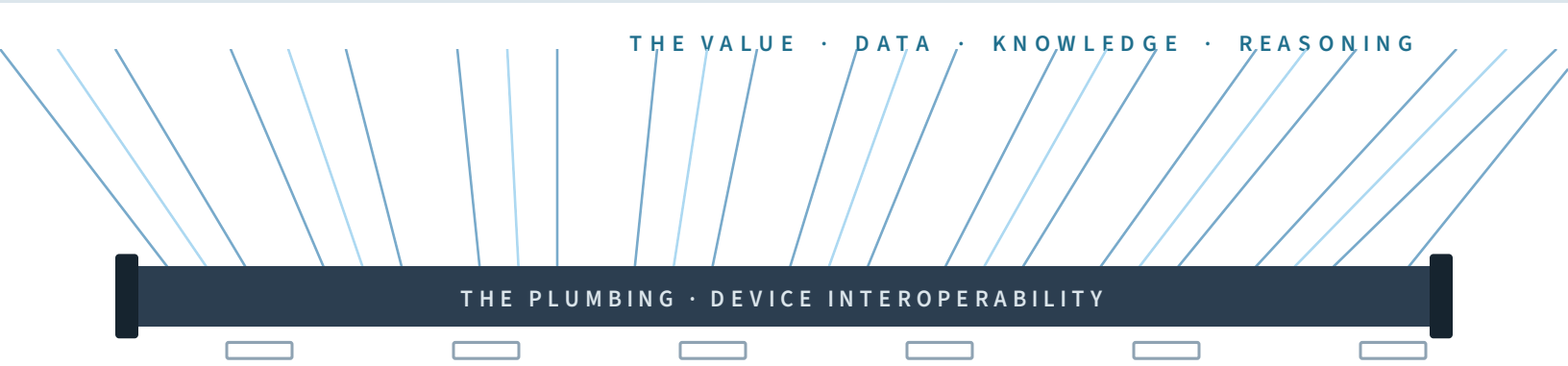
THE PLUMBING WAS NEVER THE POINT

Critical care spent years connecting the pipes.
The value was always in what flows through them,
and in the public knowledge they can be joined to.
Almost none of it is flowing yet.



Daniel Pettus

Forty years in medical device and health IT. Contributor to the IHE device interoperability standards.
Author of ***The Technology Was Never the Problem***

WHITE PAPER · SEPTEMBER 2026

THE PLUMBING WAS NEVER THE POINT

Interoperability was the pipe. The value is the data that flows through it, joined to the public knowledge the country already built, carried in a common language back to the Unified Medical Language System, and reasoned over at the bedside, while the patient is still in the bed.

CONTENTS

This paper is analysis and commentary. AI MedAgent, referenced in the text, is a research demonstration of a patent-pending method. Advisory only. Not a medical device. Not for clinical use. Simulated patients and synthetic data only. Nothing in this paper is clinical decision support or is validated for clinical use.

ABOUT THE AUTHOR

Daniel C. Pettus spent forty years in medical device and health IT leadership at Alaris, CareFusion and BD, contributed to the IHE Patient Care Device interoperability standards, and is named on two United States patents, with three provisionals pending. His 2013 article on closed-loop infusion pump integration with the EMR received the AAMI BI&T Best Article award.[13] He writes *Inside the Loop* at insidetheloopdp.substack.com.

ABOUT THIS PAPER

This is the companion argument to the book *The Technology Was Never the Problem*.[12] It builds on, and deliberately honors, the West Health Institute's 2013 analysis of the value of medical device interoperability.[1] The debt is acknowledged in the text. The graphics, the cases and the argument are original.

HOW THE NUMBERS WERE CHECKED

Every figure carries a bracketed citation keyed to the References, and each was confirmed at its primary source before it went in. Where a claim is the author's judgment rather than a sourced fact, the text says so. The appendix lists every number and where it came from.

CITE AS

Pettus DC. The Plumbing Was Never the Point: interoperability, data, and the unclaimed value in critical-care therapy management. White paper, September 2026. DOI: 10.5281/zenodo.22710022

EXECUTIVE SUMMARY

THE REFRAME

In 2013, the West Health Institute measured what medical device interoperability was worth and put the number above **thirty billion dollars a year**.[1] That number was real then and it is real now. But it measured the pipe. The larger prize was never the connection itself. It is the data that moves through the connection once it exists, joined to the public knowledge the country already paid to build, carried in a common language all the way back to the Unified Medical Language System, and reasoned over while the patient is still in the bed. In critical care, where the sickest patients throw off the most data and the least of it is used to look forward, that prize is almost entirely unclaimed. **West measured the pipes. What follows measures what is worth pumping through them**, grounds the argument in numbers you can check, and shows with two ordinary bedside cases what changes when the value, and not the plumbing, becomes the point.

BY THE NUMBERS

$14,775

US health spending per person in 2024, about double the average of comparable wealthy nations

Peterson-KFF Health System Tracker [3]

Last of 10

US rank overall, and on health outcomes, among ten high-income health systems. Second on care process

Commonwealth Fund, Mirror Mirror 2024 [2]

>$30B

West Health's 2013 estimate of the annual value of the plumbing alone, medical device interoperability

West Health Institute, March 2013 [1]

~88%

of US hospitals run smart infusion pumps

ASHP national survey, 2020 [4]

9 to 15%

have smart pump to record interoperability live. Thirty years in, that is the adoption

ASHP; ISMP; systematic review 2025 [4, 6]

1.5M

emergency department visits a year for adverse drug events; nearly 500,000 end in admission. Anticoagulants lead, at about 21 percent

US Centers for Disease Control and Prevention [7]

> *The plumbing is worth thirty billion dollars a year. What flows through it, once you join it to what the country already knows, is worth more, and almost none of it is claimed.*
>
> The argument of this paper, in one sentence.

SECTION 1

INTRODUCTION

The United States spends more on health care per person than any nation on earth, roughly **fourteen thousand eight hundred dollars** a year, about double the average of comparable wealthy countries.[3] For that money we finish last.

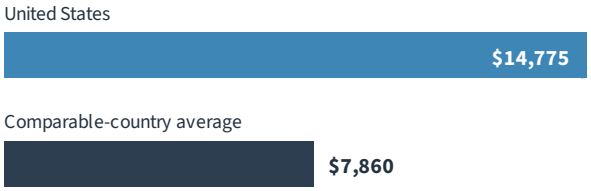
In the Commonwealth Fund's 2024 comparison of ten high-income health systems, the United States ranked **last overall and last on health outcomes**, with a life expectancy more than four years below the ten-country average and the highest rates of preventable and treatable death.[2]

Now the uncomfortable part, and I want to be fair about it. In that same study, the United States did not rank last on the process of care. It ranked **second**.[2] So the story is not that American clinicians are careless. The story is that we have taken a workforce that is well trained, deeply committed, and genuinely good at the job, and placed it inside a system that lets it make only small improvements no matter how hard it pushes. That is a painful way to waste that much talent, and it is the waste this paper is about.

We are not short on money, and in the intensive care unit we are certainly not short on data. A single critical-care patient generates a flood of it every hour, from the monitor, the ventilator, the infusion pumps, the lab, the pharmacy, and the record. What we are short on is movement. The data sits in silos, gets used to document what already happened, and rarely gets joined to anything that would help a clinician see the next problem coming.

Health spending per person, 2024

US dollars. The US spends about twice the comparable-country average.[3]



Health consumption expenditures per capita. Peterson-KFF Health System Tracker.

Ten high-income health systems compared, 2024

Where the United States finished.[2]

10th	10th	2nd
Overall	Health outcomes	Care process

THE PLUMBING

Interoperability. Devices and records able to exchange data at all: a verified order flowing to the pump, and the pump reporting back what it did.

THE VALUE

The patient's live data, joined to the public knowledge through a common language, and reasoned over in time for a human to act.

This is the companion argument to my book, **The Technology Was Never the Problem**.[12] The book makes the case that in fifty years of connectivity work, the technology was never the thing standing in the way. This paper makes the narrower case that follows from it. Even where the connectivity has been built, the connection was never the point. The plumbing is necessary. It is not sufficient. And treating the finished pipe as the finished job is exactly how an industry spends thirty years connecting devices and still leaves the value on the table.

2 The plumbing, briefly, and honestly

Interoperability in this setting has a specific meaning worth stating plainly. At its fullest, it is auto-programming: a pharmacist verifies an intravenous order in the record, and that order flows to the infusion pump and populates the rate and the limits, so the nurse confirms rather than retypes. The reverse direction, the pump reporting back what it actually did to the nurse's flowsheet, is auto-documentation. They are opposite flows with different failure modes, and confusing the two is the single most common error in this field.[9]

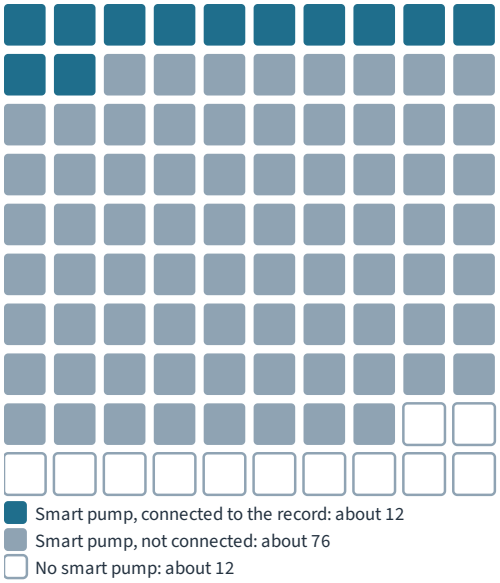
It should be said that interoperability means whatever the person using the word needs it to mean. To an EHR team it means chart data moving from one site to another across different vendors' systems. To radiology it means a DICOM image opens in any viewer no matter which machine made it. To an infusion pump company it means a validated order, aligned from the formulary to CPOE to the eMAR, programming the pump and the pump reporting back to the flowsheet. Every one of those is real plumbing, every one has a gap, and the argument of this paper applies to all of them. I use the infusion pump as the working example for one reason: it is the one place where the loop actually closes, order to device to record, so it is the one place we can see clearly what is and is not done with the water.

So how far has the plumbing actually reached. About **eighty-eight percent** of US hospitals run smart pumps.[4] Fewer than one in six have smart pump to record interoperability live, by most counts somewhere between **nine and fifteen percent**.[4, 6] Thirty years into the effort, that is the adoption.

I do not raise the gap to scold anyone. West was right that closing it is worth real money, more than thirty billion dollars a year, and the largest pieces of that estimate were not exotic. They were shorter lengths of stay and clinician time returned, about **seventeen point eight billion** and **twelve point three billion** respectively, with avoided redundant testing and reduced adverse events behind them.[1] That is the value of the pipe, and it is a good number.

Of every 100 US hospitals

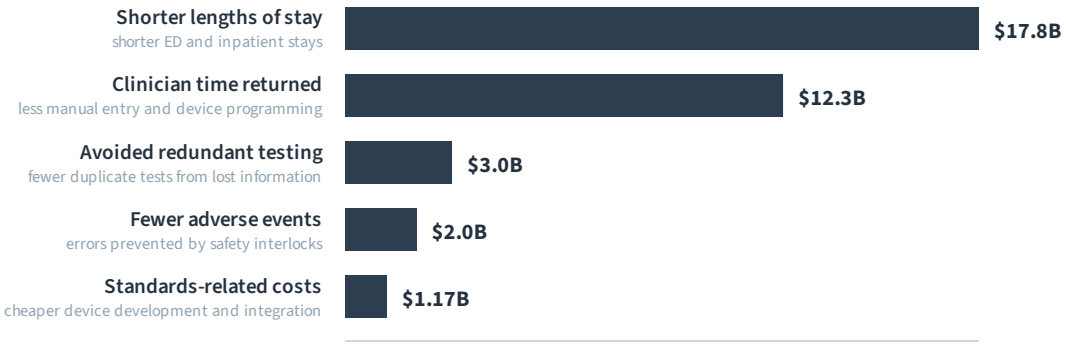
Smart pumps are nearly universal. The pump talking to the record is not.[4, 6]



Each square is one hospital in a hundred. **88** run smart pumps; of those, about **12** have the pump connected to the record, shown at the midpoint of the published 9 to 15 percent range. The remaining 12 run no smart pump at all.

What West counted: the value of the pipe

Annual savings from medical device interoperability, in billions of US dollars, as published in March 2013.[1]



Billions of US dollars per year. Components as published by the West Health Institute, March 2013. They sum to about $36B; the report

West's headline was "annual savings in excess of $30 billion." The two largest pieces, shorter stays and clinician time, are the plumbing doing exactly what it was built to do. None of it is reasoning over the data.

My point is narrower and, I think, more important. A hospital that has finished the plumbing and done nothing further has built a very reliable way to fill in a flowsheet. The water is still doing almost none of the work it could do.

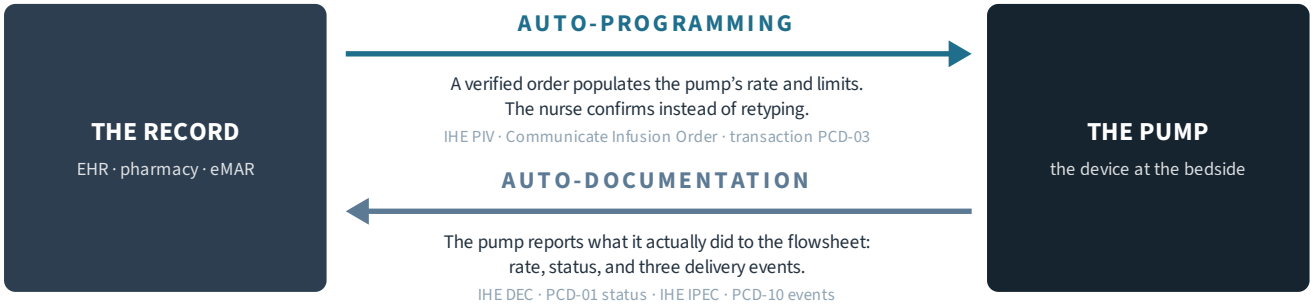
Auto-programming, done right, is a genuine safety step and a genuine time step. It removes a transcription. It puts the pharmacist's verified limits on the pump. It is the part of this story that the industry, to its credit, eventually got working where it was installed. Nothing in this paper argues against finishing it.

What this paper argues is that the finished pipe is where the interesting work begins, not where it ends. Once the order flows and the pump reports, a hospital is holding a live, structured, machine-readable stream about the most fragile patient in the building. The next two sections are about what that stream is, and what it is missing.

> *A hospital that has finished the plumbing and done nothing further has built a very reliable way to fill in a flowsheet.*

The two directions of the pipe

Opposite flows, different failure modes. Confusing them is the most common error in this field.[9]



Both directions are plumbing. Both are worth finishing. Neither one reasons over what it carries. IHE Devices Technical Framework Rev. 10.0: PIV is transaction PCD-03, DEC is PCD-01, IPEC is PCD-10.

3 What flows through the pipes

Once the pipe exists, two very different kinds of data can move through it, and the value comes from joining them.

The local stream: this patient, right now

The first is the patient's own data as it happens. The infusion channels and their rates, the monitor's vitals, the ventilator settings, the latest labs, the verified orders, the notes. This stream tells you what is happening to this specific person in this specific bed. It is detailed, it is current, and today it is used overwhelmingly to record the past rather than to reason about the next hour.

The public stream: what the country already knows

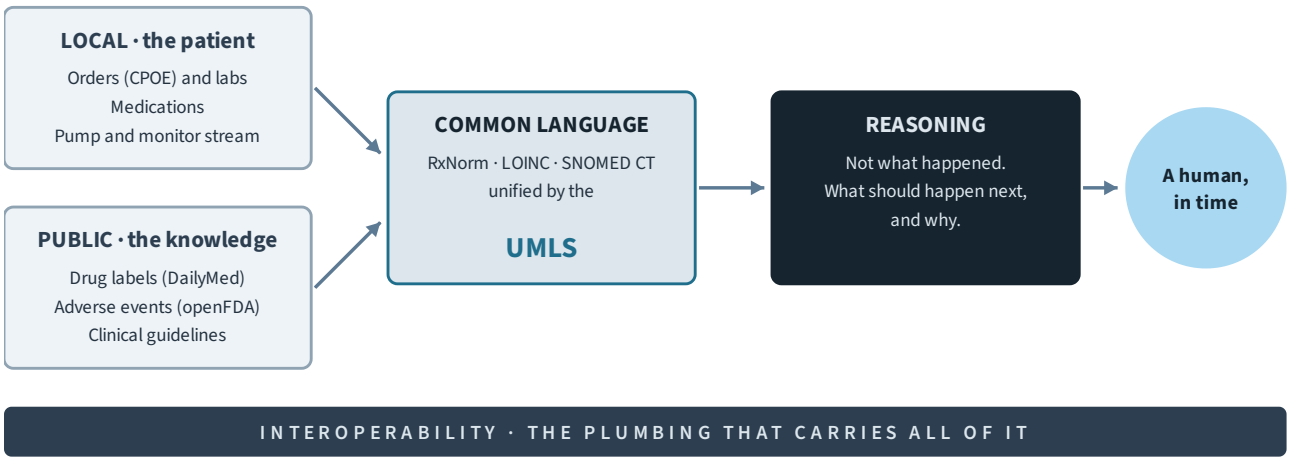
The second stream is the national knowledge, and this is the part the industry keeps forgetting it owns. The United States has already built and paid for an enormous library of public medical knowledge, and it gives it away. The FDA's structured drug labels are published through DailyMed. Adverse event reports are public through the FDA Adverse Event Reporting System and its openFDA interface. The clinical terminologies themselves are public.[8, 11] Any of us can download them today, without asking anyone's permission.

The local stream tells you what is happening. The public stream tells you what is known about it. Neither one is worth much alone. A pump rate with no idea what the drug is known to do is a number. A drug label with no idea what this patient is receiving is a document. Value begins the moment you can line them up, and lining them up is where the next section comes in.

> *The local stream tells you what is happening. The public stream tells you what is known about it. Neither one is worth much alone.*

Figure 1 · From the bedside to the UMLS

The local stream and the public knowledge only become useful once a common language joins them.



The two streams are useless apart and valuable together. The join is the whole game. Interoperability is the bar along the bottom: the plumbing that carries all of it.

4 The common language: why raw data is inert

Start with the problem that stops most people who try to join the two streams by hand. The pump calls a drug one thing. The pharmacy system calls it another. The lab has its own code, the order has a third, and the FDA label a fourth. Left as raw text, none of it matches, and a join that has to be hand-built for every drug, every device, and every hospital is brittle, expensive, and does not scale past a demo.

The fix is not new and it is not mine. It is a common language, and the country already built that too. Drugs normalize through **RxNorm**. Laboratory results and clinical observations normalize through **LOINC**. Findings, procedures, and problems normalize through **SNOMED CT**. And these are not three islands. They are unified, mapped to one another and to more than a hundred other vocabularies, by the Unified Medical Language System at the National Library of Medicine.[8]

> *"The UMLS integrates and distributes key terminology, classification and coding standards, and associated resources to promote creation of more effective and interoperable biomedical information systems and services, including electronic health records."*
>
> US National Library of Medicine, on the Unified Medical Language System [8]

This is the anchor the whole argument hangs on. With the common language in place, joining the local stream to the public knowledge stops being a hand-built miracle and becomes something a machine can do reliably, at the bedside, at scale. Without it, everything downstream is a science project. The terminologies are the reason the value layer is buildable at all, and they have been sitting in the public domain, free to download, the entire time.

Three vocabularies, one system

What each one normalizes, and what unifies them.[8]

Vocabulary	Normalizes	At the bedside
RxNorm	Clinical drugs and their names	The drug on the pump matches the drug on the FDA label
LOINC	Laboratory results and clinical observations	This morning's lab trend has one name everywhere
SNOMED CT	Findings, procedures, problems	The diagnosis and the risk speak the same language as the label

UNIFIED BY THE UMLS · NATIONAL LIBRARY OF MEDICINE · PUBLIC, AND FREE TO DOWNLOAD

> *Give the two streams a shared language and a machine can finally line up this drug, on this pump, in this patient, against everything the FDA has ever published about it. That is what "all the way back to the UMLS" means.*

5 Where the value is: reasoning, not recording

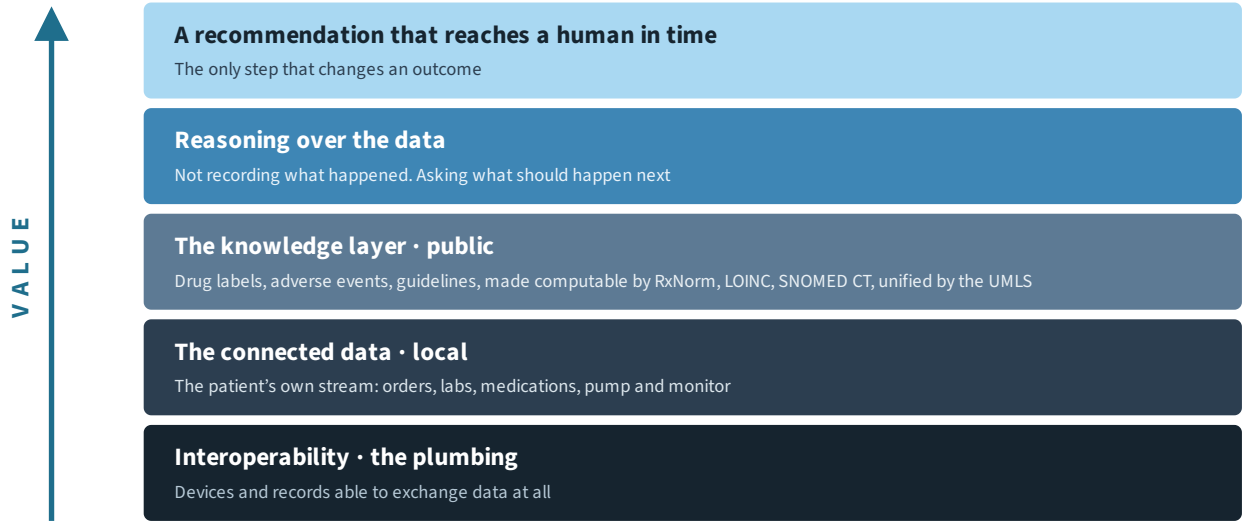
So the pipe is built, the two streams are joined, and they share a language. What do you do with that. Today, overwhelmingly, the answer is: you write it down. Nearly all of the data that moves through even a fully plumbed critical-care unit is used to document what already happened. That is not nothing. Accurate documentation matters. But documentation is the floor, not the ceiling, and the industry has spent three decades mistaking the floor for the building.

The value is in reasoning over the joined data, and specifically in reasoning forward. Given this patient's live stream and everything the public knowledge says about the drugs and conditions in play, what is the safer next step, and what could go wrong before it becomes obvious at the bedside. Not a dashboard of what already went wrong. A proactive second look, before a slow harm turns into an obvious one.

I want to be precise about the boundary, because it is where this kind of work earns trust or loses it. The point is not to replace the clinician, and it is not to have a machine pick a dose. The point is oversight that shows its evidence: a system that surfaces a rising risk, points to the specific label language or the specific lab trend behind the flag, states plainly which checks it could not perform, and hands the decision to a human who now has more to work with than a flowsheet and a memory. Reasoning with the humility to show its work, aimed at one job, which is catching the thing a busy clinician would want caught.

> *Documentation is the floor, not the ceiling, and the industry has spent three decades mistaking the floor for the building.*

Figure 2 · The plumbing is the smallest part
Interoperability connects the pipes. The value is everything stacked on top of it, and it grows as you climb.



Bottom layer: where West measured. Top layer: where the value actually is.

Draw it to scale and the point makes itself. West measured the bottom layer. The outcome lives at the top.

This is also the step that changed, and it changed from outside medicine. Acquiring data and normalizing data are problems this industry has worked on for forty years and has largely solved. Reasoning over that data at a useful level arrived recently, from the wider world of AI, and it is available now. The fourth step, connecting the result to a human being in a way that actually helps at the bedside, is still not solved. That is the honest state of the art, and it is the frontier this paper is pointing at.

THE FOUR STEPS, FROM THE BOOK

1

Acquire the data

The plumbing. Forty years of work, and largely solved where it has been installed.

2

Normalize the data

The common language. RxNorm, LOINC, SNOMED CT, unified by the UMLS. Built, public, and free.

3

Reason over the data

Arrived from outside medicine. Available now. The step that turns a record into a second look.

4

Connect it to a human

Still not solved. The only step that changes an outcome, and the frontier this paper points at.

Where the industry stands. We have spent forty years getting very good at steps one and two and calling them the whole thing. Step three is here. Step four is where the outcomes live. That sentence is the spine of *The Technology Was Never the Problem*,[12] and it is the reason the plumbing was never the point.

> *Acquire the data. Normalize the data. Reason over the data. Connect it to a human being. We got very good at the first two and called them the whole thing.*

6 Two cases, current state and future state

The argument is easier to see in the concrete, so the next two pages show two ordinary critical-care cases in the current state and the future state. Both are deliberately unglamorous. The value layer earns its keep on ordinary days, not rare ones. In each case the pipe is already built and working. What changes is what is done with the water.

HOW TO READ THE TWO CASES

CURRENT STATE
The plumbing is built and working. What happens today, with the pipe doing its job and nothing else asked of it.

FUTURE STATE
Same pipe, same order. The stream is joined to the public knowledge through the common language and reasoned over as it arrives.

IN RED
The moment the harm goes unseen. In both cases it happens after the plumbing has already succeeded.

Figure 3 · Case study

A high-alert anticoagulant on an infusion pump

Current state

The order is verified in pharmacy and, in a plumbed hospital, auto-programs the pump. The pump delivers and reports back to the flowsheet. Everything in that loop works, and it is genuinely better than retyping. But ***nothing in that loop is watching the interaction*** between this new anticoagulant and the trend that is already sitting in this patient's chart. The record has the drug. The record has the labs. No system joins them and looks forward. ***The plumbing did its job and the risk still went unseen***, because seeing it was never the plumbing's job.

Order, pump, flowsheet: connected. The lab trend: in the chart, joined to nothing.

Future state

The same verified order flows the same way. But now the joined stream, drug normalized through RxNorm and matched to its FDA label, labs normalized through LOINC, is reasoned over the moment the infusion starts. The rising bleed risk is flagged before it is obvious, with the specific label language and the specific lab trend shown as the evidence, and with a plain statement of what the system could not check. A human makes the call, sooner, with more in hand. **The pipe carried the order. The value caught the problem.**

Pump, lab and label, joined and reasoned over, reach a human with the evidence attached.

Case A · the drug that leads the harm statistics

Anticoagulants are not an exotic choice for a first case. They are the single largest cause of adverse-drug-event emergency visits in the country.

21%

of adverse-drug-event emergency department visits in the US involve an anticoagulant. Diabetes agents such as insulin account for about 14 percent, antibiotics about 13 percent.

US Centers for Disease Control and Prevention [7]

1.5 million

emergency department visits a year for adverse drug events, nearly 500,000 of them ending in admission.

US Centers for Disease Control and Prevention [7]

What the pipe did, and what it could not do

In the current state, every piece of plumbing in the case worked. The order was verified. The pump was programmed from it, not retyped. The pump reported back. That is the West value, delivered. The failure is not in the pipe. It is that no part of the pipe was ever asked to notice that the newest drug on the pump and the trend already in the chart, taken together, were heading somewhere. Seeing that was never the plumbing's job.

In the future state, nothing about the plumbing changes. What changes is that the stream the pipe already carries is joined, through the common language, to what the FDA has published about the drug, and reasoned over as it arrives. The difference between the two states is not a device. It is what is done with the water.

Case A, step by step: what the plumbing carries

Step	Carried by	Exists today
Pharmacist verifies the IV order	EHR and pharmacy system	**Yes**
Verified order populates the pump	IHE PIV, transaction PCD-03	**Yes, where installed**
Pump reports rate and status back	IHE DEC, transaction PCD-01	**Yes**
Start, stop and complete events	IHE IPEC, transaction PCD-10	**Yes**
Join the drug to its FDA label and to this patient's lab trend, and look forward	No transaction. It was never the plumbing's job.	**No**

IHE Devices Technical Framework, Rev. 10.0, Final Text, 2024.[9] The last row is the whole argument of this paper in one line of a table.

The boundary, stated plainly. The future state is oversight that shows evidence and defers to a clinician. It is never a machine choosing a dose. That is deliberate, and it is the line this work does not cross. It is also exactly how the public demonstration at aimedagent.net is built: simulated patients, synthetic data, every answer showing its sources, and every skipped safety check stated in writing.

Figure 4 · Case study

A titratable vasoactive drip, and the story the record does not read

Current state

This is the case that shows how much the plumbing already carries, and how little is done with it. A nurse titrates a vasopressor through the night, up and down, against the patient's pressure. Every one of those moves goes out on the wire. In the IHE infusion event profile a rate change is sent as a delivery-stop followed by a delivery-start with the new rate. A secondary infusion goes out with its mode set to piggyback. When the bag runs dry and the pump drifts to keep-vein-open, that goes out too, as a delivery-complete followed by a delivery-start carrying the KVO mode and rate.[9] Every delivery event carries the drug, the mode, the status, the rate and the volumes. The story of the night is on the wire, in order, with timestamps. Then it reaches the record, where, in the implementations I have seen, the flowsheet keeps the rate and the volume infused and files the rest. *The story arrived. Nobody read it forward.*

Every titration, handoff and KVO transition goes out as an event. The flowsheet keeps a rate. Nothing reads the rest.

Future state

The same event stream, joined to the pressure trend and read as it arrives, becomes what it always contained: a readable narrative of the night, the titration pattern against the pressure, the piggyback periods labeled, the KVO periods understood as KVO and not as therapy, and a proactive flag when the pattern is heading somewhere it should not, evidence shown, decision left to the human. **None of this requires a new pipe. It requires reading what the pipe already carries.**

Pump events and pressure trend, read together, become a readable night and a timely flag.

Case B · what the event stream carries, and what the record does with it

The claim in the sidebar is checkable, and I want to be exact, because the people who built these interfaces will read this. The IHE infusion event profile, IPEC, transaction PCD-10, names three required events: delivery start, stop, and complete. It names no rate-change, secondary, or KVO event. But every delivery event must carry the drug, the pump's mode, its status, the rate and the volumes, and the profile represents each transition as a stop-and-start pair with the mode and status changed.[9] BD and Baxter both publish integration statements claiming the profile, and Alaris does exactly that, which I know from direct experience with several interoperable customer sites and from the published literature on that integration.[13]

Clinical transition	How the IPEC event stream represents it	On the wire
Infusion start, stop, complete	Named required events	**Yes**
Rate change	Delivery-stop, then delivery-start with the new rate	**Yes**
Secondary (piggyback) infusion	Stop/start with mode piggyback; complete, then start back on the primary	**Yes**
Transition to keep-vein-open	Delivery-complete, then delivery-start with the KVO mode and rate	**Yes**
A readable narrative of the night, in the chart	Not a transaction. Up to the receiving system.	**Rarely, in my experience**

IHE PCD IPEC supplement, Rev. 1.4 (2014), Final Text from TF Rev. 9.0 (2019); IHE Devices TF Rev. 10.0, Vol. 2, App. M.[9] The last row is my read, not a published statistic. I would welcome a counterexample.

Why a rate is not a story, even when the story was sent

Nothing in the message says that a stop followed by a start is a rate change. That knowledge lives in a table in the supplement, and a receiver that has not read the table will read a stop as an ending, and be wrong silently. The semantics are in a document, not in the stream. So a flowsheet that keeps the rate and the volume has recorded the night faithfully and still cannot tell you what the nurse did or why, because the mode and status that carry the meaning were filed, not read. KVO is the sharpest example: the pump is still infusing, so the flowsheet shows a number, but the wire said keep-vein-open, and that number is not therapy. A piggyback is the other: the events say which line is running, and a record that treats primary and secondary as concurrent double-counts the volume anyway. Both errors happen downstream of a pipe that got it right.

In the future state nothing about the pump or the interface changes. The same events, joined to the pressure trend and read as they arrive, are enough to reconstruct the night and flag the pattern. No new pipe. The water, read.

> *The story arrived. Nobody read it forward.*

7 Why it is not flowing yet

If the pipes exist in the best hospitals, the knowledge is public, and the language is free, why is almost none of this happening. The honest answer has several layers, and I have spent a career peeling them.

The first layer is that **public is not the same as free, and neither one is the same as reachable**. The standards really are open now. You can read every page of FHIR, SMART on FHIR, and LOINC without asking anyone. But reaching real patient data in a real hospital, in real time, still means keys, approvals, fees, and a test environment built specifically not to behave like the ward. I have gotten further through that maze than most, because I did it for a living, and I still hit walls that hospitals pay specialists to climb. A nurse with a good idea, or a small company, mostly turns back, and who could blame them.

The second layer is **the missing pipe itself**. For all the talk of interoperability, there is still no standard, real-time feed of a verified intravenous order out to a reasoning system that lives outside the four walls. The pharmacy-verified order travels as an internal message inside the hospital.[10]

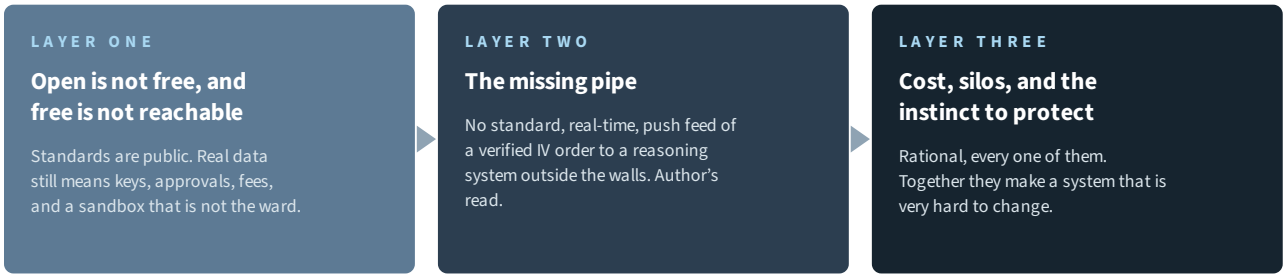
The modern record standard can be asked for a medication order, but it is built to be polled, not to push the instant something changes, and it carries no clean signal for "this order was modified after the bag was prepared."[10] That specific gap is not a detail. It is the difference between oversight that is current and oversight that is stale, and no vendor ships it today. That is my read, based on the current standards and every shipping architecture I could examine, and I will happily be corrected by anyone who has built it.

The third layer is the plain one: **cost, silos, and the entirely rational instinct to protect**. The organizations holding the data are guarding real assets and real liabilities, and I do not think they are villains for it. But complexity, cost, silos, and caution all push the same direction, toward a system that is very hard to change. And change is precisely what the outcome numbers at the top of this paper demand.

It gets harder from here, not easier. The population is aging, and the sickest years of the most people are still ahead of us. These problems are arriving in larger numbers, not fading. The cost of leaving the value in the pipe compounds every year we wait.

Figure 5 · Every layer of "open" has another layer under it

Three honest barriers, in the order a builder meets them.



And in the middle of all of it, quietly, a patient still waiting.

SECTION 8

CONCLUSION

West Health measured the pipes in 2013 and found them worth more than thirty billion dollars a year.[1] That work was right, and closing the plumbing gap is still worth doing. But the plumbing was the means, and somewhere along the way the industry started treating it as the end.

We declared victory at the connection and never asked what the connection was for.

The answer is a four-step chain, and it is the spine of the book this paper accompanies. Acquire the data. Normalize the data. Reason over the data. Connect it to a human being.[12] We have spent forty years getting very good at the first two and calling them the whole thing. The third step arrived from outside medicine and is available today. The fourth is unsolved, and it is where the outcomes actually live.

I am retired, which means I have nothing to sell and no job to protect by saying this out loud. I built a working demonstration of the reasoning layer in the open, on public data, in a matter of weeks, for a problem this industry has called too hard for thirty years. It runs on simulated patients and it shows its work, and it is not a product, a company, or anything you can buy. It is an argument that the value is buildable now, by someone with a laptop and forty years of scar tissue, if we would only stop mistaking the pipe for the water.

The plumbing was never the point. Keep peeling.

> *Stop declaring victory when the pipe is connected. The pipe was never the point. Measure the value, build for the value, and hand it to a human who can use it.*

CALL TO ACTION

ONE

Stop declaring victory at the connection

A finished pipe is the start of the work, not the end of it. Treat auto-programming and auto-documentation as the floor.

TWO

Measure the value, and build for it

Join the local stream to the public knowledge through the common language that already exists, and reason over it forward, not backward.

THREE

Hand it to a human who can use it

Oversight that shows its evidence, states what it could not check, and leaves the decision with the clinician. That is the unsolved step, and the one that changes an outcome.

Appendix · how the numbers were checked

Every figure in this paper was validated against its primary source before it went in, per my standing rule that a data claim I cannot source is a data claim I do not make. Two things in this paper are explicitly my read rather than a sourced fact, and both are labeled as such in the text: the judgment that no vendor today ships a real-time, push-based external order feed with a post-preparation change signal, and the framing of the four-step value chain, which is the argument of my book rather than a citation. Where a case study describes a future state, it describes oversight that surfaces evidence to a clinician. It does not describe a device choosing a dose, and nothing in this paper should be read as clinical decision support or as validated for clinical use.

EVERY NUMBER, AND WHERE IT CAME FROM

Figure used	What it says	Primary source	Ref
$14,775 per person	US health consumption expenditures per capita, 2024; comparable-country average about $7,860	Peterson-KFF Health System Tracker	[3]
Last of 10; last on outcomes; second on care process	Ranking among ten high-income health systems; life expectancy more than four years below the ten-country average	Commonwealth Fund, Mirror Mirror 2024 (September 2024)	[2]
More than $30 billion a year	Annual savings from medical device interoperability; components $17.8B length of stay, $12.3B clinician productivity, $3B redundant testing, $2B adverse events, $1.17B standards-related	West Health Institute, March 2013	[1]
About 88 percent	US hospitals using smart infusion pumps (87.9 percent)	ASHP national survey of pharmacy practice, 2020	[4]
9 to 15 percent	US hospitals with smart pump to EHR interoperability implemented	ASHP; ISMP guidelines 2020; systematic review, Medical Devices: Evidence and Research, 2025	[4, 5, 6]
1.5 million; about 500,000; 21 percent	Annual ADE emergency department visits; hospitalizations; share involving anticoagulants (diabetes agents about 14 percent, antibiotics about 13 percent)	US Centers for Disease Control and Prevention, Medication Safety	[7]
RxNorm, LOINC, SNOMED CT, unified by the UMLS	Source vocabularies integrated by the UMLS Metathesaurus; definition quoted verbatim	US National Library of Medicine	[8]
IPEC events and what they carry	PCD-10 names three required events, delivery start, stop and complete; every delivery event carries drug, operational mode, pump status, rate and volumes; rate changes, secondary infusions and the KVO transition are represented as stop/start event pairs with the mode and status changed	IHE PCD IPEC supplement Rev. 1.4 (2014), Final Text from TF Rev. 9.0 (2019); IHE Devices TF Rev. 10.0, Vol. 2 App. M	[9]
Order feed is pull, not push	FHIR MedicationRequest and MedicationDispense are queried; no standard push for post-preparation modification	HL7 FHIR; SMART on FHIR	[10]

On the West comparison. This paper borrows West's discipline, its Current State and Future State framing, and its habit of showing where every number came from. It does not borrow its text, its graphics, or its assumptions, and it does not attempt a dollar estimate of its own. The one number this paper adds to West's is zero: a deliberate refusal to invent a value figure it cannot defend. If a defensible bottom-up model is built later, it will be published with its arithmetic, as West published theirs.

References

[1] West Health Institute. *The Value of Medical Device Interoperability: Improving Patient Care with More Than $30 Billion in Annual Health Care Savings.* March 2013. Savings components: reduced length of stay ($17.8B), clinician productivity ($12.3B), redundant testing ($3B), adverse events ($2B), standards-related costs ($1.17B); set against roughly $700B in annual wasteful spending. westhealth.org

[2] The Commonwealth Fund. *Mirror, Mirror 2024: A Portrait of the Failing U.S. Health System.* September 2024. Ten high-income countries compared; the US ranks last overall and last on health outcomes while spending the most, and second on care process. commonwealthfund.org

[3] Peterson-KFF Health System Tracker. *How does health spending in the U.S. compare to other countries?* US health spending about $14,775 per person (2024), roughly double the comparable-country average (about $7,860). healthsystemtracker.org

[4] Pedersen CA, et al. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration, 2020. Approximately 87.9 percent of hospitals use smart infusion pumps; smart pump to EHR interoperability implemented in roughly 9 to 15 percent. *American Journal of Health-System Pharmacy.*

[5] Institute for Safe Medication Practices. *Guidelines for Optimizing Safe Implementation and Use of Smart Infusion Pumps.* 2020. ismp.org

[6] *Evaluating the Impact of Smart Infusion Pump Interoperability on Reducing Medication Administration Errors: A Systematic Literature Review.* Medical Devices: Evidence and Research, 2025. Corroborates the 9 to 15 percent interoperability adoption range against approximately 88 percent smart pump adoption.

[7] US Centers for Disease Control and Prevention. *Medication Safety: Adverse Drug Events, facts and statistics.* More than 1.5 million ADE-related emergency department visits per year, nearly 500,000 requiring hospitalization; anticoagulants about 21 percent, diabetes agents about 14 percent, antibiotics about 13 percent. cdc.gov

[8] US National Library of Medicine. *Unified Medical Language System (UMLS).* Integrates RxNorm (drugs), LOINC (observations), SNOMED CT (clinical findings), and more than one hundred other source vocabularies. nlm.nih.gov/research/umls

[9] IHE International. *IHE Devices Technical Framework,* Rev. 10.0, Final Text, November 2024, and *IHE PCD Technical Framework Supplement: Infusion Pump Event Communication (IPEC),* Rev. 1.4, 2014 (Final Text from Rev. 9.0, 2019). Order to pump via Point-of-Care Infusion Verification (PIV, transaction PCD-03); pump status to enterprise via Device Enterprise Communication (DEC, PCD-01); infusion events via IPEC (PCD-10), whose required events are delivery start, stop and complete, each carrying drug, operational mode, pump status, rate and volumes, with rate changes, secondary infusions and keep-vein-open represented as stop/start event pairs (Vol. 2, Appendix M). Public IHE Integration Statements claiming IPEC include BD (Alaris System) and Baxter (Spectrum IQ Gateway, January 2020). ihe.net; ushospitalproducts.baxter.com

[10] HL7 International. *HL7 Version 2 pharmacy/treatment order messages (RDE)*, the internal form in which a pharmacy-verified order travels inside the hospital; *FHIR: MedicationRequest and MedicationDispense;* SMART on FHIR. FHIR order data is retrievable by query (pull), with no standard push notification for post-preparation order modification. hl7.org

[11] US Food and Drug Administration and US National Library of Medicine, public knowledge assets: *DailyMed* (structured product labeling), *FDA Adverse Event Reporting System (FAERS)* and *openFDA.* dailymed.nlm.nih.gov; open.fda.gov

[12] Pettus DC. *The Technology Was Never the Problem.* 2026. pettusbook.com

[13] Pettus DC. Worth the Effort? Closed-Loop Infusion Pump Integration with the EMR. *Biomedical Instrumentation & Technology* 2013;47(6):467. AAMI BI&T Best Article, 2014. doi.org/10.2345/0899-8205-47.6.467

The plumbing was never the point. **Keep peeling.**

This paper is one chapter of a longer argument. **The Technology Was Never the Problem** is that argument in full: forty years of trying to connect medical devices, what actually stopped it, and why the answer was never engineering.

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THE AUTHOR

Daniel C. Pettus

Forty years at Alaris, CareFusion and BD. Named on two US patents, three provisionals pending.

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