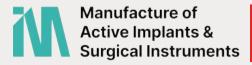
Ingenieurie Medicale

DE LA RECHERCHE AUX PREMIERES UTILISATIONS CHEZ L'HUMAIN

ANNE VANHOESTENBERGHE

Manufacture of Active Implants and Surgical Instruments (MAISI) School of Biomedical Engineering and Imaging Sciences King's College London

8 October 2024





IMPACT ULB Oct 24 2 / 15

IMPACT OF HEALTHCARE ENGINEERING RESEARCH

IMPACT OF HEALTHCARE ENGINEERING RESEARCH Improve quality of life



- Improve quality of life • Improve healthcare services

IMPACT OF HEALTHCARE ENGINEERING RESEARCH Improve quality of life • Improve healthcare services • How?

IMPACT

• Improve healthcare services

Improve quality of life

- How?
 - ► NEW MEDICAL DEVICE: clinical adoption

- Improve quality of life
- Improve healthcare services
- How?
 - ► NEW MEDICAL DEVICE: clinical adoption
 - ► NEW "BASIC SCIENCE" DEVICE: new understanding of physiological process

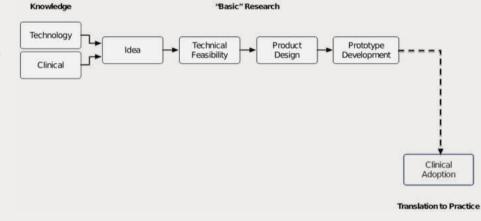
Improve quality of life

- Improve healthcare services
- How?
 - ► NEW MEDICAL DEVICE: clinical adoption
 - ► NEW "BASIC SCIENCE" DEVICE: new understanding of physiological process
 - ▶ NEW TECHNOLOGY: used in novel medical or basic science devices

PIPELINE

HEALTHCARE INNOVATION

Healthcare Engineering translation pipeline.





ULB Oct 24

PIPELINE

TECHNOLOGY READINESS LEVELS?

TRL 8 - system complete and qualified TRL 9 - actual system proven in operational environment

TRL 1 - basic principles observed

TRL 2 - technology concept formulated

TRL 3 - experimental proof of concept

TRL 4 - technology validated in lab TRL 5 - technology validated in relevant environment TRL 6 - technology demonstrated in relevant environment TRL 7 - system prototype demonstration In operational environment



PIPELINE

NSLATI

REGULATORS

Tivie

- Early TRL: new material, new actuation method, new sensor, new algorithm...
- systematic testing, multiple batches, statistics
- Need system integration
- Progression through TRLs is not linear

TRL 2 - technology concept formulated TRL 3 - experimental proof of concept TRL 4 - technology validated in lab TRL 5 - technology validated in relevant environment TRL 6 - technology demonstrated in relevant environment TRL 7 - system prototype demonstration In operational environment TRL 8 - system complete and qualified TRL 9 - actual system proven in operational environment

TRL 1 - basic principles observed

- PIPELINE
- Thance ame

REGULATORS

TEGGEATORS

FUNDING

- Early TRL: new material, new actuation method, new sensor, new algorithm...
- TRL 4-7: Validation, systematic testing, multiple batches, statistics
- Need system integration
- Progression through TRLs is not linear

TRL 1 - basic principles observed TRL 2 - technology concept formulated TRL 3 - experimental proof of concept TRL 4 - technology validated in lab TRL 5 - technology validated in relevant environment TRL 6 - technology demonstrated in relevant environment TRL 7 – system prototype demonstration In operational environment TRL 8 - system complete and qualified TRL 9 - actual system proven in operational environment

PIPELINE

Transport army

REGULATORS

Funding

- Early TRL: new material, new actuation method, new sensor, new algorithm...
- TRL 4-7: Validation, systematic testing, multiple batches, statistics
- Need system integration
- Progression through TRLs is not linear

TRL 1 - basic principles observed TRL 2 - technology concept formulated TRL 3 - experimental proof of concept TRL 4 - technology validated in lab TRL 5 - technology validated in relevant environment TRL 6 - technology demonstrated in relevant environment TRL 7 – system prototype demonstration In operational environment TRL 8 - system complete and qualified TRL 9 - actual system proven in operational environment

- PIPELINE
- Translat

REGULATORS

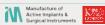
TIME

FUNDING

- Early TRL: new material, new actuation method, new sensor, new algorithm...
- TRL 4-7: Validation, systematic testing, multiple batches, statistics
- Need system integration
- Progression through TRLs is not linear

TRL 2 - technology concept formulated TRL 3 - experimental proof of concept TRL 4 - technology validated in lab TRL 5 - technology validated in relevant environment TRL 6 - technology demonstrated in relevant environment TRL 7 – system prototype demonstration In operational environment TRL 8 - system complete and qualified TRL 9 - actual system proven in

TRL 1 - basic principles observed



IMPACT

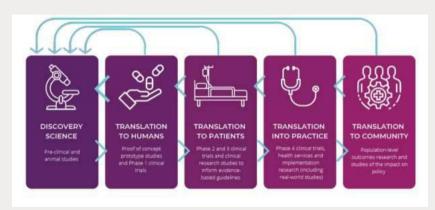
PIDELINE

TRANSLATION

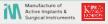
REGULATO

Time

FUNDING



NCRI Beyond the Horizon - Bridging the translational Gap



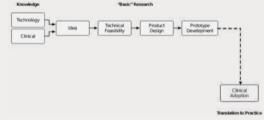
PIPELINI

TRANSLATION

REGULATORS

Time

Funding





Impact

Pipeline

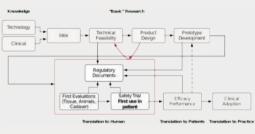
TRANSLATION

TEEGCEATORS

Trace

TIME

Funding



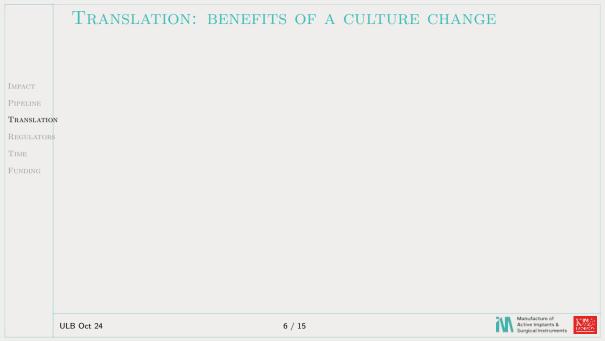


Healthcare Engineering translation pipeline.

Knowledge "Basic" Research Technology Technical Product Prototype Idea Feasibility Design Development Clinical Regulatory Documents Safety Trial First Evaluations Efficacy Clinical First use in (Tissue, Animals, Performance Adoption Cadaver) patient Translation to Human Translation to Patients Translation to Practice



TRANSLATION



SYSTEMATIC REVIEW article Front Digit Health, 03 August 2022 TRANSLATION Sec. Health Technology Implementation Https://doi.org/10.3369/fstgm.2022.957367 Translational research in health technologies: A scoping review Naga N. V. Mayren^{5,17}, Luis Alcoforado^{1,5}, Arthur Chioro⁴, Felipe Fernandes⁴, Thatsa S. Lima⁶, [2] Erika B. Camargo⁶ and [3] Ricardo A. M. Valentim² Manufacture of Active Implants & ULB Oct 24 6 / 15 Surnical Instruments

TRANSLATION: BENEFITS OF A CULTURE CHANGE

Translation: benefits of a culture change

IMPACT

PIPELIN

TRANSLATION

REGULATORS

Time

Funding

SYSTEMATIC REVIEW article Front. Digit. Health, 03 August 2022 Sec. Health Technology

Https://doi.org/10.1589/fidgen.2022.957367

Translational research in health technologies: A

scoping review



The development of health technologies is strongly regulated in Brazil. This characteristic, also evidenced in other countries analyzed in the included articles, gives translational researchers a kind of route that, if followed during the development process of a new device, minimizes relevant risks. It is critical that an understanding of this critical path of translational research be incorporated into the culture of universities and research centers in order to facilitate meeting a set of requirements, accelerate the process, and minimize the risks inherent in the development of innovative technologies. Thus, we understand that it is

Translation: benefits of a culture change

IMPACT

PIPELINI

Translation

REGULATOR

Time

FUNDING

SYSTEMATIC REVIEW article Front. Digit. Health, 03 August 2022 Sec. Health Technology Implementation https://doi.org/10.1589/high.2022.957367

Translational research in health technologies: A scoping review



The development of health technologies is <u>strongly regulated</u> in Brazil. This characteristic, also evidenced in other countries analyzed in the included articles, <u>gives translational researchers</u> a <u>kind of route</u> that, if followed <u>during the development process</u> of a new device, <u>minimizes relevant risks</u>. It is critical that an <u>understanding of this critical path</u> of translational research be <u>incorporated into the culture</u> of universities and research centers

in order to facilitate meeting a set of requirements, accelerate

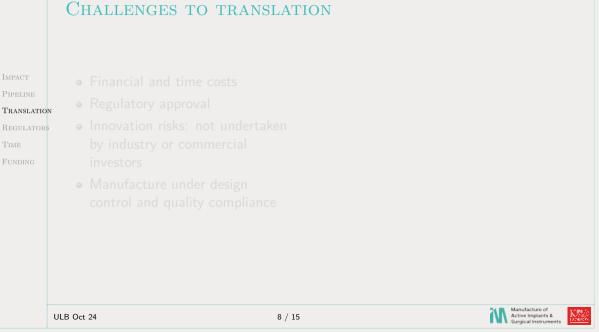
the process, and minimize the risks inherent in the development of innovative technologies. Thus, we understand that it is

Healthcare Engineering translation pipeline.

Knowledge "Basic" Research Technology Technical Product Prototype Idea Feasibility Design Development Clinical Regulatory Documents Safety Trial First Evaluations Efficacy Clinical First use in (Tissue, Animals, Performance Adoption Cadaver) patient Translation to Human Translation to Patients Translation to Practice



TRANSLATION



TRANSLATION 3.2 Clinical trial problem For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bavon 2016 ULB Oct 24 8 / 15

CHALLENGES TO TRANSLATION



- Financial and time costs
- Regulatory approva
- Innovation risks: not undertaker by industry or commercial investors
 - Manufacture under design control and quality compliance

3.2 Clinical trial problem

For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bayon 2016

TRANSLATION

TRANSLATION

Regulatory approva

Financial and time costs

 Innovation risks: not undertaked by industry or commercial investors

 Manufacture under design control and quality compliance

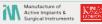
3.2 Clinical trial problem

For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bayon 2016

Before the clinical trials can begin, however, institutional and regulatory approval has to be obtained. In terms of logistics and financial resources, this stage usually exceeds by far what academic groups can muster. Since new technology is usually considered very risky, it will not easily be taken up by industry or commercial investors. Typically, investors tend to derisk investments by outsourcing development-related work to research groups or start-ups. New technology is often acquired by big companies by buying start-ups, but seldom before successful clinical trials. On the other hand, forming a start-up just to get the industry interested in a new technology creates an even larger overhead of work for an academic team. Furthermore, quite often, approvals for the use of experimental devices in humans comprise manufacture of such devices under design control protocols and compliance with quality assurance practices. In the usual case, universities have neither established good manufacturing practice protocols compliant with quality systems regulations for medical devices nor dedicated prototyping areas. A final point in this regard is the establishing of intellectual property, which is costly and an additional burden on the way to a product, where, quite often, the budget will be extremely strained by concept development.

Popp 2017

ULB Oct 24 8 / 15



Financial and time costs

Regulatory approval

 Innovation risks: not undertaker by industry or commercial investors

 Manufacture under design control and quality compliance

3.2 Clinical trial problem

TRANSLATION

For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bayon 2016

Before the clinical trials can begin, however, institutional and regulatory approval has to be obtained. In terms of logistics and financial resources, this stage usually exceeds by far what academic groups can muster. Since new technology is usually considered very risky, it will not easily be taken up by industry or commercial investors. Typically, investors tend to derisk investments by outsourcing development-related work to research groups or start-ups. New technology is often acquired by big companies by buying start-ups, but seldom before successful clinical trials. On the other hand, forming a start-up just to get the industry interested in a new technology creates an even larger overhead of work for an academic team. Furthermore, quite often, approvals for the use of experimental devices in humans comprise manufacture of such devices under design control protocols and compliance with quality assurance practices. In the usual case, universities have neither established good manufacturing practice protocols compliant with quality systems regulations for medical devices nor dedicated prototyping areas. A final point in this regard is the establishing of intellectual property, which is costly and an additional burden on the way to a product, where, quite often, the budget will be extremely strained by concept development.

Popp 2017

ULB Oct 24 8 / 15



IMPACT

PIPELINE

TRANSLATION

REGULATORS

TIME

- Financial and time costs
- Regulatory approval
- Innovation risks: not undertaken by industry or commercial investors
- Manufacture under design control and quality compliance

3.2 Clinical trial problem

For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bayon 2016

Before the clinical trials can begin, however, institutional and regulatory approval has to be obtained. In terms of logistics and financial resources, this stage usually exceeds by far what academic groups can muster. Since new technology is usually considered very risky, it will not easily be taken up by industry or commercial investors. Typically, investors tend to derisk investments by outsourcing development-related work to research groups or start-ups. New technology is often acquired by big companies by buying start-ups, but seldom before successful clinical trials. On the other hand, forming a start-up just to get the industry interested in a new technology creates an even larger overhead of work for an academic team. Furthermore, quite often, approvals for the use of experimental devices in humans comprise manufacture of such devices under design control protocols and compliance with quality assurance practices. In the usual case, universities have neither established good manufacturing practice protocols compliant with quality systems regulations for medical devices nor dedicated prototyping areas. A final point in this regard is the establishing of intellectual property, which is costly and an additional burden on the way to a product, where, quite often, the budget will be extremely strained by concept development.

Popp 2017

ULB Oct 24 8 / 15 Active for Active implants & Surgical Instruments

Impact

PIPELINE

TRANSLATION

REGULATORS

Time

- Financial and time costs
- Regulatory approval
- Innovation risks: not undertaken by industry or commercial investors
- Manufacture under design control and quality compliance

3.2 Clinical trial problem

For new kinds of devices, such as for PMA regulated in the United States, the biggest hurdle can come at the very end with the clinical trials. One never knows if it really works until clinical trials have been done at significant financial and time costs. Whenever possible, the failure risk of pro-Bayon 2016

Before the clinical trials can begin, however, institutional and regulatory approval has to be obtained. In terms of logistics and financial resources, this stage usually exceeds by far what academic groups can muster. Since new technology is usually considered very risky, it will not easily be taken up by industry or commercial investors. Typically, investors tend to derisk investments by outsourcing development-related work to research groups or start-ups. New technology is often acquired by big companies by buying start-ups, but seldom before successful clinical trials. On the other hand, forming a start-up just to get the industry interested in a new technology creates an even larger overhead of work for an academic team. Furthermore, quite often, approvals for the use of experimental devices in humans comprise manufacture of such devices under design control protocols and compliance with quality assurance practices. In the usual case, universities have neither established good manufacturing practice protocols compliant with quality systems regulations for medical devices nor dedicated prototyping areas. A final point in this regard is the establishing of intellectual property, which is costly and an additional burden on the way to a product, where, quite often, the budget will be extremely strained by concept development.

Popp 2017

ULB Oct 24 8 / 15 Manufacture of Active Implants & Surjoid Instruments

Healthcare Engineering translation pipeline.

Knowledge "Basic" Research Technology Technical Product Prototype Idea Feasibility Design Development Clinical Regulatory Documents Safety Trial First Evaluations Efficacy Clinical First use in (Tissue, Animals, Performance Adoption Cadaver) patient Translation to Human Translation to Patients Translation to Practice



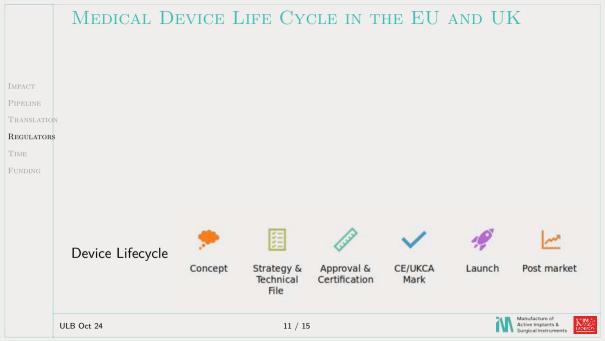
TRANSLATION

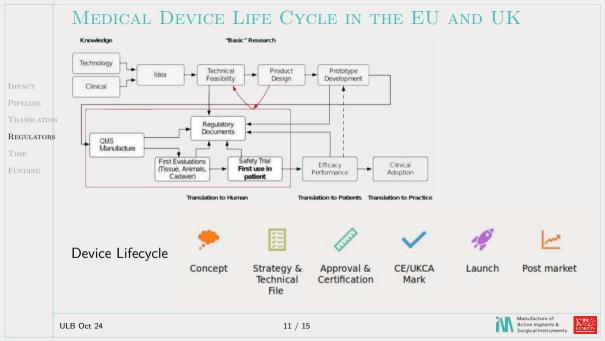
Healthcare Engineering translation pipeline.

Knowledge "Basic" Research Technology Technical Product Prototype Idea Feasibility Design Development Clinical Regulatory Documents QMS. Manufacture Safety Trial First Evaluations Efficacy Clinical First use in (Tissue, Animals, Performance Adoption Cadaver) patient Translation to Human Translation to Patients Translation to Practice

TRANSLATION

FROM TRANSLATIONAL PIPELINE TO MEDICAL DEVICE LIFECYCLE AS SEEN BY REGULATORS REGULATORS... ULB Oct 24 10 / 15





Married Total Control of the Control Republishy Apprecial & PROTOTYPE CHARLES BEING BREAK Characte CONCEPT PHASE Trapi. EXECUTED DUBISHION (1) 1 / sensitive - 34 46 MONTHS SHE SHOWNER - 1.14 Months -- nakwane Translation from basic science to human studies. BASIC DESIGNA PROOF OF PROTOTYPENESION AND AND TRUE S | DESTRUCTION AND ADDRESS OF THE PARTY OF CLINICAL TRIALS. MANDEACTORING EIRSTINDOSTINAL PRODUCT READY DEVELOPMENT PLAN CONCERT READY DESIGN READY BATCH (SELLING UNITY) PRODUCT DESIGN & 040 DEVELOPMENT (QMS-00-P01) REGULATORS C) SEVANS ME HISK MANAGEMENT ATM ADMINISTRACE (CMS-MM-P01) MANUFACTURING TO MOLLIME MANUFACTURING COMPLIANCE & REGULATORY SUPPORT Design review (Adapted from: strategy) re.net, Time to Medical Device Commercialization ~2017: Manufacture of 12 / 15 ULB Oct 24 Active Implants & Surgical Instruments

AND ADDRESS OF THE PARTY OF THE Republish Agoresia & PROTOTYPE CHARLES BEING BREAK Charance CONCEPT PHASE Trasin EXPECTED DUBATION (1) 1 / securities - Je 46 MONTHS - A SERVICE THE 1.14 MONTH - 3.34 MOSON Translation from basic science to human studies. BASIC DESIGNA PROOF OF PROTOTYPENESION AND AND TRUE S | DESTRUCTION AND INCOME. CLINICAL TRIALS. MANDEACTORING E EIRSTINDOSTRIAL PRODUCT READY DEVELOPMENT PLAN CONCEPT READY DESIGN READY BATCH (SELLING UNITY) PRODUCT DESIGN & 040 DEVELOPMENT DESCRIPTION DESCRIPTION (QMS-00-P01) REGULATORS RESTRICTION (T) REPORTED HISK ASSAUGISEASENT ATM ADMINISTRACE IOMS-MM-POTT MANUFACTURING TO MULCIME MANUFACTURING COMPLIANCE & REGULATORY SUPPORT Design review (Adapted from: strategy) re.net, Time to Medical Device Commercialization ~2017: Manufacture of ULB Oct 24 12 / 15 Active Implants & Surgical Instruments

Married Total Control of the Control Republishy Apprecial & PROTOTYPE CHARLES BEING BREAK Characte CONCEPT PHASE Trapi. EXECUTED DUBISHION (1) 1 / sensitive - 34 46 MONTHS SHE SHOWNER - 1.14 Months -- nakwane Translation from basic science to human studies BASIC DESIGNA PROOF OF PROTOTYPENESION AND AND TRUE S | DESTRUCTION AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS O CLINICAL TRIALS. MANDEACTORING EIRSTINDOSTINAL PRODUCT READY DEVELOPMENT PLAN CONCEPT READY DESIGN READY BATCH (SELLING UNITY) PRODUCT DESIGN & 040 DEVELOPMENT DEDICAL OWNERS DEDICAMENTATION (QMS-00-P01) REGULATORS C) SEVANS ME HISK MANAGEMENT ATM ADMINISTRACE (CMS-MM-P01) MANUFACTURING TO MOLLIME MANUFACTURING COMPLIANCE & REGULATORY SUPPORT Design review (Adapted from: strategy) re.net, Time to Medical Device Commercularation ~2017) Manufacture of 12 / 15 ULB Oct 24 Active Implants & Surgical Instruments



AIMD TRANSLATION: HOW LONG DOES IT TAKE?

ELINE

LATION

TIME



AIMD TRANSLATION: HOW LONG DOES IT TAKE?

Time

UroMems Initiates First-in-Human Study of Its Smart Implant to Treat Stress Urinary Incontinence

SHARE THIS ARTICLE











This initial clinical trial is a key milestone in the development of its UroActive™ System

CRENOBLE France, Nov. 29, 2022 /PRNewswire/ - UroMems, a global company developing breakthrough, mechatronics technology to treat stress urinary incontinence (SUI), announced today that it has successfully completed the first-inhuman implant of the UroActive** System, the first smart automated artificial urinary sphincter (AUS) investigational device to treat SUI. This initial clinical study is a key milestone in the development of UmActive



NEWS PROVIDED BY

Nov 29, 2022, 10:00 ET

Linchtenny --

AIMD TRANSLATION: HOW LONG DOES IT TAKE?

Time

UroMems Initiates First-in-Human Study of Its Smart Implant to Treat Stress Urinary Incontinence

NEWS PROVIDED BY Nov 29, 2022, 10:00 ET SHARE THIS ARTICLE 000000





CRENOBLE France Nov 29 2022 /PRNewswire/ -- UroMems, a global company developing breakthrough mechatronics technology to treat stress urinary incontinence (SUI), announced today that it has successfully completed the first-inhuman implant of the UroActive** System, the first smart automated artificial urinary sphincter (AUS) investigational device to treat SUI. This initial clinical study is a key milestone in the development of UroActive

Philippe Cinquin, P. Mozer, H. Lamraoui, Agnès Bonvilain, G. Robain. Dispositif de prévention des fuites urinaires. France, N° de brevet: FR0757159, 2007, (hal-00419384)



