Examining the Effects of The Combined Use of Automating and Linking Technologies in US Healthcare Supply Chains

Randy V. Bradley, The University of Tennessee

Terry L. Esper, The Ohio State University

Joonhwan In, California State University – Long Beach

Kang Lee, Auburn University

Bogdan C. Bichescu, The University of Tennessee

Terry Anthony Byrd, Auburn University

Agenda

① Study Background

② Hypotheses

③ Study Design

④ Results

Impetus for Study

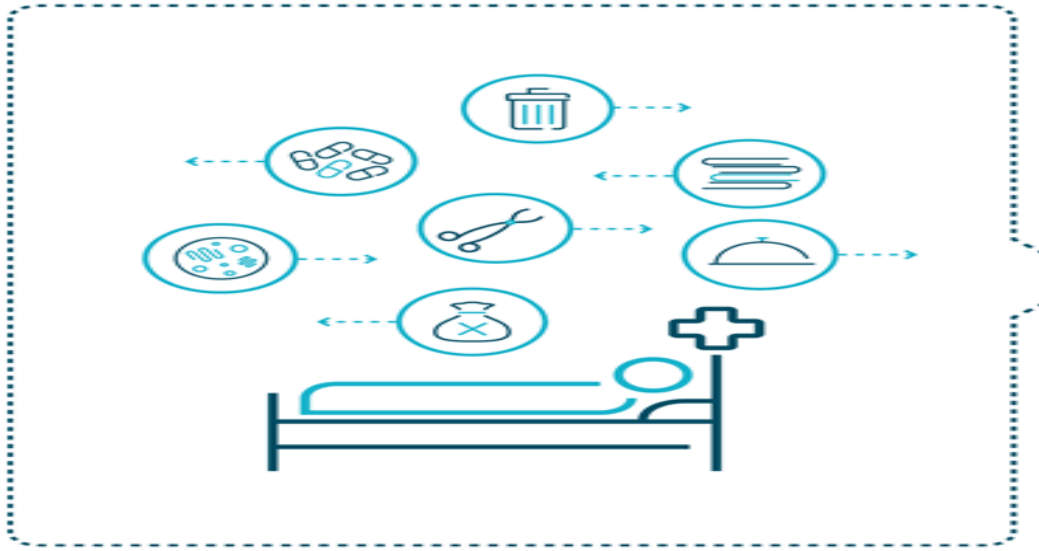
- Value-based purchasing (VBP) is a paradigm shift
  - Hospitals are reimbursed (or penalized) based on for quality of care (Burwell, 2015)
    - Conformance quality
    - Experiential quality
  - Shift from throughput model to valuable outcomes model
  - Need to capture asset utilization at the point of care
- Revenue cycle and cash flow management are vital to operations
  - Supply chain (SC) costs account for 40-45% of hospitals' operating expenses (Langabeer and Helton, 2016)
  - Need to increase supply chain and labor efficiency
  - Stock-outs in healthcare are more impactful than in other sectors

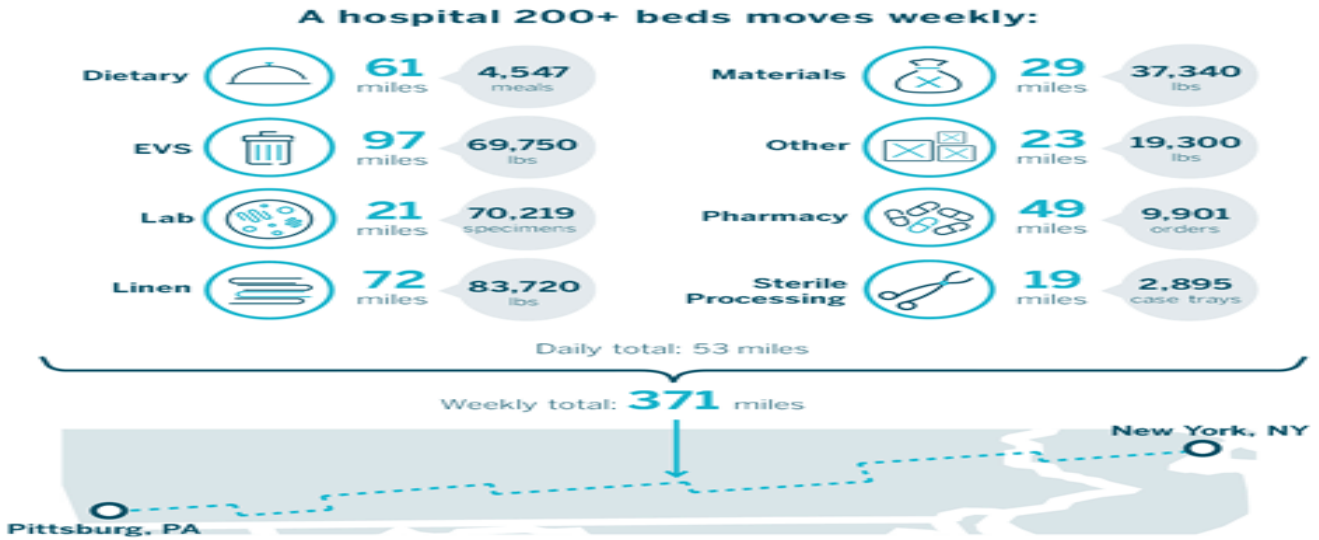
Understanding the Product (Patient) Journey

Most hospital leaders don't realize the high volume of materials moving through their facility each week.

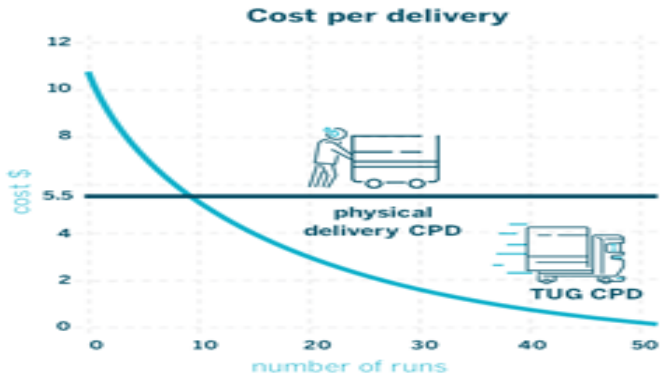
Materials	**EVS**	**Dietary**	**Pharmacy**
29 miles · 37,340 lbs	97 miles · 69,750 lbs	61 miles · 4,547 meals	49 miles · 9,901 orders
Lab	**Linen**	**Sterile Processing**	**Other**
21 miles · 70,219 specimen	72 miles · 83,720 lbs	19 miles · 2,895 case trays	23 miles · 19,300 lbs

Understanding the Product (Patient) Journey

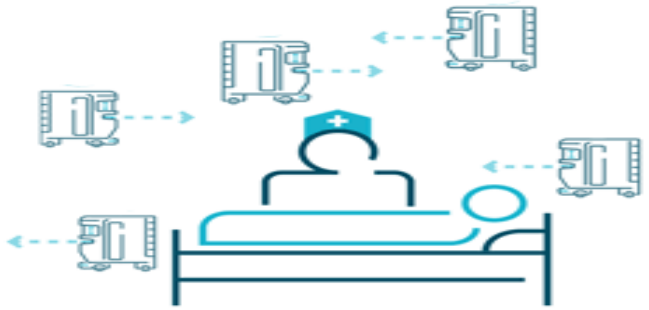




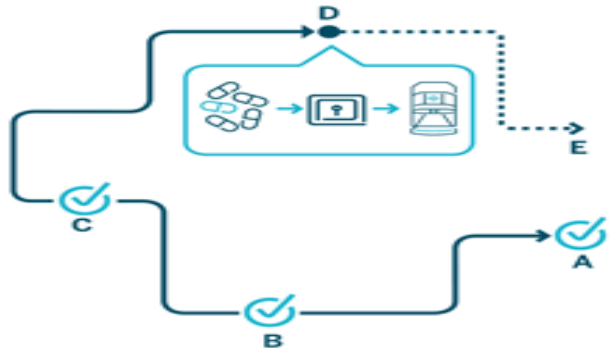
Value of automated delivery and tracking:



lowers cost per delivery by 50%-80% (CPD)



improves patient satisfaction and care



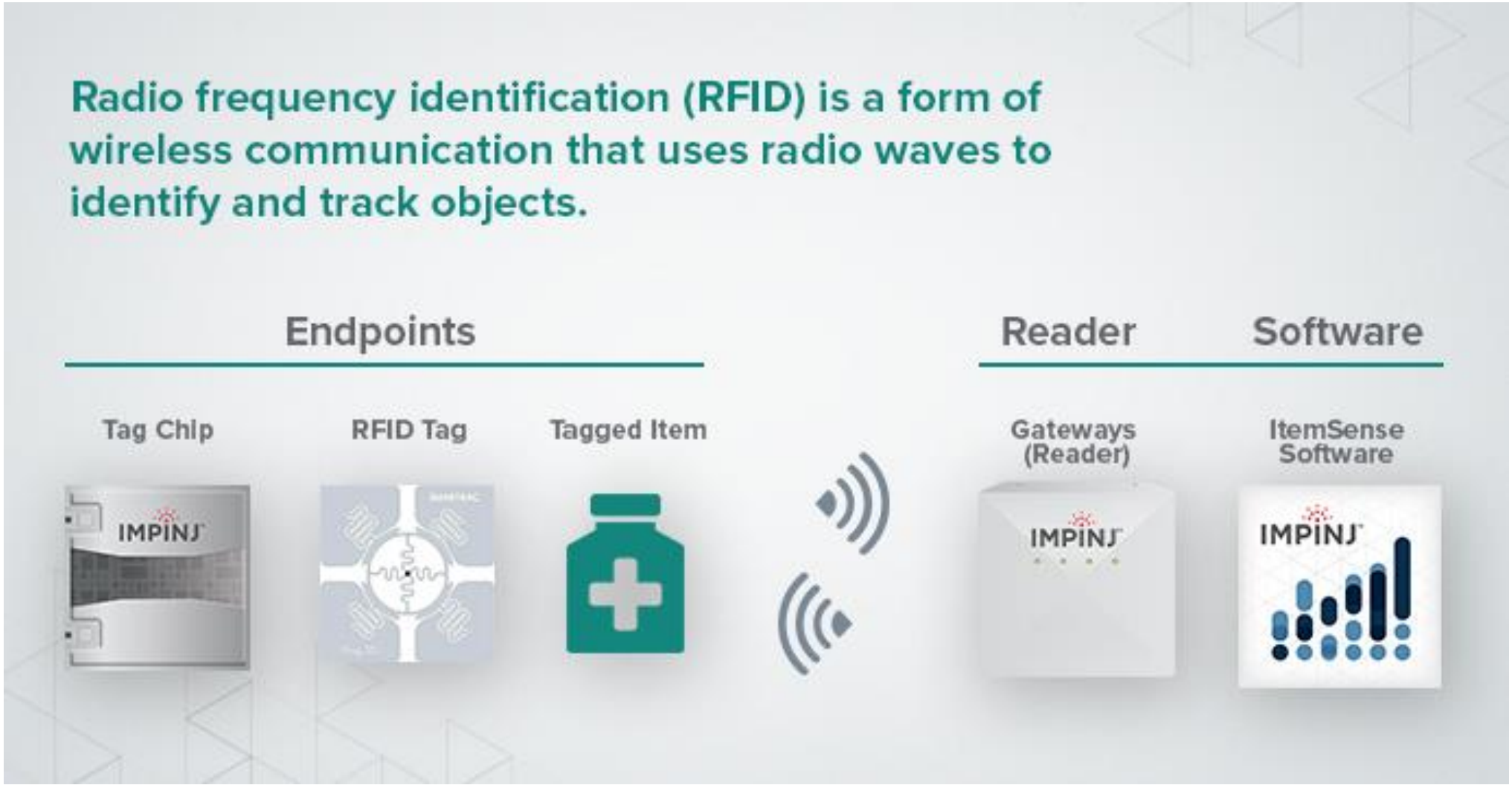
automates compliance and control with full chain of custody

Automating Technology

- Facilitates execution of processes by performing tasks with precision, speed, and accuracy, with limited human intervention (Burton-Jones 2014).
  - Provides accurate and timely information
  - Improves workflow
  - Reduces costs
  - Increases productivity

- Focal automating technology - radio frequency identification (RFID)

Automating Technology - RFID




SURGICAL
SAFETY
SCANNER
Set your worries free with RFID


SURGICAL
SAFETY
SCANNER
Set your worries free with RFID


SURGICAL
SAFETY
SCANNER
Set your worries free with RFID

Linking Technology

- Vital to B2Bi
  - Facilitates integration of disparate systems across organizations
  - Link the interdependencies of data flows
  - Ensures data compliance
  - Allows supply chain members to automate data flows
  - Optimizes inter-organizational processes

- Focal linking technology – Electronic Data Interchange (EDI)
  - Establishes ELs between parties via exchanges of information in a structured, computer-driven form

Linking Technology - EDI

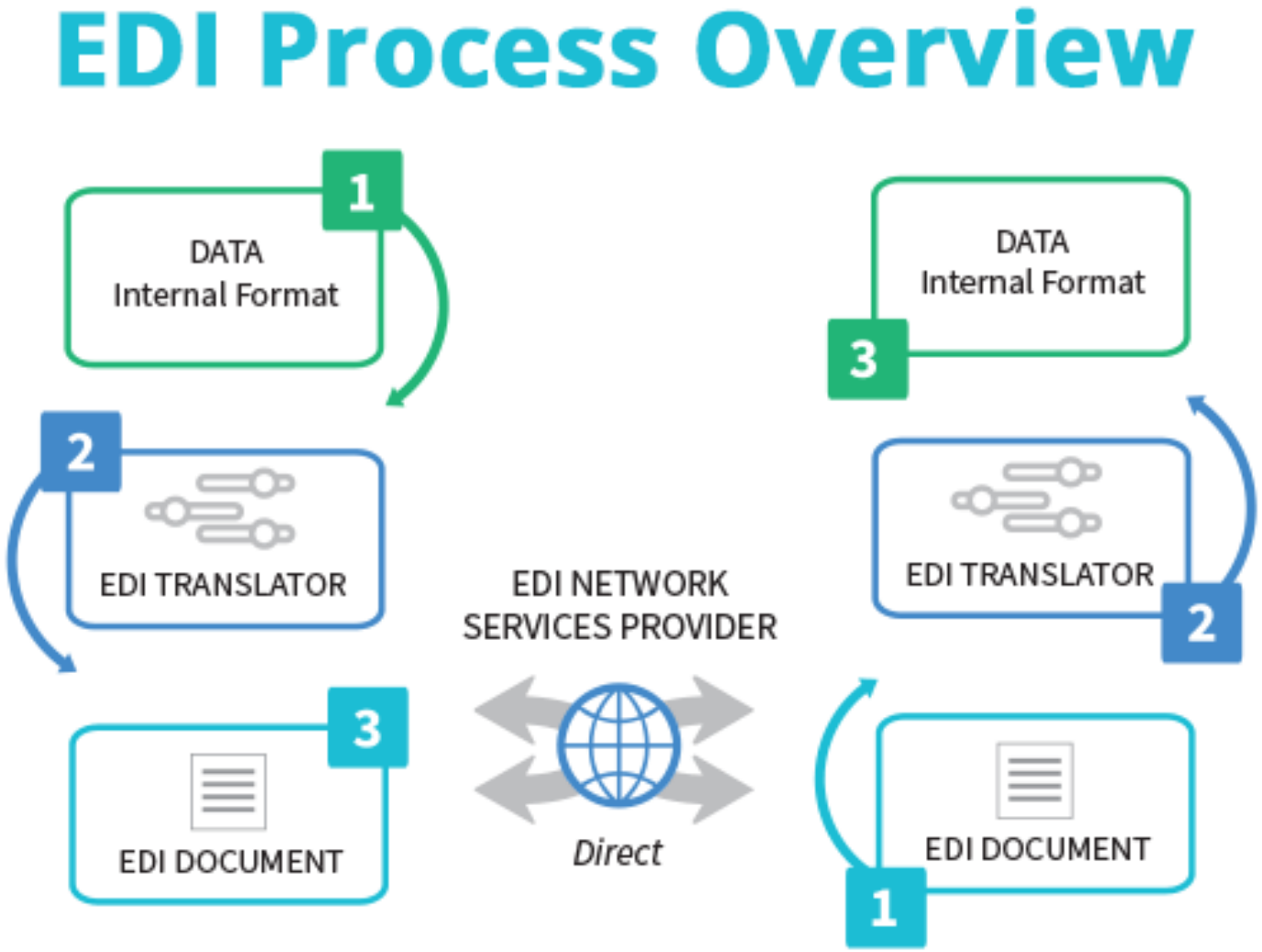


Image Source: https://www.1edisource.com/resources/edi/

RFID Use Case: Operating Room Documentation

Clinical Cashier?

Standard Supply Issues in The Operating Room

Supply Returns – 70%

Orthopedic Procedures

- Door Opened: Every 1.5 min/90 seconds
- Total case open door time: 10.75 minutes
- Percentage of supply related openings: 30%

Development

Smart Trash Can

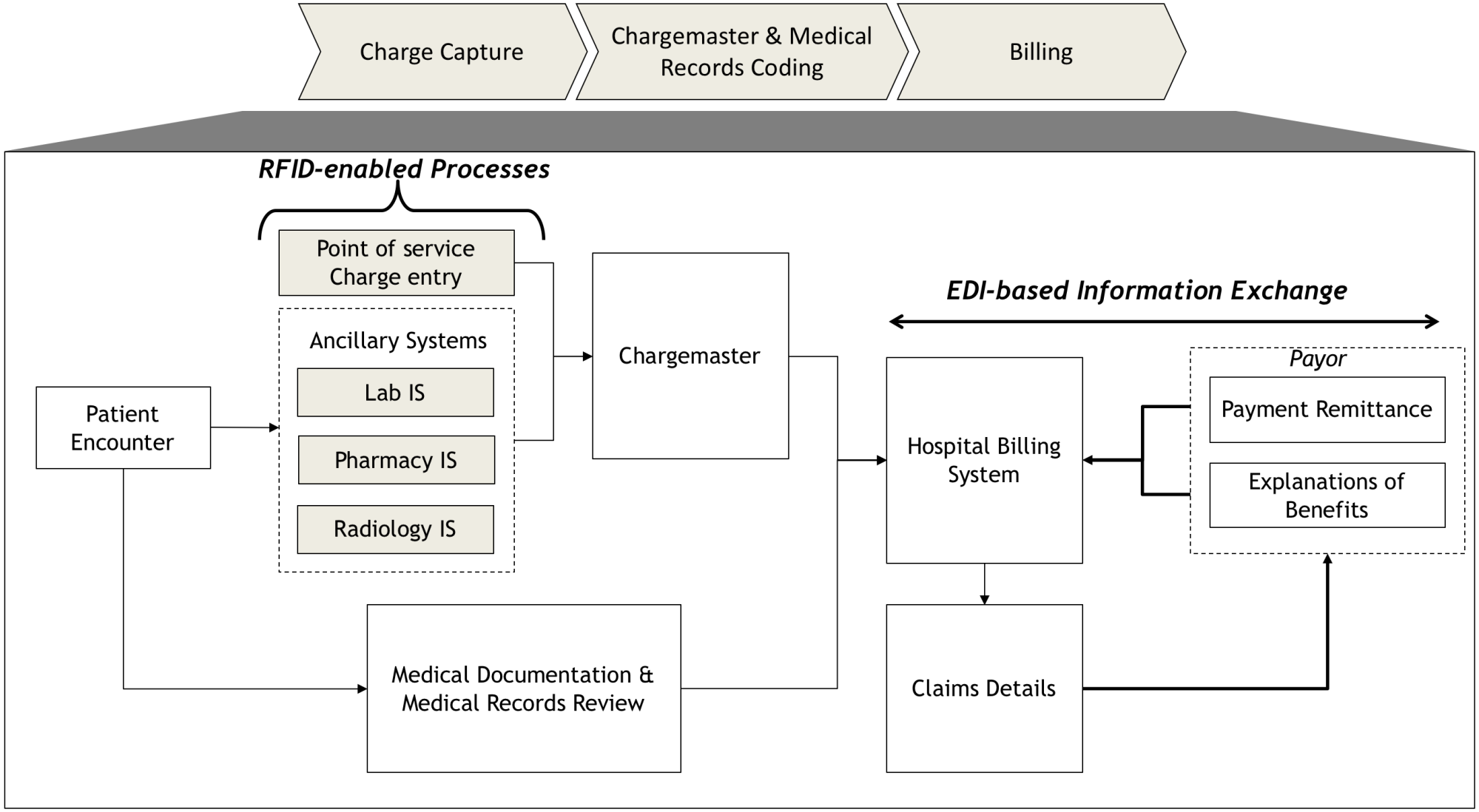
Disposal of Supply Wrappers

Automatic Usage Capture

Benefits of RFID in the OR

- 99.8% accurate usage and charge capture
- Association of supplies and implants to specific patients
- Accurate case cost
- Item expiration alert
- Automated UDI documentation

Background



Resource Orchestration Theory (ROT)

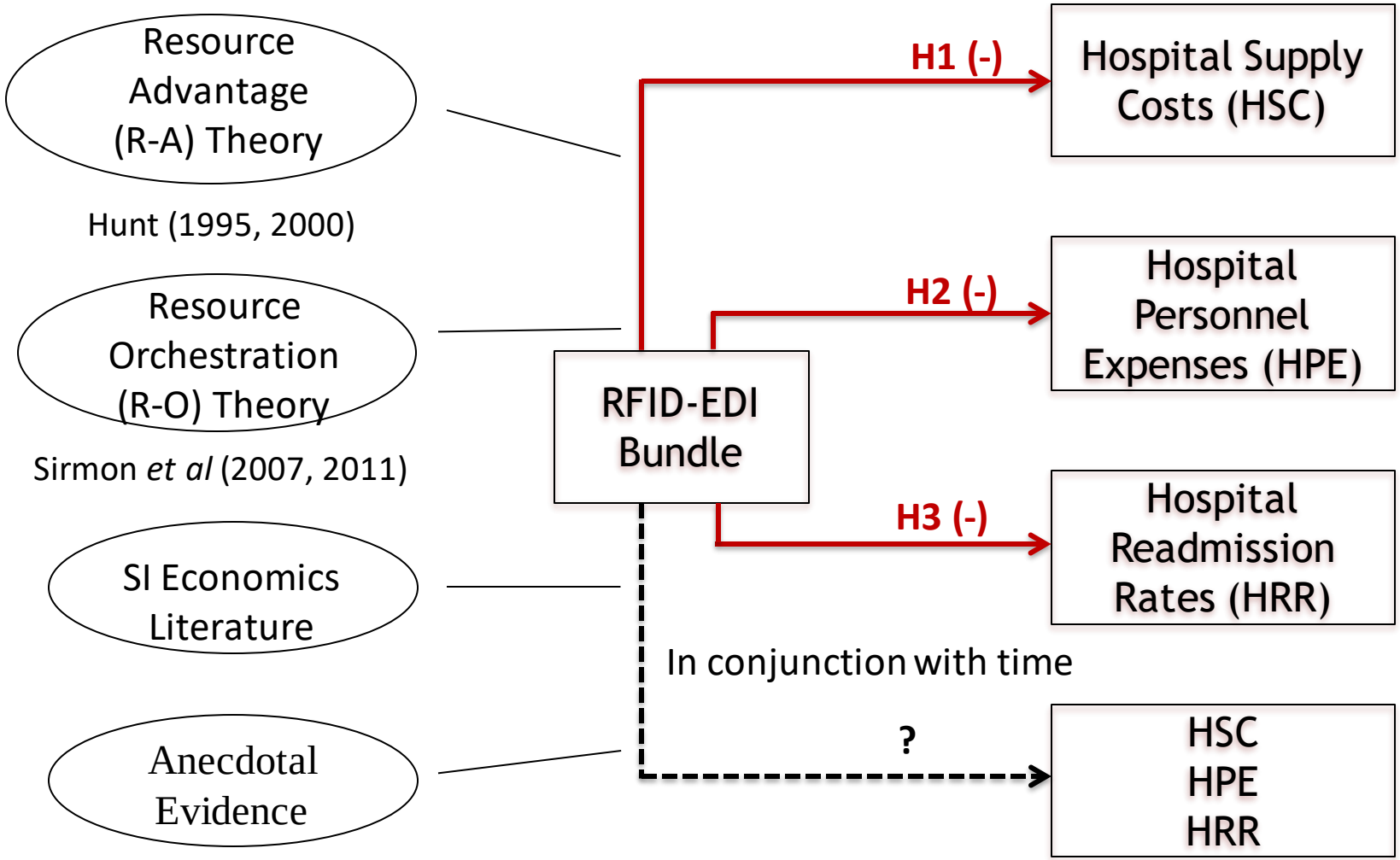
- The value of resources is in effective “bundling” and “leveraging” not accumulation (Sirmon et al., 2011)
- Bundling is the joint use of resources
- Leveraging is consistent use of a resource bundle over time”

Research Question

What is the effect of the joint use of RFID and EDI on various aspects of hospital performance?

HASLAM
COLLEGE OF BUSINESS
THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Hypothesized Relationships



Data Sources

- AHD (American Hospital Directory)
  - Tracks performance of most US hospitals
  - Provides annual, hospital-level data structured around 7 reports:
    - Profile, departments, financial, financial indicators, quality, inpatient, and outpatient
- HIMSS Analytics
  - Tracks adoption and use of IT in hospitals
- Center for Medicare and Medicaid Services (CMS) Cost Reports

Study Sample

- Sample
  - 3,327 U.S. hospitals
  - approximately 60% of all acute care hospitals in the country
  - does not include hospitals that adopted EDI or RFID prior to the timeframe of our study
- Time frame
  - 8-year period from 2008 to 2015

Analysis – Generalized Method of Moments (GMM)

- GMM approach (Hansen, 1982) enables consistent estimation Arellano and Bond (1991) the dynamic models proposed in Eq (1)

$$ln(PERF_{i,t+1}) = \beta_0 PERF_{it} + \beta_1 RFIDandEDI_{it} + \beta_2 RFIDonly_{it} + \beta_3 EDIonly_{it} + \beta_4 RFIDafterEDI_{it}$$
$$+ \beta_5 RFIDafterNONE_{it} + \beta_6 EDIafterNONE_{it} + \beta_7 CMI_{it} + \beta_8 Urban_{it} + \beta_9 Profit_{it} + \beta_{10} Government_{it}$$
$$+ \beta_{11} System_{it} + \beta_{12} Beds_{it} + d_t + \alpha_i + v_{it}. \quad \textbf{Eq (1)}$$

$$ln(PERF_{i,t+1}) = \beta_0 PERF_{it} + \beta_1 RFIDandEDI_{it} + \beta_2 RFIDonly_{it} + \beta_3 EDIonly_{it} + \boldsymbol{\beta_4 LENGTH_{it}}$$
$$+ \boldsymbol{\beta_5 Length \times RFIDandEDI_{it}} + \boldsymbol{\beta_6 Length \times RFIDonly_{it}} + \boldsymbol{\beta_7 Length \times EDIonly_{it}} + \beta_8 CMI_{it}$$
$$+ \beta_9 Urban_{it} + \beta_{10} Profit_{it} + \beta_{11} Government_{it} + \beta_{12} System_{it} + \beta_{13} Beds_{it} + d_t + \alpha_i + v_{it}. \quad \textbf{Eq (2)}$$

Model Results/Findings for Supply Costs

- **Hospitals jointly using the RFID-EDI bundle have lower supply costs, and thereby better supply cost efficiency**
- No significant association with supply costs in hospitals using only RFID
- Hospitals using only EDI have higher supply costs
- The first year of joint use of the RFID-EDI bundle is associated with higher supply costs

Model Results/Findings for Personnel Expenses

- **Hospitals using the RFID-EDI bundle have lower personnel expenses**

- Hospitals using only RFID or EDI have higher personnel expenses

Model Results/Findings for Readmission Rates

- **Hospitals using the RFID-EDI bundle have lower readmission rates**
- No significant association with hospitals using only RFID and readmission rates
- Hospitals using only EDI have lower readmission rates
- The first year of joint use of the RFID-EDI bundle has no significant association with readmission rates

Post-hoc: Long-term Effects of RFID-EDI Joint Use

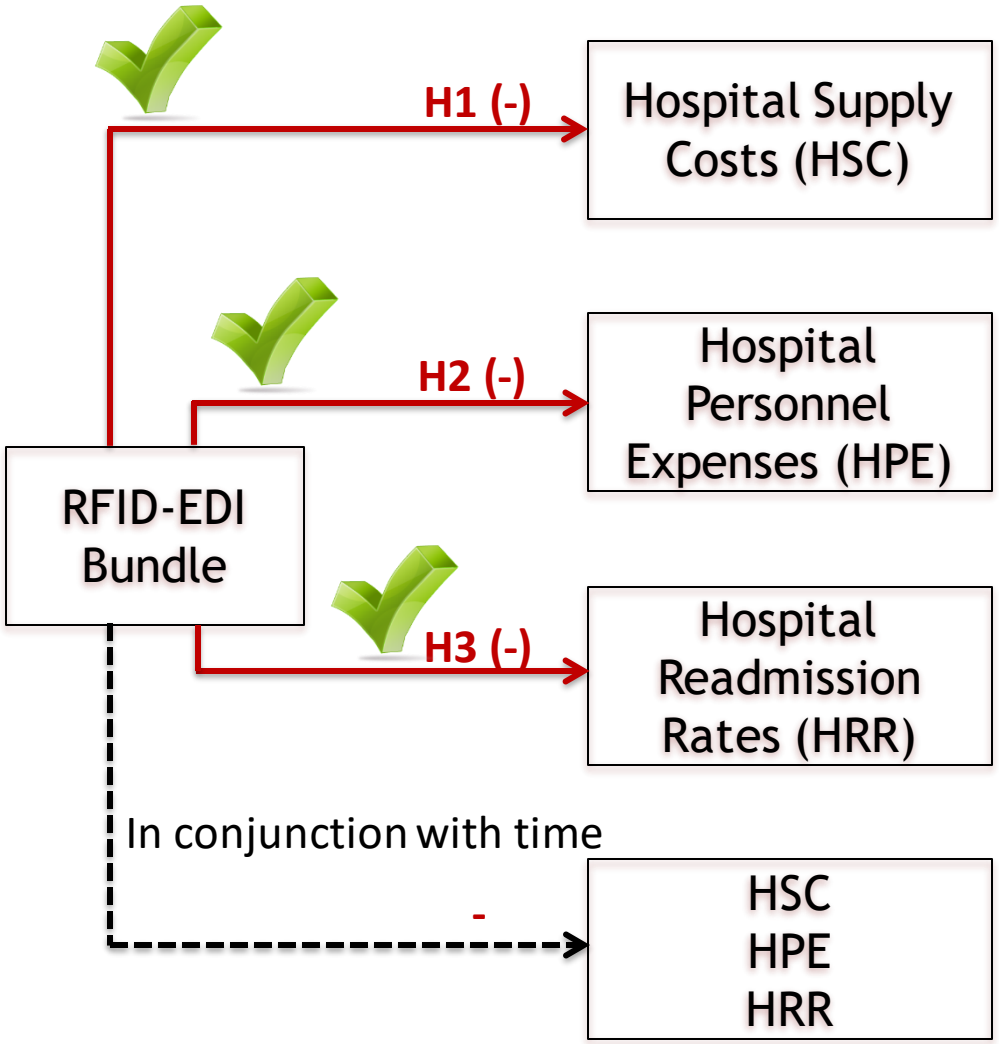
- **Long-term, continued leveraging of the RFID-EDI bundle is associated with…**
  - **Lower supply costs:** ~9% decrease for each year of continued leveraging of the bundle
  - **Lower personnel expenses:** ~6% decrease for each year of continued leveraging tof he bundle
  - **Lower hospital readmission:** ~1.6% decrease for each year of continued leveraging of the bundle

- Using only RFID over time
  - Lower supply costs
  - No significant association with personnel expenses or readmission rates
  - hospitals using only RFID and readmission rates

- Using only EDI over time
  - Higher supply costs and personnel expenses

- Hospital readmission rates are not time-dependent with respect to adopting only RFID or EDI

Hypothesis Testing Results



Implications

- The effects of RFID-EDI joint use on supply costs, personnel expenses, and readmission rates are time dependent
- Consider longer windows when evaluating the effects of multiple technologies on operational performance
- Differences between service operations product-based operations make it challenging to find or realize benefits of an RFID- EDI bundle through common supply chain and financial metrics

HASLAM
COLLEGE OF BUSINESS
THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Thank You!

Randy V. Bradley, Ph.D., CPHIMS, FHIMSS

rbradley@utk.edu

@randyvbradley

linkedin.com/in/randyvbradley

+1-865-974-1761

+1-334-354-5966

HASLAM COLLEGE OF BUSINESS
THE UNIVERSITY OF TENNESSEE, KNOXVILLE