An Economic Analysis of Midline Venous Catheters to Reduce IV Contrast Extravasation

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Background

- Mechanisms of contrast extravasation[1]
  - Leakage from venotomy
    - Backflow from fibrin sheath[2,3]
    - Fractured catheter
  - Migration of catheter out of vessel
  - Erosion through vessel
- Midline (MDL) use declined in in 1990s
  - Hypersensitivity reactions to catheter material[3]
- Interest in midlines returning to reduce central-line associated blood stream infections (CLABSI)[4-6]
- Preferred for IV access for 6-14 days[7]

Proposed Benefits

- MDLs are less likely to have infiltration/extravasation
  - Tip is distal to venotomy
    - Fibrin sheath takes time to develop and won't be relevant for ~1 week
    - Long length less likely to migrate out of vessel
  - Erosion through vessel wall not likely immediately
- New catheter materials do not cause allergic reactions
- Longevity is 7-16 days[8]
  - PIV lifespan 44 hr – 99 hrs[9-11]

Methods

- Brief analysis of potential cost-savings for using MDL versus PIVs
  - Cost of placing MDLs in select patient populations divided by cost of PIVs and subsequent new PIVs during a single inpatient encounter
- Review of the literature
  - Lifespan PIV catheters
  - Cost of PIV placement[8,12]
  - Cost of ultrasound-guided MDL
- Assumptions
  - Average length of stay for inpatient scanned with contrast: 8.9 days[13]
  - 30% of contrast enhanced imaging done as inpatient[14]
    - Extravasation rate is as low as 0.21%
  - 41% of patients scanned in ER will become inpatients[15]

Our Model and Examples

$$= \frac{\dfrac{Midline\ costs}{PIV\ costs}}{\$32\ [(\dfrac{Inpatient\ days}{Average\ PIV\ life} \times Inpatient\ population) + ER\ population + Outpatient\ population]}$$

$$= \frac{\$90}{\$32\ ((\dfrac{8.9d}{1.83d} x0.3 + 0.38 + 0.32)} = \frac{\$90}{\$32(2.16)} = \frac{\$90}{\$69.1} = 1.3$$

Modified formula with no outpatients and assumption of scanned ER patients that become inpatients:

$$= \frac{\$90}{\$32\ [(\dfrac{Inpatient\ days}{Average\ PIV\ life}(Inpatient\ population + \text{ER admissions}) + ER\ not - admitted)]}$$

$$= \frac{\$90}{\$32\ ((\dfrac{8.9d}{1.83d} x(0.44 + 0.23)) + 0.33)} = \frac{\$90}{\$32(3.58)} = \frac{\$90}{\$114.56} = 0.78$$

Results

Description	PIV lifespan	ER admissions included?	Outpatients included?	Result
Original model	44 hours	No	Yes	1.3
ER patients admitted	44 hours	Yes	No	0.78
Longer PIV	65 hours	Yes	No	1.1
Breakeven PIV life	58 hours	Yes	No	1.0

Discussion

- Cost savings from prevented extravasation insignificant compared to total costs
  - Due to the extremely low rate
  - Most extravasations require only conservative treatment[14]

- Midlines can save money relative to PIVs
  - Greater savings realized when PIV dwell time is shorter
  - Assumes midlines dwell time is greater than length of admission

Limitations

- Average PIV dwell time is likely institution dependent
- Costs estimates for line placement
- Extravasation rate for MDLs unknown
  - MDLs currently not recommended for vasopressors
- Rate of ER to inpatient estimated from abdominal CTs

Conclusion

- Midline catheters likely reduce contrast extravasation
- Potential cost savings due to single line placement on admission or at time of CT scan
- More research needed to confirm assumptions made
  - Midline catheters are more durable
  - Midline catheters do not cause extravasation

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