

An Aging Model for Medical Equipment

Binseng Wang, ScD, CCE
Torgeir Rui, siv.ing
Sodexo HTM



About the Speaker: Binseng Wang

- Binseng Wang is a vice-president with Sodexo HTM, an independent medical equipment service organization located in the USA.
- Previously, Dr. Wang was Director, Quality & Regulatory Affairs for Greenwood Marketing LLC, Vice President, Quality & Regulatory Affairs, for Sundance Enterprises, Aramark Healthcare Technologies, and MEDIQ/PRN. He also worked as a Visiting Scientist at NIH, Adjunct Professor at the Milwaukee School of Engineering, and Associate Professor at Univ. of Campinas, Brazil.
- He is a fellow of ACCE and AIMBE. He received the 2010 AAMI CE Achievement Award, the 2015 ACCE Lifetime Achievement Award and the 2019 AAMI-TRIMEDX Iconoclast award. He was inducted into the Clinical Engineering Hall of Fame by ACCE in 2017 and granted the title of Honorary Life Member by the Int'l Federation of Medical & Biological Eng. (IFMBE) in 2022. He was chair of ACCE International Committee 2018-2023.
- He earned a Doctor of Science (ScD) degree from MIT and is a Certified Clinical Engineer (CCE).



MD EXPO
New England • October 8-10, 2024

About the Speakers: **Torgeir Rui**

- Torgeir Rui is a lead data analyst with Sodexo HTM, an independent medical equipment service organization.
- He has held various research and development roles in logistics automation, healthcare, healthcare technology management, electric power, and automotive industries.
- He earned a Sivilingeniør (M.Sc.Eng. equivalent) degree from the Norwegian University of Science and Technology.



Torgeir Rui, **siv.ing**



Research Team (in alphabetic order by last name)

- Morgan Ayers-Comegys, BBA, MHA – Director of Capital Equipment Planning
- Jason Gibson, BBA – Director, Compliance
- Torgeir Rui, siv.ing – Lead Data Analyst
- Scott Skinner, MBA, PhD - Director of Capital Equipment Planning
- Kevin Steward, AS, CBET – Director, Mobilization
- Binseng Wang, ScD, CCE – VP, Program Management
- Steve Williams – Internal Quality Auditor



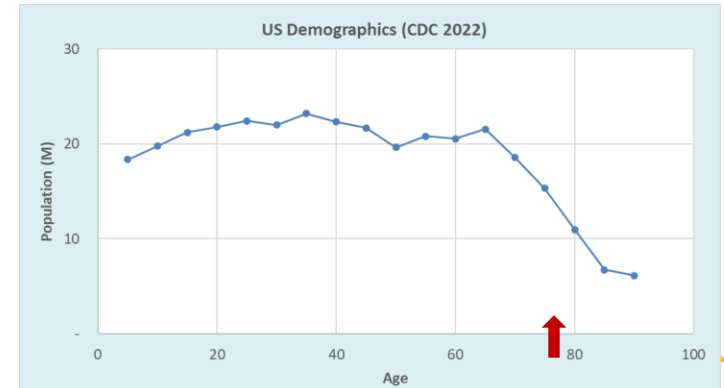
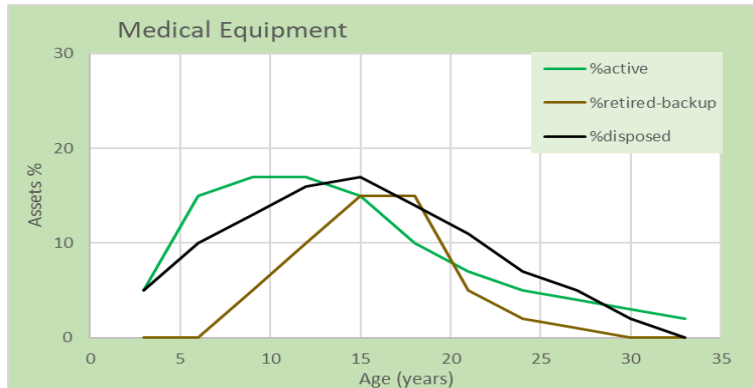
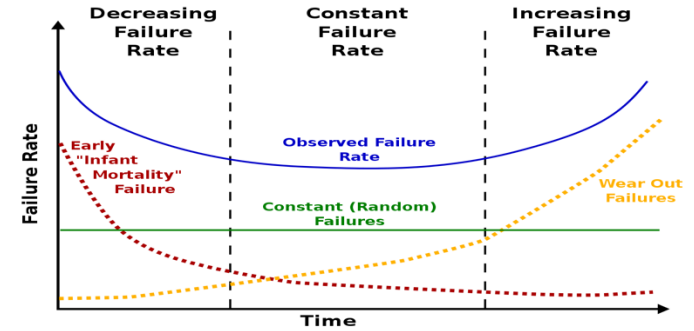
CONTENTS

- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- PRIOR RESULTS
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- AN EQUIPMENT AGING MODEL
 - Model Development
 - Model Testing
 - Model Applications
- DISCUSSION
- CONCLUSIONS



INTRODUCTION – Aging: Machine vs Humans vs Medical Equipment

- Industrial (manufacturing) machine: a bathtub
 - Early failures (“infant mortality”)
 - Constant failures (“random”)
 - Wear out failures (aging)
- Human beings (US demographics + e_0 ↑)
- Medical equipment (hypothesis)



INTRODUCTION - Aging impact on maintenance and replacement planning

- If equipment's aging does have a significant impact on its reliability (and safety for patients and users)=> must consider aging impact on:
 - Inventory sufficiency & back-ups
 - **Maintenance** strategy planning & revisions
 - **Replacement** ("retirement") & disposal planning
- Traditional approach: many HDOs and consultants use the *AHA's Estimated Useful Lives of Depreciable Hospital Assets* for replacement planning (indicated with ↑ in Results) or one of the following documents
 - US Army's *TB7 – Maintenance Expenditure Limits for Medical Materiel*
 - VHA equipment life expectancies (VAMDNS)
 - ECRI: expected useful lives (Biomedical Guide)



MD EXPO
New England • October 8-10, 2024

METHODOLOGY

- **Data Source**: ~342,000 pieces of equipment belonging to >100 Sodexo HTM hospital clients, managed 30+ years. This is only a portion (~57%) of the inventory and service history due to data quality issues
- **Equipment Age (EA)**: year manufactured or acquired/installed
- **Data Analyses**
 - Repairs (and PMs) versus age
 - Active equipment versus age (human analogy: living persons vs age)
 - Disposals versus age (human analogy: deaths vs age)
 - Estimated life expectancy (ELE) at purchase/installation (human analogy: life expectancy at birth)

METHODOLOGY (CONT.)

- **Aging Impact on Equipment Reliability/Maintenance**

- #CM (and PM) workorders performed in each *Equipment Age* divided by the *#Equipment Managed* in that age period, for a certain equipment type. Each equipment type may have **multiple** brands and models.
 - **Repair (aka CM)**: restore equipment to original specifications
 - **Planned Maintenance (PM aka SM)**: preventive maintenance (replacement of wearable parts) and/or safety & performance inspections (SPI)

- **Aging Impact on Equipment Disposal/Replacement/Storage**

- #equipment removed from active inventory (aka "retired") at each *Equipment Age* for a certain equipment type due to:
 - Replacement: replaced by another equipment with identical or similar function
 - Disposal: discarded, traded-in, cannibalized, etc.
 - Storage: equipment stored for reactivation whenever needed (back ups)

- **Estimated life expectancy (ELE)**

- #years equipment is expected to last based on prior disposal history assuming 30 years maximum, ignoring infant mortality and gender or race, using 5 years of disposal history



CONTENTS

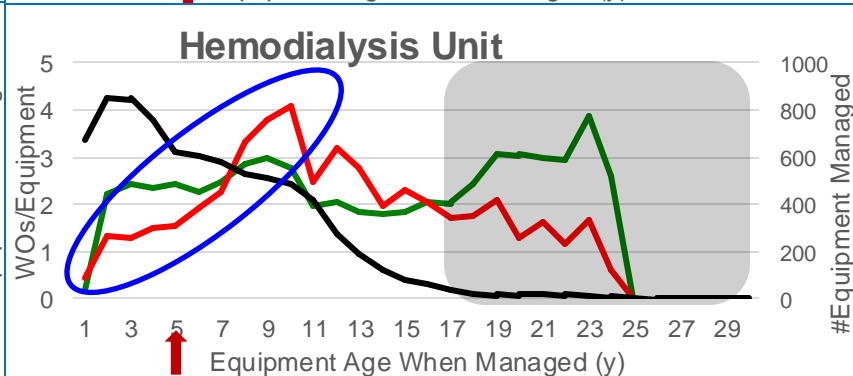
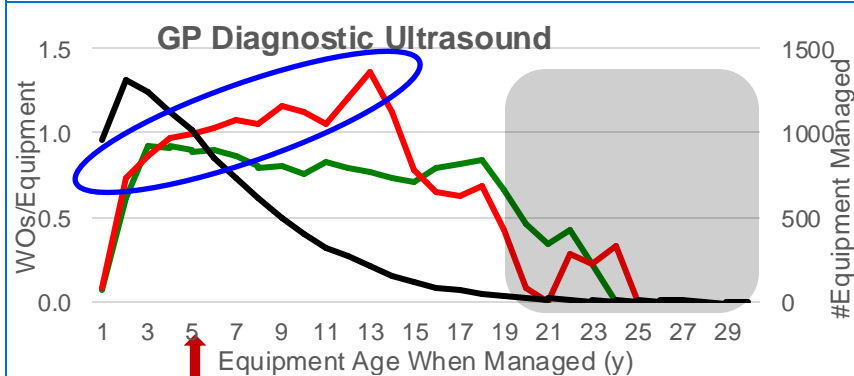
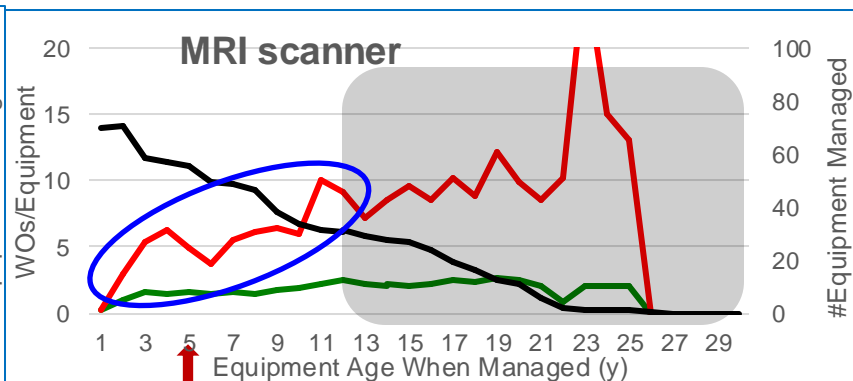
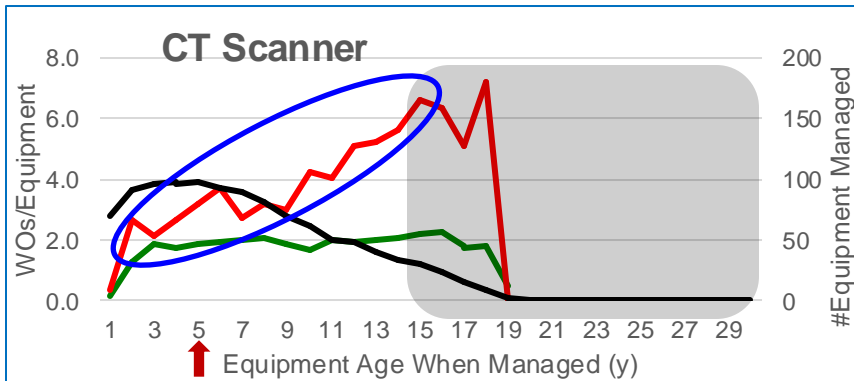
- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- **PRIOR RESULTS**
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- AN EQUIPMENT AGING MODEL
 - Model Development
 - Model Testing
 - Model Applications
- DISCUSSION
- CONCLUSIONS

PRIOR RESULTS - Aging impact on maintenance

- Equipment Categorized per **aging impact** on maintenance:
 - **Clear** impact of aging (**CIA**): visible increase of CMs/equipment with age (validated with analysis of variance)
 - **No** impact of aging (**NIA**): invisible increase of CMs/equipment with age (validated with analysis of variance)
 - **Inconclusive** impact of aging (**IIA**): unclear increase of CMs/equipment with age => further study needed to reclassify into CIA or NIA.

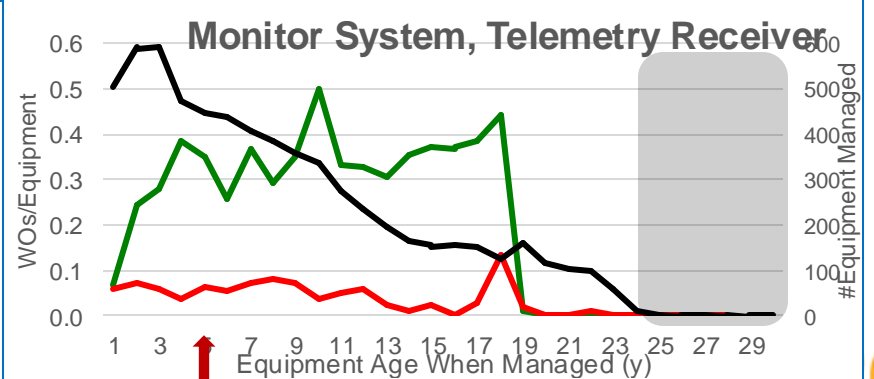
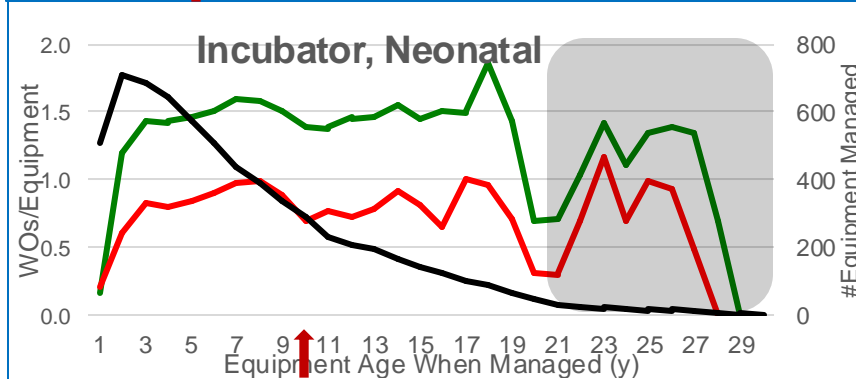
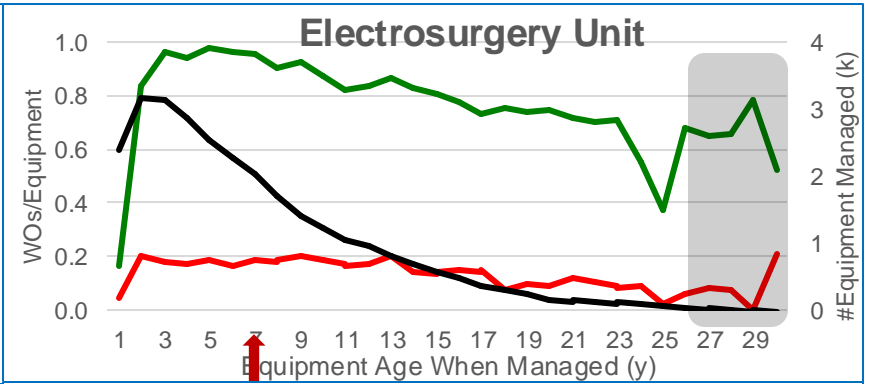
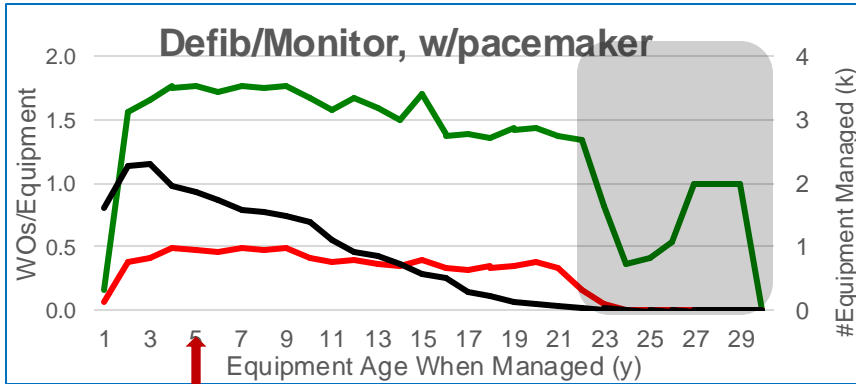
PRIOR RESULTS – Clear Impact of Aging (CIA)

— PMs/Equipment
 — CMs/Equipment
 — #Equipment Managed
 ↑ AHA EUL



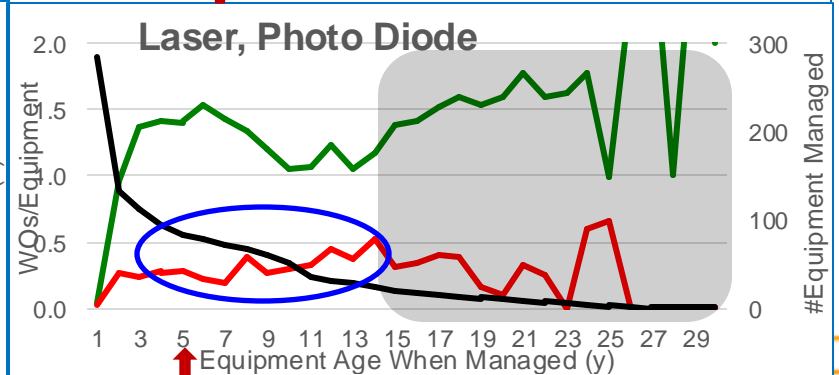
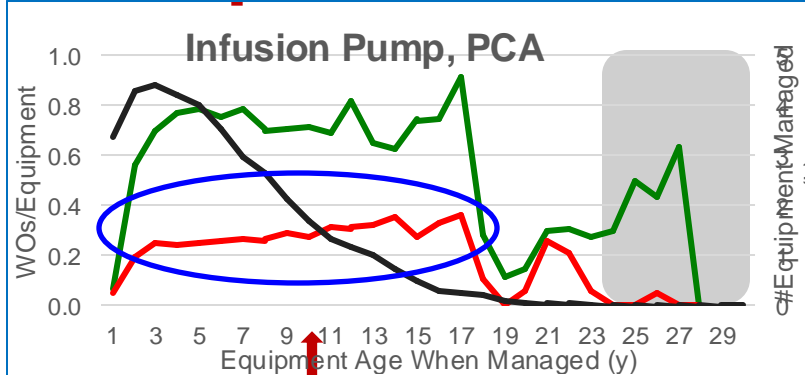
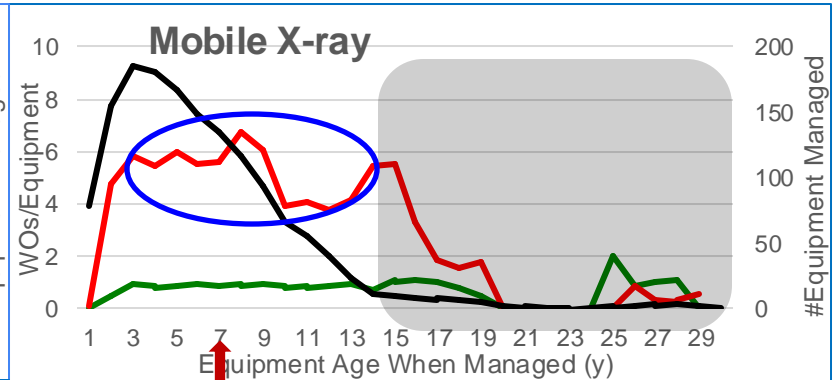
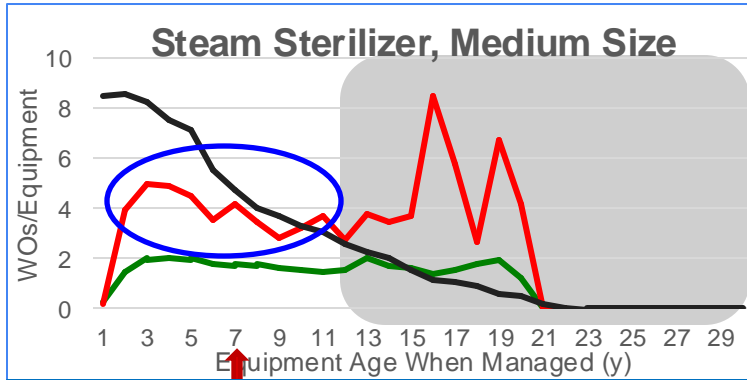
PRIOR RESULTS – No Impact of Aging (NIA)

— PMs/Equipment
 — CMs/Equipment
 — #Equipment Managed
 ↑ AHA EUL



PRIOR RESULTS – Inconclusive Impact of Aging (IIA)

— PMs/Equipment
 — CMs/Equipment
 — #Equipment Managed
 ↑ AHA EUL

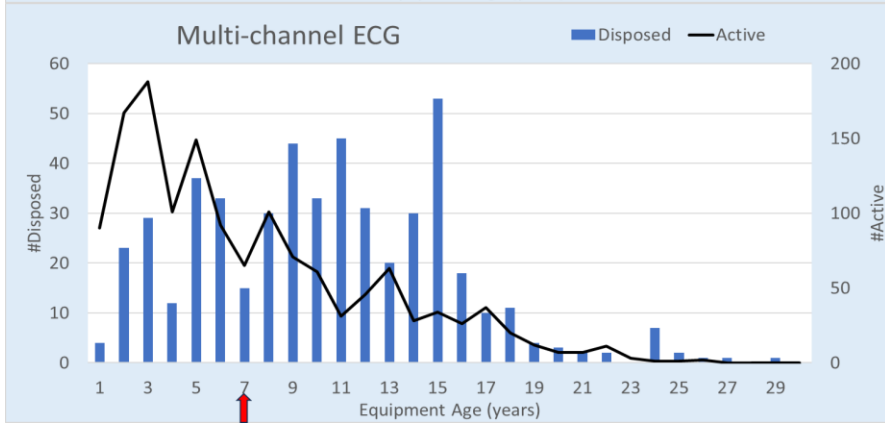
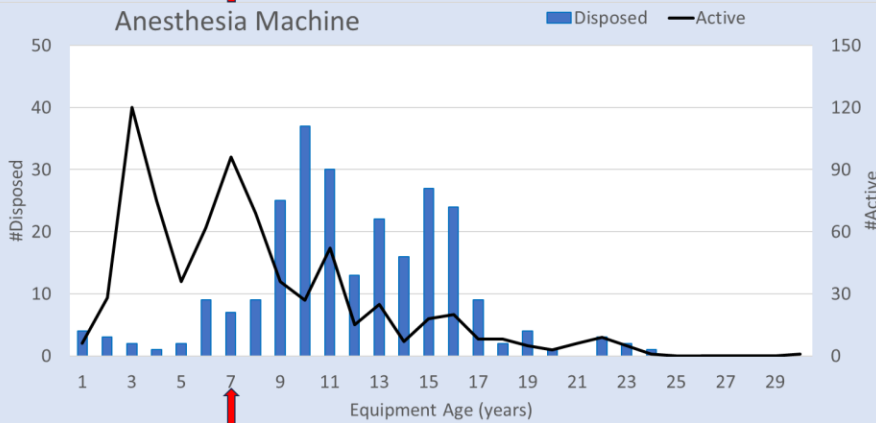
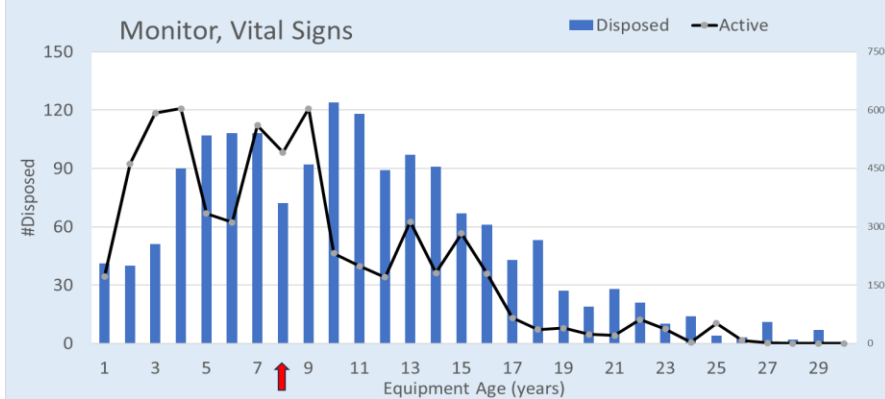
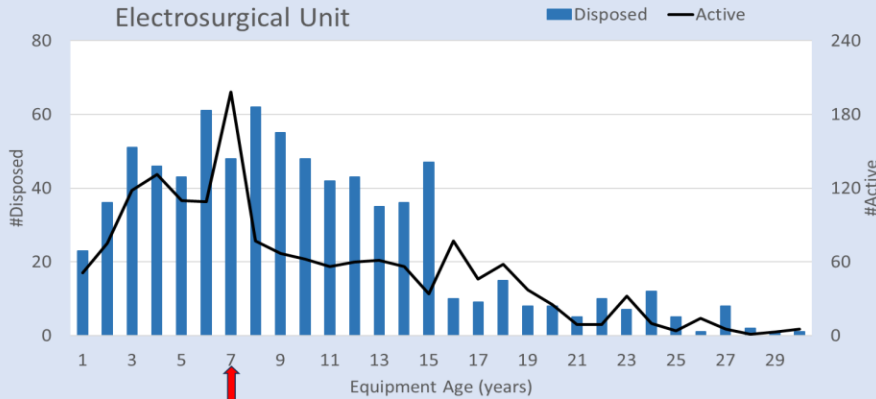


PRIOR RESULTS - Aging impact on lifespan

- Equipment categorized per disposal pattern:
 - **Gradual (as needed) disposal**: disposal/replacement of individual pieces whenever needed (repair cost > X% replacement cost/fair market value) => typically normal (Gaussian) distribution over time with occasional spike for various reasons
 - **Group (lumped) disposal (& acquisition)**: wholesale disposal/replacement (or acquisition) of a particular brand/model for recall/upgrade and other reason(s)

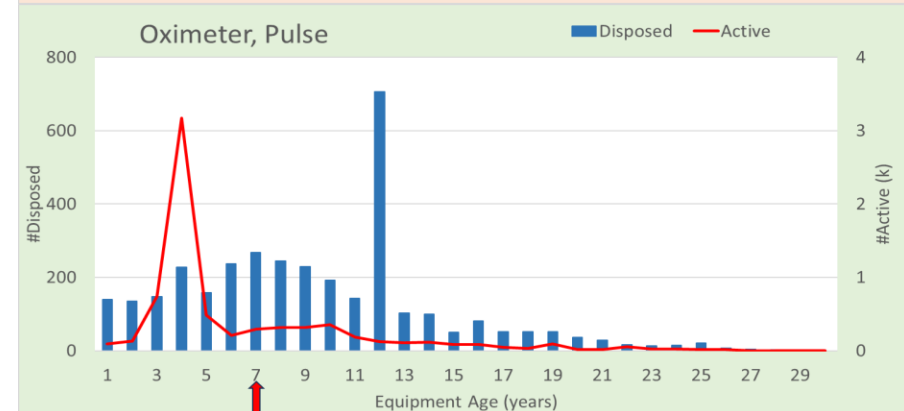
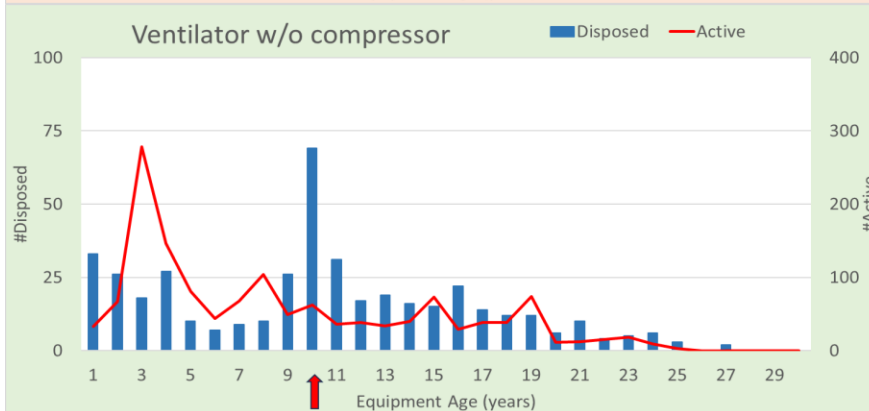
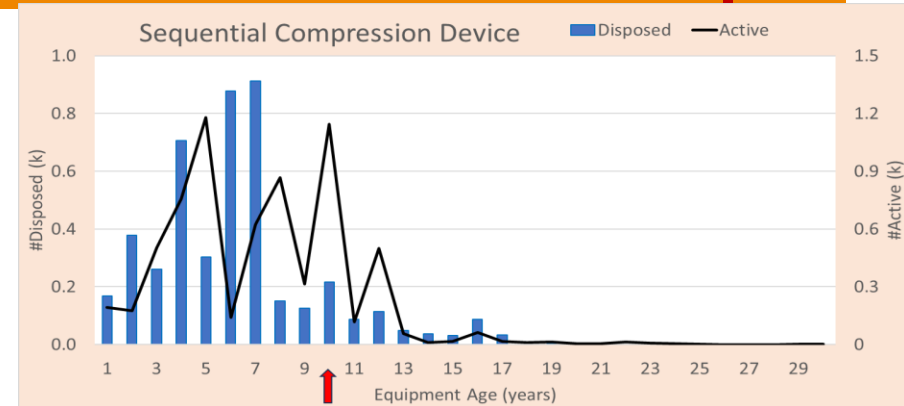
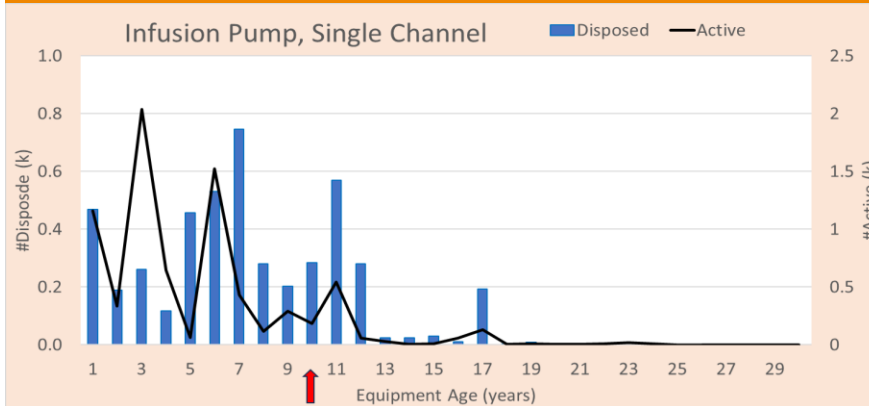
PRIOR RESULTS – Gradual disposal

↑ AHA EUL



PRIOR RESULTS – Group disposal & acquisition

↑ AHA EUL



PRIOR RESULTS – ELE vs EUL, LE & ExUL

GROUP	EQUIPMENT TYPE	AHA EUL	VHA LE	ECRI ExUL	ELE	GROUP	EQUIPMENT TYPE	AHA EUL	VHA LE	ECRI ExUL	ELE
Biomed	Continuous passive motion machine	10	11	10	22	Biomed	Neonatal warmer	10	9	7	18
	Defib/monitor w/pacemaker	5	6	7	14		Pt lift	10	10	10	21
	Electric bed	12	12	15	19		Pt monitor, multiparameter	7	9	8	16
	Heart lung bypass system	8	8	10	13		Pulmonary function system	8	11	8	13
	Hemodialysis machine	5	8	10	19		Pulse oximeter	7	8	7	13
	Hypo/hyperthermia machine	10	11	10	15		Sequential compression device	10	6	7	15
	Infusion pump, controller	10	9	10	13		Stretcher	15	10	10	18
	Infusion pump, feeding	10	8	10	21		Telemetry monitor receiver station	5	9	8	13
	Infusion pump, modular	10	8	10	20		Telemetry transmitter	5	9	8	13
	Infusion pump, multi-channel	10	8	10	13		Therapeutic ultrasound	7	12	8	18
	Infusion pump, PCA	10	8	10	14		Ventilators (w/o compressors)	10	7	10	16
	Infusion pump, single channel	10	8	10	11		Vital signs monitor	8	9	8	19
	Infusion pump, syringe	10	8	10	22		Anesthesia machine	7	8	10	17
	Intra aortic balloon pump	7	6	8	18		Autotransfusion unit	6	8	8	14
	Multichannel ECG	7	8	10	16		Blood warmer, surgical	7	8	8	11
	Neonatal incubator	10	7	7	16		Electrosurgical unit	7	8	7	16

PRIOR RESULTS – ELE vs EUL, LE & ExUL (cont.)

GROUP	EQUIPMENT TYPE	AHA EUL	VHA LE	ECRI ExUL	ELE	GROUP	EQUIPMENT TYPE	AHA EUL	VHA LE	ECRI ExUL	ELE	
Surg	Heart lung bypass system	8	8	10	12	DI	Mobile X-ray	7	7	15	15	
	Image guided surgical system	7	7	10	9		MRI scanner	5	9	10	16	
	Multi-gas anesthesia monitor	8	9	8	14		Nuc Med camera	5	8	10	21	
	Robotic surgical system	7	7	7	10		PACS work station	5	5	7	12	
	Steam sterilizer, medium	12	8	15	12		Radiology flat panel detector	5	6	10	22	
	Surgical light, ceiling mounted	10	12	10	21		Ultrasonic bladder scanner	5	5	4	12	
	Surgical table	15	12	15	18		Blood gas/pH analyzer	5	7	7	8	
	Waste management system	10	8	10	7		Chemistry analyzer	5	7	7	12	
DI	Bone density scanner	7	5	10	15	Lab	Coagulation analyzer	5	7	6	14	
	Contrast injector, angiographic	10	10	10	20		Hematology analyzer	7	7	7	13	
	CT scanner (33-128 slices)	5	6	8	25		Refrigerated centrifuge	5	6	10	25	
	Diagnostic US, cardiac	5	5	5	13		Table-top centrifuge	7	6	10	16	
	Diagnostic US, general purpose	5	5	5	13							
	Diagnostic US, point of care	5	5	4	14							
	Digital mammography unit	5	6	7	14							
								average	6.5	7.5	8.5	15.5
								standard deviation	2.1	1.6	2.2	4.0

CONTENTS

- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- PRIOR RESULTS
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- **AN EQUIPMENT AGING MODEL**
 - **Model Development**
 - **Model Testing**
 - **Model Applications**
- DISCUSSION
- CONCLUSIONS

AN EQUIPMENT AGING MODEL

- Model Variables

VARIABLE	FACTORS CONSIDERED	Score 0-3	Score 4-7	Score 8-10
STRESS	Mechanical, electrical, chemical, environmental (temperature, humidity, power, voltage), etc.	Low stress (low power, voltage, humidity, few corrosive chemicals)	Medium stress (medium power, voltage, humidity, some corrosive chemicals)	High stress (high power, voltage, humidity, very corrosive chemicals)
DURABILITY	Design (material) and production (workmanship) choices affecting the ability of equipment to endure normal use conditions	Poorly made with weak material, parts and accessories	Competently built with standard material, parts and accessories	Skillfully built with solid material, parts and accessories
USE	Likelihood of heavy use or abuse, frequent movements, etc.	Not likely	Somewhat likely	Very likely

AN EQUIPMENT AGING MODEL

- Model Without Weights

$$\text{Aging Score (\%)} = (\text{STRESS} + (10 - \text{DURABILITY}) + \text{USE}) / 30$$

- Model With **Weights**

$$\text{Aging Score (\%)} = (\text{STRESS} * W_S + (10 - \text{DURABILITY}) * W_D + \text{USE} * W_U) / 100, \text{ where}$$

$$W_S + W_D + W_U = 10$$

Model Development

- Equipment Types Studied

CLASS	EQUIPMENT TYPE	AGING IMPACT	CLASS	EQUIPMENT TYPE	AGING IMPACT	
Biomedical	Defib/monitor w/pacemaker	NIA	Surgical	Anesthesia Machine	NIA	
	Electric Bed	IIA		Autotransfusion Unit	NIA	
	Hemodialysis Machine	CIA		Blood Warmer, Surgery	NIA	
	Hypo/hyperthermia Machine	NIA		Electrosurgical Unit	NIA	
	Infusion Pump, Feeding	IIA		Surgical Table	CIA	
	Infusion Pump, Modular	CIA		Waste Management System	CIA	
	Infusion Pump, Multi-channel	CIA	Diagnostic Imaging	CT Scanner	CIA	
	Infusion Pump, PCA	CIA		Diagnostic Ultrasound, General Purpose	CIA	
	Infusion Pump, Single Channel	CIA		Diagnostic US, cardiac	IIA	
	Infusion Pump, Syringe	CIA		Diagnostic US, point of care	IIA	
	Neonatal Incubator	NIA		Mammography Unit, Digital	CIA	
	Pt Monitor, Multi-parameter	NIA		Mobile C Arm, Digital	IIA	
	Stretcher, Mobile	CIA		Mobile X-ray	IIA	
	Telemetry Monitor, Receiver Station	NIA		X-ray, General Purpose	CIA	
	Telemetry Transmitter	CIA		Analyzer, Blood Gas/PH	CIA	
	Ventilators (w/compressors)	IIA		Lab	Centrifuge, Refrigerated	NIA
	Ventilators (w/o compressors)	CIA			Centrifuge, Table Top	NIA

Model Development (cont.)

CLASS	EQUIPMENT TYPE	STRESS	DURABILITY	USE	Scoring weights			Aging Score w/weights	Aging Score w/o weights	AGING IMPACT
					Ws	Wd	Wu			
Biomedical	Defib/monitor w/pacemaker	7	7	7	2	5	3	50%	57%	NIA
	Electric Bed	8	8	10	2	5	3	56%	67%	IIA
	Hemodialysis Machine	10	8	10	2	5	3	60%	73%	CIA
	Hypo/hyperthermia Machine	7	8	7	2	5	3	45%	53%	NIA
	Infusion Pump, Feeding	6	8	8	2	5	3	46%	53%	IIA
	Infusion Pump, Modular	6	4	9	2	5	3	69%	70%	CIA
	Infusion Pump, Multi-channel	6	4	9	2	5	3	69%	70%	CIA
	Infusion Pump, PCA	7	4	9	2	5	3	71%	73%	CIA
	Infusion Pump, Single Channel	6	4	9	2	5	3	69%	70%	CIA
	Infusion Pump, Syringe	6	4	9	2	5	3	69%	70%	CIA
	Neonatal Incubator	8	8	7	2	5	3	47%	57%	NIA
	Pt Monitor, Multi-parameter	6	9	8	2	5	3	41%	50%	NIA
	Stretcher, Mobile	9	8	8	2	5	3	52%	63%	CIA
	Telemetry Monitor, Receiver Station	5	9	8	2	5	3	39%	47%	NIA
	Telemetry Transmitter	7	6	9	2	5	3	61%	67%	CIA
Ventilators (w/compressors)	8	8	8	2	5	3	50%	60%	IIA	

Model Development (cont. 2)

CLASS	EQUIPMENT TYPE	STRESS	DURABILITY	USE	Scoring weights			Aging Score w/weights	Aging Score w/o weights	AGING IMPACT
					Ws	Wd	Wu			
Surgical	Anesthesia Machine	8	8	7	2	5	3	47%	57%	NIA
	Autotransfusion Unit	8	8	7	2	5	3	47%	57%	NIA
	Blood Warmer, Surgery	7	7	7	2	5	3	50%	57%	NIA
	Electrosurgical Unit	5	8	8	2	5	3	44%	50%	NIA
	Surgical Table	8	8	8	2	5	3	50%	60%	CIA
	Waste Management System	8	7	8	2	5	3	55%	63%	CIA
Diagnostic Imaging	CT Scanner	10	9	10	2	5	3	55%	70%	CIA
	Diagnostic Ultrasound, General Purpose	7	8	9	2	5	3	51%	60%	CIA
	Diagnostic US, cardiac	6	8	6	2	5	3	40%	47%	IIA
	Diagnostic US, point of care	6	8	7	2	5	3	43%	50%	IIA
	Mammography Unit, Digital	8	8	7	2	5	3	47%	57%	CIA
	Mobile C Arm, Digital	8	8	8	2	5	3	50%	60%	IIA
	Mobile X-ray	8	8	7	2	5	3	47%	57%	IIA
X-ray, General Purpose	8	8	7	2	5	3	47%	57%	CIA	
Analyzer, Blood Gas/PH	7	8	7	2	5	3	45%	53%	CIA	

Model Development: Threshold

- Aging threshold determination

Aging Threshold (AT) = (average (CIA scores) + average (NIA scores))/2

- Using weights: AT = 51%
- Without weights: AT = 59%

- Aging threshold use

- If aging score \geq AT => CIA
- If aging score $<$ AT => NIA

CONTENTS

- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- PRIOR RESULTS
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- AN EQUIPMENT AGING MODEL
 - Model Development
 - [Model Testing](#)
 - Model Applications
- DISCUSSION
- CONCLUSIONS

Model Testing

- 5 CE/HTM professionals with >10 years of experience, not involved in the model formulation, assigned scores

		Tester 1	Tester 2	Tester 3	Tester 4	Tester 5	AVG	SD	Model
WEIGHT	STRESS	2	3	3	3	3	2.8	0.4	2
	DURABILITY	5	3	4	1	3	3.2	1.5	5
	USE	3	4	3	6	4	4.0	1.2	3
THRESHOLD	with weights	53%	55%	58%	51%	46%	53%	4%	51%
	without weights	54%	53%	61%	44%	43%	51%	7%	59%

- CONCLUSION:** the model is robust

CONTENTS

- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- PRIOR RESULTS
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- AN EQUIPMENT AGING MODEL
 - Model Development
 - Model Testing
 - [Model Applications](#)
- DISCUSSION
- CONCLUSIONS

Model Applications

1. Maintenance Planning

o SM/PM Planning

AGING IMPACT or SCORE	SM/PM PLAN
CIA or Score $\geq 60\%$	Follow OEM recommendations on SM/PM tasks and parts replacement (true preventive maintenance). Consider increasing frequency for those that score $>66\%$.
NIA or Score $< 60\%$	Adopt AEM w/reduced frequency and/or tasks, including run to failure (RTF) for those that score $\leq 53\%$, unless required by regulations.

o CM Planning

AGING IMPACT or SCORE	CM PLAN
CIA or Score $\geq 60\%$	Plan for increasing demand for parts and labor with age
NIA or Score $< 60\%$	Repair as needed if the repair cost is $< 30\%$ of replacement cost and $<$ fair market value; otherwise replace



Model Applications – Impact of Model Variables on Maintenance

- Impact of Model Variables on Maintenance Planning

EQUIPMENT TYPE	STRESS	DURABILITY	USE	AGING SCORE	SM/PM Plan
Infusion pump, modular - ORIGINAL SCORES	6	4	9	70%	OEM recommended tasks & consider frequency increase
Infusion pump, modular – Critical Access Hospital w/lower use	6	4	5	57%	AEM – reduced frequency
Infusion pump, modular – better built w/lower use	6	10	9	50%	AEM - RTF
Defib/monitor - ORIGINAL SCORES	7	7	7	57%	AEM – reduced frequency
Defib/monitor - more durable device	7	9	7	50%	AEM - RTF
Defib/monitor - ED/Ambulance w/higher use	7	7	9	63%	OEM recommended tasks & frequency
Stretcher, mobile – ORIGINAL SCORES	9	8	8	63%	OEM recommended tasks & frequency
Stretcher, mobile - more durable device	9	10	8	57%	AEM – reduced frequency
Stretcher, mobile – Emergency Dept (ED) w/higher use	9	8	10	70%	OEM recommended tasks & consider frequency increase
Waste Management System - ORIGINAL SCORES	8	7	8	63%	OEM recommended tasks & frequency

Model Applications

2. **Replacement Planning**: should NOT be based solely on age
- Instead, consider these categories of variables:
 - Clinical Impact
 - Safety
 - **Condition**
 - Supportability

Aging Impact or Score	REPLACEMENT PLAN	
	APPROACH	MULTIVARIATE METHOD IMPROVEMENTS
CIA or Score $\geq 60\%$	Analyze each piece or group of equipment to create a multi-year replacement plan & budget	- CONDITION : emphasize aging effects - SUPPORTABILITY : compare age with life expectancy and EOL/EOS
NIA or Score $< 60\%$	Instead of individualized analysis, use prior history to create an annual " contingency fund " for replacement as needed	- CONDITION : ignore aging and focus on repair frequency and costs - SUPPORTABILITY : seek alternative sources of parts and labor

Model Applications

- Maintenance Risk Assessment:** update Fennigkoh & Smith method (aka risk-based criteria) with aging scoring to be consistent with ISO 14971 risk definition:

Risk := Severity & Probability

		Aging Category or Score (Probability)	
		CIA or Aging Score $\geq 60\%$	NIA or Aging Score $< 60\%$
Function + Physical Risk (Severity)	EM ≥ 12	OEM recommended tasks & consider frequency increase	OEM recommended tasks & frequency
	EM < 12	AEM – reduced SM/PM frequency and some tasks	AEM – floating SM/PM or Run to Failure

CONTENTS

- INTRODUCTION
- METHODOLOGY
 - Data source
 - Equipment age
 - Maintenance and disposal data
- PRIOR RESULTS
 - Aging impact of on maintenance
 - Aging Impact on lifespan
 - Equipment life expectancy
- AN EQUIPMENT AGING MODEL
 - Model Development
 - Model Testing
 - Model Applications
- DISCUSSION
- CONCLUSIONS

DISCUSSION

- Testing with experienced CE/HTM professionals not involved in model formulation proved a simple, quantitative aging model can be build with only 3 variables: STRESS, DURABILITY and USE
- **STRESS** and **USE** are intuitive
- **DURABILITY** is becoming more and more relevant due to the tendency of low-cost equipment build for selling proprietary consumables and accessories
- Data available for model building and testing were limited by data quality issues, possible lower usage when older equipment are used for backups, bulk replacements due to standardization, etc.
- Some equipment types were not possible to clearly identify aging pattern (**IIA**) and will require more studies
- Bundling of multiple brands/models may have obscured significant differences among brands/models
- Technology innovations sometimes cause premature disposals, not aging



CONCLUSIONS

- This simple model can replace analyses of large amount of data collected over extended period, but refinements may be needed for specific equipment types (~1,700) or brands/models (>10,000)
- Understanding aging can help to improve significantly **maintenance planning** (both SM/PM and CM)
- Age is clearly NOT the only or primary factor for replacement, but the aging model can refine multivariate **replacement planning**
- Aging knowledge can help update the F&S method to be consistent with ISO 14971 **risk assessment** for AEM decisions
- Understanding aging pattern can help to better select new equipment to reduce total co\$t of ownership (TCO)



Articles Available on J Clin Eng

- Medical Equipment Aging - Part I - Impact on Maintenance – JCE Apr-June 2024
- Medical Equipment Aging - Part II - Impact on Lifespan – JCE July-Sept 2024
- Medical Equipment Aging - Part III - An Aging Model for Maintenance and Replacement Plannings – JCE Oct-Dec 2024



Bonus: CE/HTM ROI

- Prior CE/HTM cost (CEx) justifications:
 - **COSR**: CEx/Cost Capital Devices (CCD) [aging studies show CEx depends on technology, not acquisition cost]
 - **Benchmarking**: limited, incomplete data available
 - **CEx**: 0.5-2% HDO OpEx, typically 1.1%, but still considered **cost** without clear return
- Useful life extension
 - Aging studies showed: ELE > 2 AHA EUL => postponed replacements, i.e., reduced CapEx
 - Example:
 - 400 bed HDO, CEx = \$6.2 M, CCD = \$110 M
 - Assuming: 1/3 AHA EULs of 5, 7 and 10 years => extended to 10, 15 and 20 years
 - CapEx savings/year = \$8.3 M
 - **ROI = (CapEx savings/year – CEx)/CEx = 33%!!!**

Thank you!

Questions & suggestions are most welcome!

Contact information:

Binseng Wang

Email: Binseng.wang@sodexo.com

Torgeir Rui

Email: Torgeir.rui@sodexo.com



MD EXPO

New England • October 8-10, 2024



MD EXPO

New England • October 8-10, 2024