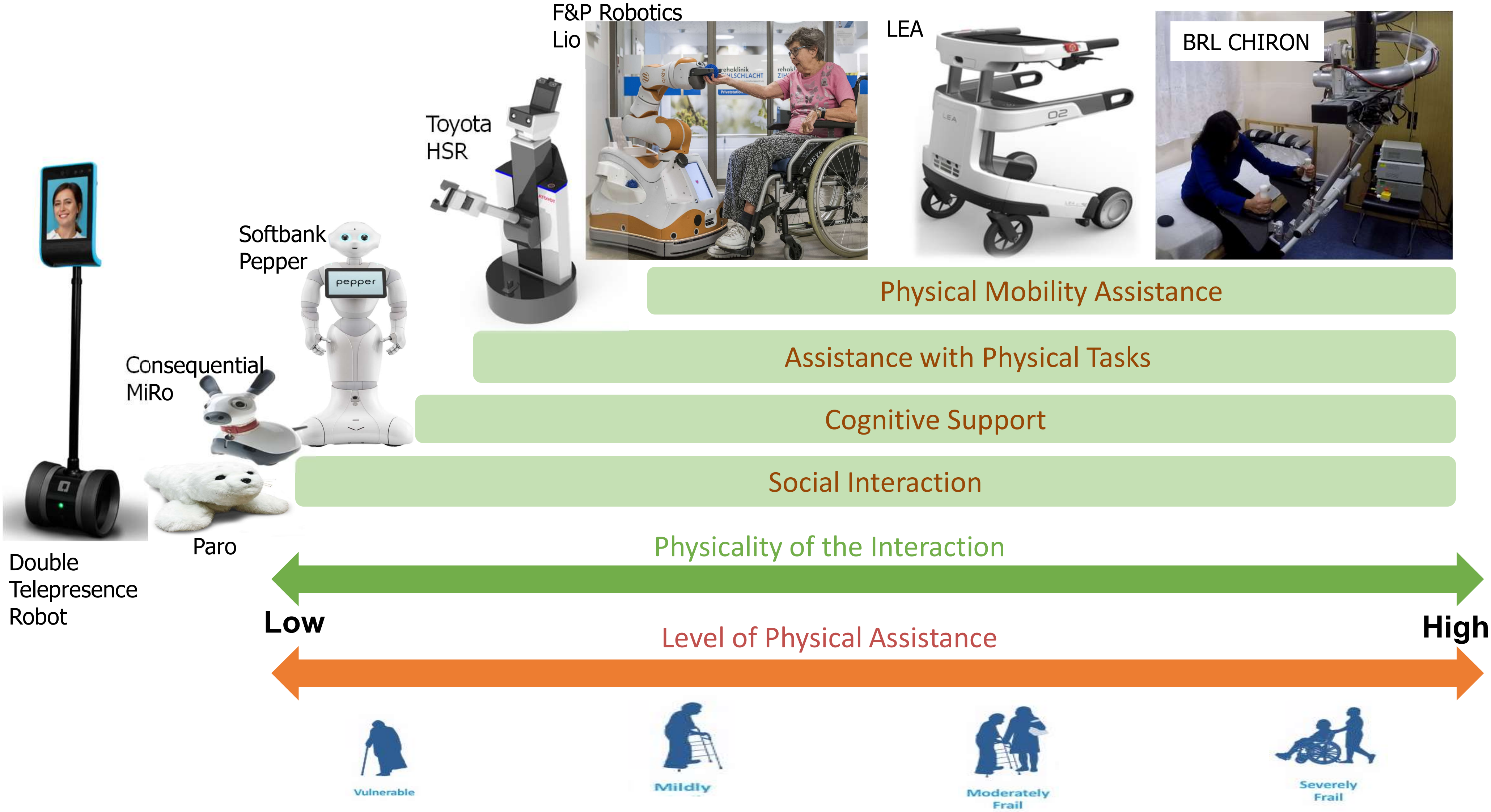


Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, Mitnitski A. A global clinical measure of fitness and frailty in elderly people. *CMAJ*. 2005 Aug 30;173(5):489-95

- Robotic assistance must be *adaptable* – behaviour must be easily reconfigurable to different user needs and characteristics
- Operational conditions are complex and multivariate, often with no analytic solutions

Real-world operational conditions

Levels of Assistance and Interaction



Personas and Scenarios to Support User-Centred Design

Amy (age 76)

- Frailty level~4 (vulnerable)
- Cause of frailty: fractured hip due to a fall over broken paving stone in garden resulting in weakness and loss of balance
- Location: living at home
- Goal of robotic assistance: to maximise independence.

Independent Living at Home (Amy):
In this scenario Amy may require the use of CHIRON to assist Sit-to-Stand from an armchair, Walking across the room and to Stand-to-Sit onto a dining room chair. The chairs could be of different seat heights. This scenario should also consider the maximum walk distance within room and the need of the robot to communicate with Amy to give prompts, encouragement and reassurance. Micro Scenarios that could develop from this comprise: stand up and sit down quickly, walk at slower and faster paces, carrying a book, poor posture when walking, and Amy's cat suddenly walking across her pathway.

Anna (age 89)

- Frailty level~4 (vulnerable)
- Cause of frailty: after-effects of chest infection
- Location: in hospital
- Goal of robotic assistance: to practise walking to improve strength and stamina and regain confidence using a walking stick.

Rehabilitation Therapy in Hospital (Anna & Alison):
In this scenario, Anna uses CHIRON primarily to provide therapeutic standing and walking exercises, but also as a general mobility aid around hospital wards. Micro scenarios included in this case are: Anna needing to stop and rest every few steps due to breathlessness or needing to call for help /assistance.
As in previous scenario, the goals and needs of Alison(Anna's physiotherapist) should be considered. Alison is encouraging Anna to repeat and follow a pattern of Sit-to-Stand, Walking, and Stand-to-Sit, and she would like to monitor and record Anna's progress.

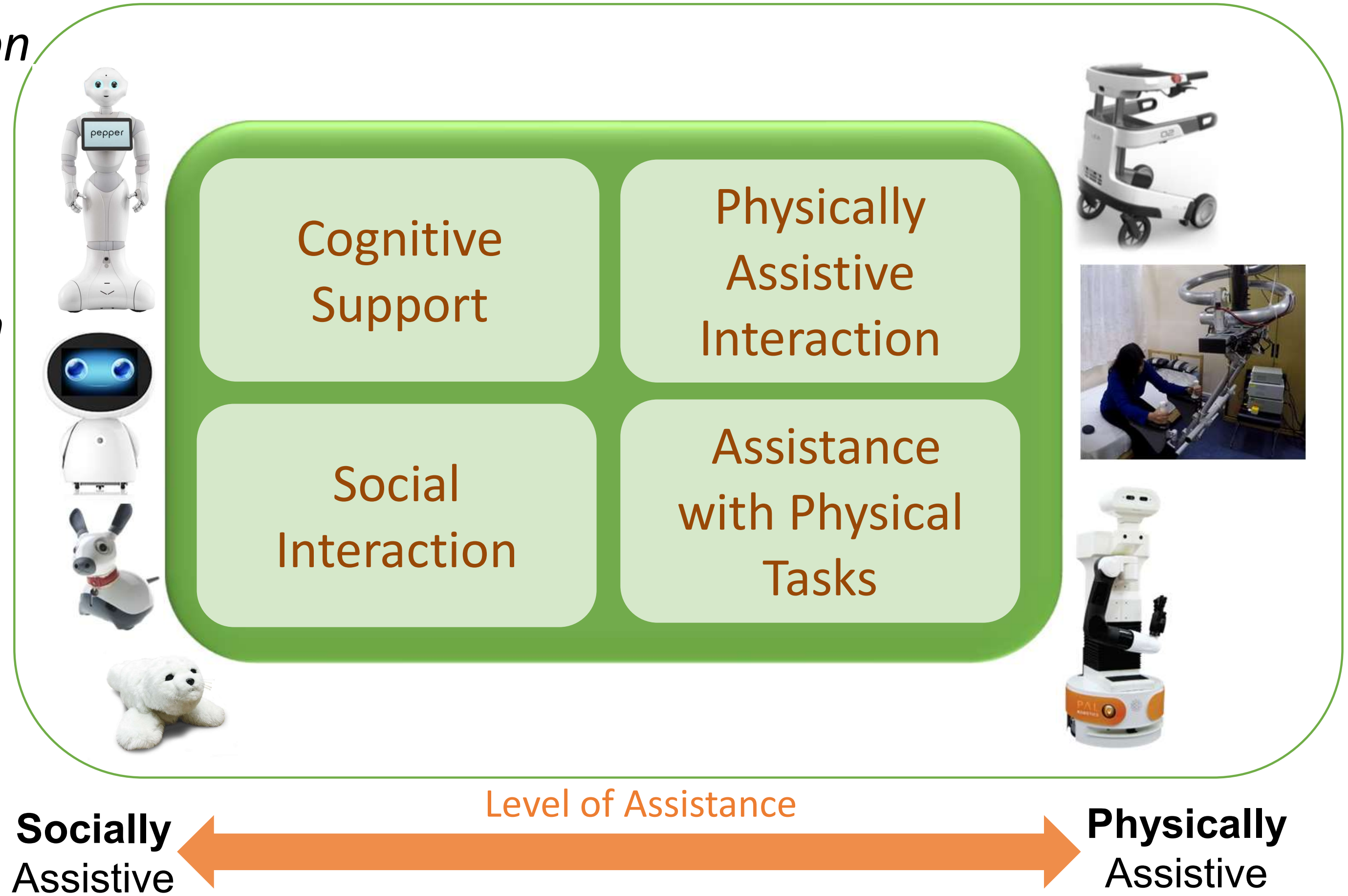
Arjun (age 80)

- Frailty level~6 (moderately frail)
- Cause of frailty: after-effects of a stroke
- Location: living at home
- Goal of robotic assistance: to reduce number of carers from two to one (family member Arrush)

Living at home with a Carer (Arjun & Arrush):
In this scenario a severely frail user named Arjun is using the robot at home, accompanied by a Family Carer (non-or semi-professional) named Arrush, to stand from a bed, take a few steps and sit down onto a wheelchair. Micro-scenarios in this case comprise the following variations: stand to manage clothing and/or to adjust posture and sit further back on seat, transfer between bed, shower chair/commode and wheelchair, support needed to maintain balance when walking and/or to stand briefly to be able to adjust clothing, manage personal hygiene, and verbal step by step instructions needed to stand, walk or sit.
Moreover, in this case the goals and needs of the carer(Arrush), who would like to be able to help his dad on his own should also be considered. He will need to be able to direct and control CHIRON, as well as encourage, guide and assist his father, without relying on other carers.

Safety considerations regarding robot assistance

1. *Is the initial system configuration correctly determined?*
2. *Is the adaptation mechanism appropriate?*
3. *How is online system adaptation to the user's changing needs verified?*
4. *Should the robot always assist? To what extent should it assist?*



Potential Hazards
derived from consultation with care experts

User Related

- User collapsing or falling
- User lets go suddenly (e.g. distracted by ringing phone)
- User could rush towards their target in an uncontrolled way, once they are standing, which could lead to a collision or a fall.
- User has a bent posture, and hits their head on the robot
- User has wet hands and slips off (loses grip of) the robot handles
- User wants to stop but cannot let go, e.g. due to arthritis
- Loose clothing gets in the way and causes restriction/tripping
- User feels anxious (especially at the point of letting go of the chair) and fails to transfer onto the robot properly, leading to a fall
- User wants to sit (or collapse) straight back down before completing the Sit-to-Stand action.

Falling Modes

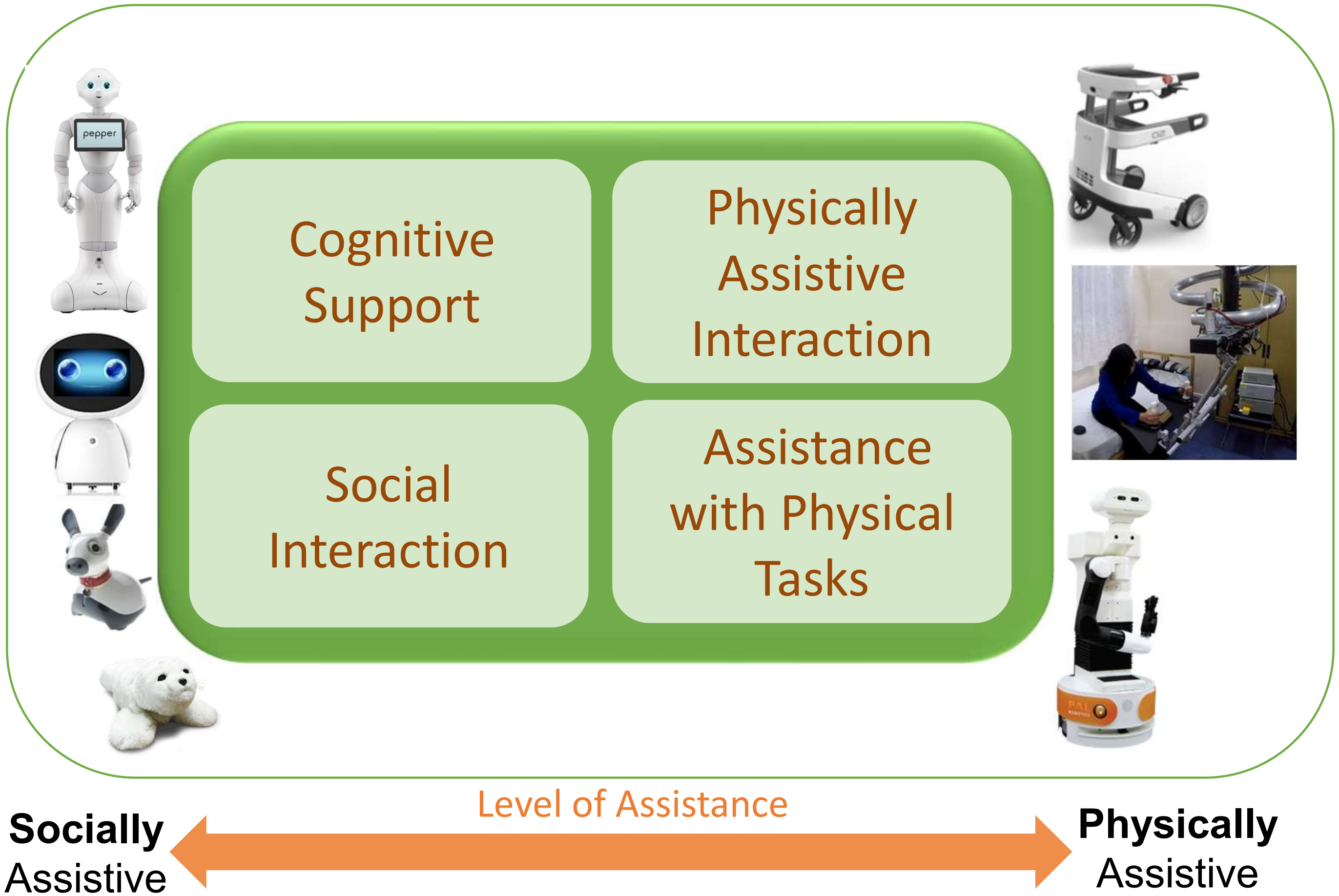
- Fainting from standing up too quickly.
- Tipping forward and getting caught up in the robot
- Falling backwards and hitting the chair that the user is standing up from, or hit his/her legs on the bed he/she is standing up from
- Falling into a small or narrow space, e.g. between furniture or between bed and wardrobe, where it is difficult for the user to get up with or without assistance from the robot.
- Falling forward and colliding with the robot
- Crumpling to the floor while still holding the handles resulting in injure, e.g. shoulder injury.
- Losing balance or having sudden pain or a muscle spasm, and fall over
- Foot/feet slippage forward during standing

Robot Related

- Equipment failure, leaving the user in a stranded position
- Speed mismatch between robot and User – robot moves too quickly and pulls the User across the room or off their feet (to fall down)
- Robot does not encourage good standing or sitting technique, which may either be dangerous (risk of strain injury) or counter-productive to rehabilitation.
- Robot noise levels: excessive or anxiety-inducing noise may have a negative impact on user behaviour.
- User might not find the robot behaviour or embodiment acceptable

Who does what and when and how often?

1. *System safety assessment*
2. *Initial system configuration*
3. *Training the user(s)*
4. *Verification of performance (human factors, clinical efficacy and safety)*
5. *Updating the system*
6. *Routine maintenance (cleaning)*
7. *Scheduled maintenance (re-calibration and system performance testing)*
8. *Breakdown support and repairs*
9. *Ongoing system review*

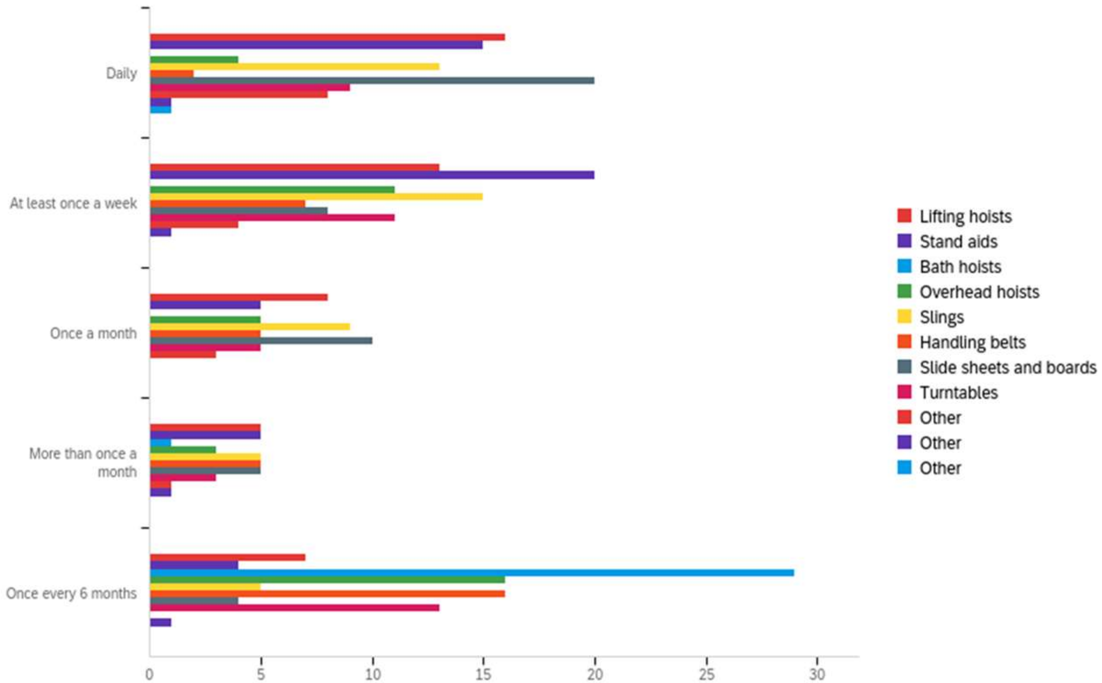


Roles in the real-world

1. Healthcare professionals
2. Social care professionals
3. Unpaid carers
4. Informal assistants (volunteers)
5. End-user

Survey with HCPs regarding training needs

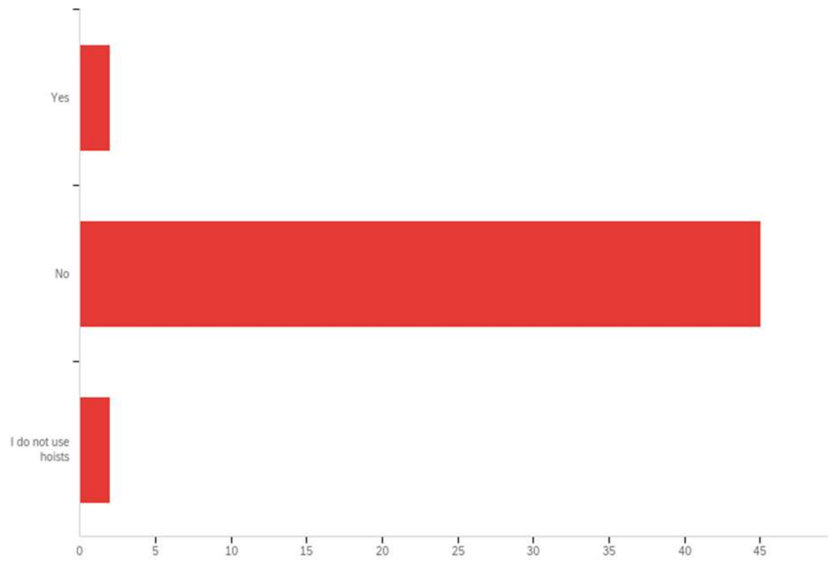
- National Association for Safety and Health in Care Services
- ASSOCIATION OF CHARTERED PHYSIOTHERAPISTS IN NEUROLOGY (ACPIN)
- Skills for Care UK



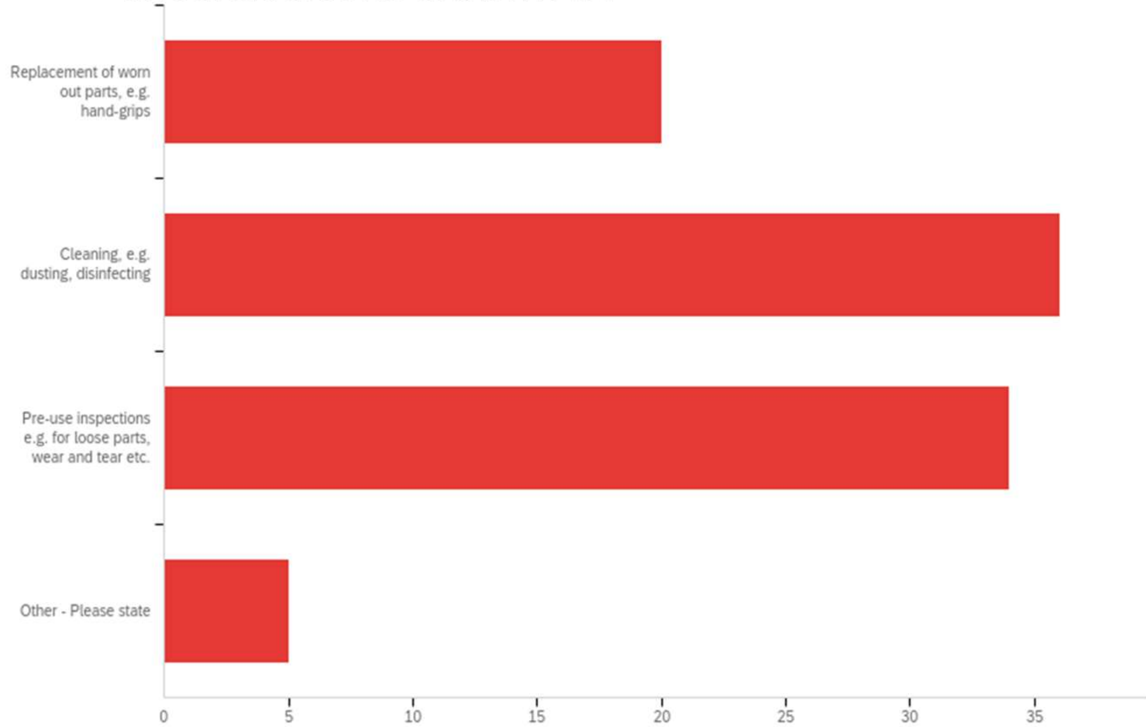
Patient Groups	LEA Walker	Robear	Resyone Bed	CHIRON
Stroke	22	14	13	11
Frail	20	13	10	12
Parkinson's Disease	20	5	5	2
Multiple Sclerosis	12	5	5	9
Functional Neurological Disorder	8	2	2	6
Acute spinal cord injury	3	2	5	5
Elderly	8	3	2	1
paediatrics	1	12		
Motor neurone disease	2	2	8	
Dementia	4	3	1	3

Survey findings

Q If you use hoists, are you required to carry out any calibration before you use them?

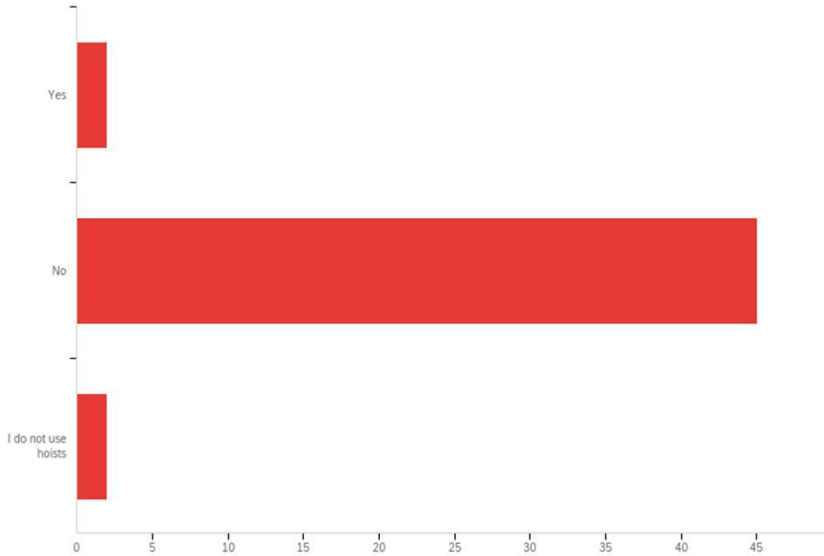


Q Robots are complex machines and are likely to require more maintenance. What basic care or maintenance tasks would you be happy to take on yourself for this type of robot, provided you have been given instructions/training?

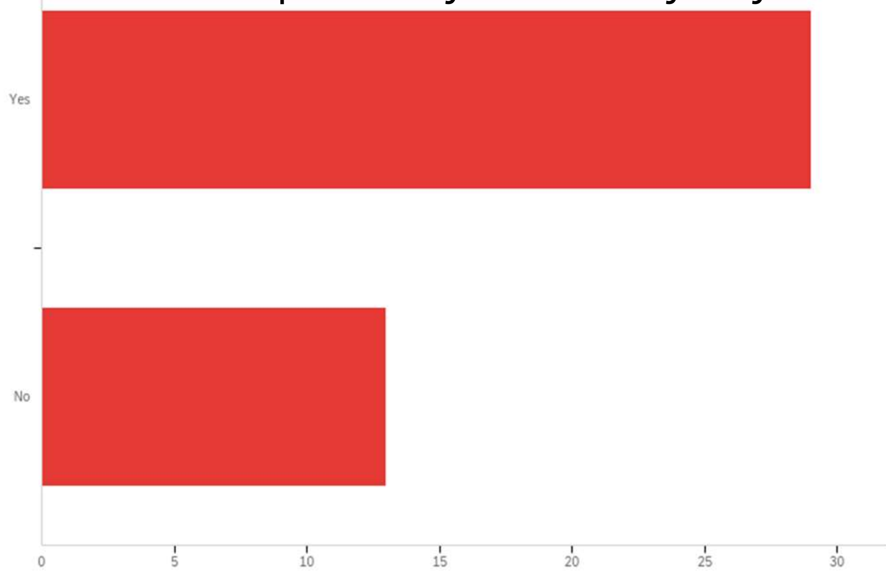


Survey findings

Q If you use hoists, are you required to carry out any calibration before you use them?



Q32 Would you see these basic maintenance tasks for this type of robot as part of your everyday role?



Survey

Q25. What do you think the content of a training course should be for a robot of this kind?
principles behind it / rationale, how it works, demo, try it out for yourself, case studies and experience time with different pathologies, trouble shooting
Practical. Emergency scenarios., Errors of the machine. Setting up the machine correctly., Appropriate patient group for use with patients. How to use the controls.
User manual, demonstration face to face, usage, observation, practice, sign off.
Clear YouTube video that is easy to refer to Face to face explanation and trial with clinicians to understand functions.
How to use it, who it is appropriate for, cost, how to order and how long it takes to install, what types of property would it be available for, physical practice of how to use, what to do if it fails.
the way the mechanism work with physiological movement.
Safety features
History. Data. How it works. Safe loads. Contra-indications. Competency. Demonstration and trial.
practical using the robot with different client problems explain what to do in an emergency,
Theory of tech, hands on, patient workshops, equipment on.loan for short periods which remote drop in workshops/ mentor sessions.
Theory of operation, Hands on practice. Practice with a patient & trainer
Should include basics of robotics
Health and safety Risk assessing Patient education Practical in order to relate with the user

Identification of potential training content areas

+ Introduction to robotics
+ Working with health data in relation to robot selection and configuration
+ Ethical considerations
+ Critical appraisal of technologies
+ Guiding patients and carers to engage with the technology
+ Device-specific knowledge – safety assessment, system set-up, calibration and testing
+ Assessing and prescribing Assistive Robotics technologies
+ Technical support and troubleshooting (device-specific)
+ Relevant regulation, standards, guidelines and protocols

Operator (Health Care Professional) Training Challenges

- **Challenges in identifying specific training needs**
  - **Early stage of development of physically assistive robotic systems**
  - **Lack of existing, consistently delivered training**
  - **Variability in HCPs' existing digital skills between and within areas of practice**
  - **Variability in HCPs' attitudes towards robotic systems**
  - **Variability in digital skills and attitudes among patients, service users and their carers**
  - **Tailoring training to different professions and to different stages of education and career**
  - **Lack of existing standards, regulation, protocols and guidance**
- **Factors relating to the delivery of training**
  - **Supporting a learning environment at an organisational level**
  - **Shortage of qualified instructors and champions**
  - **Requirement to adapt robotic systems to individual patients' needs and location**
  - **Range of potential training delivery mechanisms**
  - **Evaluating, resourcing and funding training**

Conclusions

- Novel physically assistive robotic applications are still emerging:
    - ➢ Step change compared to existing ways of supporting and delivering care

- Complex user conditions and needs are difficult to characterise analytically:
    - ❑ Participatory co-design approaches are vital
        - ➢ Initial modelling to learn generalized solutions
        - ➢ Identification of required range of adaptability
    - ❑ Ensures that robot designs can fulfil the specific clinical, cognitive and psychological care needs of their users, and the risks are assessed accurately.

- There are still gaps in industry standards and design methods:
    - ❑ Functional and non-functional requirements elicitation and representation
    - ❑ Safety analysis and risk assessment
    - ❑ Verification and validation