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# **COST AND FINANCIAL ECONOMIC IMPACT IN CATHETER ASSOCIATED URINARY TRACT INFECTION (CAUTI): A SYSTEMATIC REVIEW**

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### **ABSTRACT**

**Background:** Catheter-associated urinary tract infections (CAUTI) was the first condition chosen for nonpayment because of its anticipated effect on large numbers of hospitalizations. The risk of CAUTI is mainly related to the duration of catheterization, occurring at a rate of 5% per day. This study is to identify the cost and financial economic impact of intervention and prevention including an indication of CAUTI, number of events, duration of urinary catheterization, length of stay, the cost for antibiotics and hospitalization cost in catheter-associated urinary tract infection (CAUTI) to reducing the rate and hospital payment.

**Methods:** Systematic Review with PRISMA – P Protocol in 2009 method from a relevant database such as PubMed and ProQuest search engine in 2007 until 2017. Total document selected by full text is 10 article.

**Results:** Based on literature search and screening article after using intervention and prevention strategy for CAUTI in the USA, UK and Thailand have a good impact in the duration of urinary catheterization, length of stay, the cost for antibiotic and hospitalization cost. Some article result that the change in the rate of CAUTI was not significantly different before and after the policy and validity in identifying CAUTI is limited.

**Conclusions:** Cost impact in catheter-associated urinary tract infections (CAUTI) can preventable by reducing unnecessary urinary catheter use (appropriate indication), shortening catheter duration, bladder bundles intervention, supervision, and evaluation of the implementation.

**Keywords:** Adults, inpatient, indwelling catheter urinary, prevention, intervention, cost and financial economic impact.

### **BACKGROUND**

Catheter-associated urinary tract infection (CAUTI) is the most common nosocomial infection, CAUTIs account for 80% of nosocomial UTIs and 40% of all nosocomial infection [1] and cause for significant morbidity, increasing healthcare cost by prolonging hospital stay. This condition can adversely affect patients' health-related quality of life. [2]

Hospital-acquired CAUTI was the first condition chosen for nonpayment because of its anticipated effect on large numbers of hospitalizations. In Michigan (USA) estimated 449.334 healthcare-associated catheter-associated urinary tract infections (CAUTIs) per year, associated with an additional cost (in 2007) of US

\$749–1007 per admission (or an estimated US \$3,744 when complicated by bloodstream infections). It is not surprising that CAUTIs were among the first hospital-acquired conditions selected for non-payment by Medicare as of October 2008, and have been further targeted for complete elimination as a ‘never event,’ with a national goal to reduce CAUTI by 25% by 2014. These national initiatives renewed public and research interest in the prevention of CAUTI, prompting updates of several comprehensive guidelines and reviews of strategies to prevent CAUTI released since 2001 Making Health Care Safer report. [3,4]

Since October 2008, the Centers for Medicare & Medicaid Services (CMS) no longer pays hospitals to treat specific, “reasonably preventable” hospital-acquired complications as part of a value-based purchasing plan to encourage hospitals to improve patient safety and reduce Medicare spending. Administrative discharge claims data (submitted by hospitals to request payment) are now used to deny payment for these complications and publicly report and compare hospitals by complication rates. The CMS rules are complex for identifying these complications in administrative discharge data.[3] Many CAUTI prevention strategies have been “bundled” into a composite of multimodal sets interventions success in reducing rate and cost.[1,2,4,]

CAUTI is the most common nosocomial infections, but there are a few articles which analyze the financial impact and CAUTI because collecting data for diagnosis CAUTI in the hospital is rarely documented. The objective in this review was to investigate the cost and financial, economic impact in catheter-associated urinary tract infection (CAUTI) by indications, intervention, challenge and prevention strategies to reduce the rate and hospital payment.

## METHODS

The preferred reporting items of Systematic Reviews Meta-Analyses (PRISMA) guidelines were adhered to when conducting this review. The article was collected from Pubmed and ProQuest search engine from 2007 until 2017.

### *Search strategy and study selection*

Databases searched included Pubmed and ProQuest as electronic data sources. This study using PICO-S technique (Participants, Intervention, Compare, and Outcome – Study) for evidenced-based medical research. (1) CAUTI or Indwelling catheter urinary, (2) adults, inpatient, (3) Prevention for CAUTI, (4) research method qualitative, quantitative and systematic review research in the English language from 2007 until 2017.

### *Study Inclusion criteria*

The article that included and assessed for eligibility in this review was an article that shows the impact of the economic financial of the cost-effectiveness of Catheter-Associated Urinary Tract Infection (CAUTI). This article including the impact of nonpayment for CAUTI, improvement programs prevention CAUTI, Direct cost CAUTI in era managed care, financial, economic impact, an article in the English language.

### *Study exclusion criteria*

The article that excluded from this review was an article that nonfull paper, doesn’t have a result to the impact of economic financial and cost-effectiveness of CAUTI in the title and abstract, first discussion about HAI’s, genetics, new medication of UTI, duplicate article, besides the English language, etc.

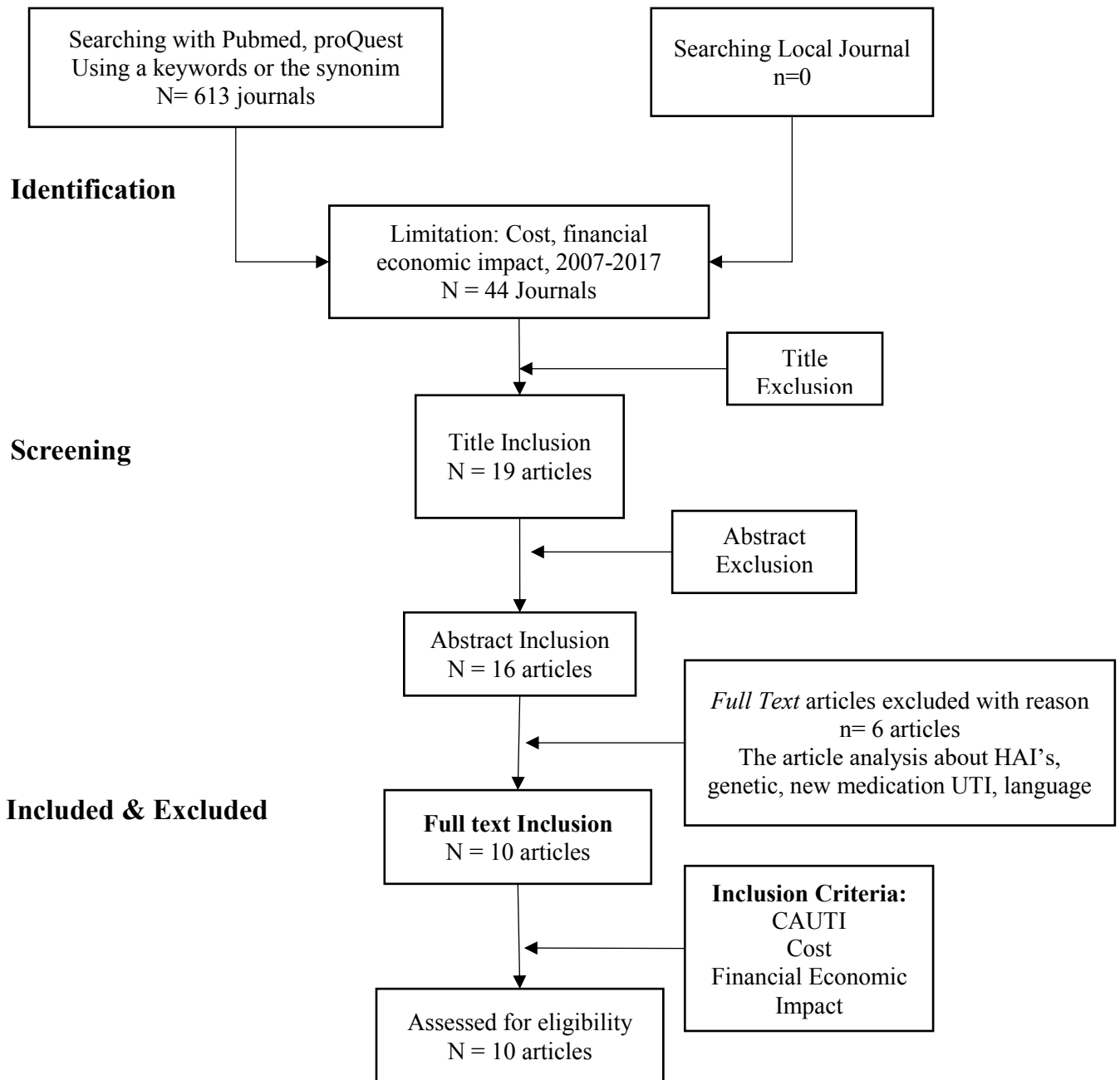


Figure 2. Flowchart of PRISMA Methods

## RESULT

### *The number of systematic reviews*

Using Pubmed search engine, with keywords “Adults, inpatient, indwelling catheter urinary, prevention for CAUTI” resulting 406 documents. When we use limitation keywords cost, and financial economic impact, resulting in 17 documents. 15 documents were selected during title reading. 14 documents selected by general reading, eight documents selected by full-text reading and the end eight documents were selected by full-text review and assessed for eligibility. Using ProQuest search engine, with keywords “CAUTI and Cost Effective” resulting 207 documents. When we use limitation full text resulting 171 documents, use “published more than ten years” resulting 146 documents, eliminating about language resulting 145 documents. More phases were added, “CAUTI AND Cost Effectiveness AND Financial Economic Impact” resulting in 27 documents. By a title reading, four documents were selected, two documents selected by full-text review and assessed for eligibility. Total ten documents selected by full text it was read thoroughly not only the abstract.

Table 1. Included Review-Journal number 1-10

No	Author	Title	Method	Result
1	Jennifer Meddings, Mary A M Rogers, et al (2013).	Reducing Unnecessary Urinary Catheter Use and Other Strategies to Prevent Catheter-Associated Urinary Tract Infection: An Integrative Review in Michigan (USA).	Systematic review and meta-analysis	30 studies the rate of CAUTI has reduced by 53% using a reminder or stop order. <sup>[1]</sup>
2	Pickard R, et al. (2012).	Types of urethral catheter for reducing symptomatic urinary tract infections in hospitalized adults requiring short-term catheterization: multicentre randomized controlled trial economic evaluation of antimicrobial and antiseptic-impregnated urethral catheters (the catheter trial) in the United Kingdom.	Randomised controlled trial.	The primary economic analysis suggested that nitrofurazone-impregnated catheters would be the most effective option at current NHS prices. <sup>[2]</sup>
3	Apisarnthanarak Anucha; Thongphubeth Kanokporn, RN; Sirinvaravong Sirinaj; Kitkangvan Danai; Yuekyen Chananart; Warachan Boonyasit; Warren K. David; Fraser J Victoria. (2007).	The effectiveness of Multifaceted Hospitalwide Quality Improvement Programs Featuring an Intervention to Remove Unnecessary Urinary Catheters at a Tertiary Care Center in Thailand.	Cohort study	A multifaceted intervention to remove unnecessary urinary catheters can significantly reduce the duration of urinary catheterization and the CAUTI rate in a hospital in a developing country. <sup>[4]</sup>
4	Sutherland, T; Beloff, J; McGrath, C; Liu, X; Pimentel, M; Kachalia, A; Bates, D; Urman, R (2015).	A Single-Center Multidisciplinary Initiative to Reduce Catheter-associated Urinary Tract Infection Rates Quality and Financial Implications in New England.	Cross-sectional with internal audit data	66% initial decrease in ICU CAUTIs, from 5.4 cases per 1,000 catheter days to 1.8 cases per 1000 catheter days, with \$4502 in savings per 1000 days. <sup>[5]</sup>



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No	Author	Title	Method	Result
5	Palmer A.Jennifer, Lee M. Grace, Dutta-Linn Maya M, Wroe Peter & Hartmann W. Christine. (2013).	Including Catheter-Associated Urinary tract infections in the 2008 CMS Payment Policy: A Qualitative Analysis in the USA.	Cross-sectional Qualitative study.	The overall impact of the 2008 CMS payment policy should continue to be carefully monitored. Future changes to the CMS payment policy are planned and will need to be evaluated. <sup>[6]</sup>
6	Schuller, K; Probst, J; Hardin, J; Bennett, K; Martin, A (2013).	The initial impact of Medicare's nonpayment policy on catheter-associated urinary tract infections by hospital characteristics in the USA.	Cross-sectional study	The change in the rate of CAUTIs was not significantly different before and after the policy's payment change. <sup>[7]</sup>
7	Tambyah A. Paul; Knasinski Valerine, et al (2002).	Direct Cost of Nosocomial Catheter-Associated Urinary Tract Infection The Era Managed Care in Chicago.	Prospective observational and Laboratory Study.	a. 235 patients acquired CAUTIs during the study; most of the CAUTIs were completely asymptomatic, and only 52% were diagnosed by the patients' physicians using the hospital laboratory. b. The 123 CAUTIs diagnosed by the hospital laboratory were judged to \$20,662 in extra costs of diagnostic tests and \$35,872 in extra medication costs, a mean of \$589 (median, \$356) precaution. <sup>[8]</sup>
8	Trautner, B (2010)	Management of Catheter-Associated Urinary Tract Infection(CAUTI) in USA, UK	Systematic Review	Several strategies show promise for decreasing inappropriate insertion of urinary catheters and duration of catheterization. <sup>[9]</sup>
9	Zhan, C; Elixhauser, A; Richards, C; Wang, Y; Baine, W; Pineau, M; Verzier, N; Kliman, R, Hunt, D (2009).	Identification of Hospital-Acquired Catheter-Associated Urinary Tract Infections From Medicare Claims Sensitivity and Positive Predictive Value in the USA.	Cohort retrospective	The validity in identifying CAUTIs from Medicare claims is limited. Fewer than 1% of UTIs were identified by the ICD-9-CM code 996.64 that identifies CAUTIs explicitly. <sup>[10]</sup>
10	Meddings, J, Reichert Heidi, Rogers A.M.Mary, Saint Sanjay, Stephansky Joe, McMahon F. Laurence. (2012).	Impact of Non-Payment for Hospital-Acquired Catheter-Associated Urinary Tract Infection: A Statewide Analysis in Michigan (USA).	Cross-sectional study	CAUTI rates determined by claims data appear inaccurate. Requested payment for non-catheter-associated UTIs as secondary diagnoses: 10.0% of discharges. CAUTIs lowered payment for 25 of 781343 (0.003%) hospitalizations in 2009 <sup>[12]</sup>

Analysed variables related CAUTI among several countries with variable parameters is requested payment, some events and impact have shown in the table below:

Table 2. The result between the USA, UK, and Thailand <sup>[1,4,5]</sup>

No	Variable	United States of America (USA)	United Kingdom (UK)	Thailand
1	Requested Payment	<p>A. UTI as secondary diagnosis</p> <ul style="list-style-type: none"> <li>• 2007: 10% (95% CI: 9.5 to 10.5)</li> <li>• 2009: 10.3% (CI: 9.8 to 10.9)</li> </ul> <p>B. CAUTI as secondary diagnosis :</p> <ul style="list-style-type: none"> <li>• 2007: 0.09 % (CI: 0.06 to 0.12)</li> <li>• 2009: 0.14 % (CI 0.11 to 0.17)</li> </ul>	In 2014, total requested payment is \$21,159	Not mentioned
2	Number of events	449334 healthcare-associated catheter-associated urinary tract infections (CAUTIs) per year	In 2010, 5.4 UTI per 1000 catheter-days	CAUTI rate was 21.5 infections per 1,000 catheter-days from July 1, 2004, to June 30, 2005.
3	Impact	<ul style="list-style-type: none"> <li>• Reduced by 53 % (rate ratio 0.47; 95% CI 0.30 to 0.64, p&lt;0.001) using a reminder or stop order</li> <li>• The 123 CAUTIs diagnosed by the hospital laboratory were judged to \$20,662 in extra costs of diagnostic tests and \$35,872 in extra medication costs, a mean of \$589 (median, \$356) perCAUTI</li> </ul>	<p>After intervention in 2014:</p> <ul style="list-style-type: none"> <li>• Decreased from 2.2 than 1.5 per 1000 catheter-days</li> <li>• Saving ±20%; \$4,502</li> </ul> <p>The nitrofurazone implemented catheter would be the most effective option to use.</p>	<p>Post-intervention:</p> <p>The rate of inappropriate catheterization decreasing from 20.4% to 11% (21.5 to 5.2 infections per 1000 catheter-days)</p> <ul style="list-style-type: none"> <li>• Duration of urinary catheterization decreasing from 11 to 3 days</li> <li>• Length of stay decreasing from 16 to 5 days</li> <li>• Costs for antibiotics reduced from 63% (\$3,739 to \$1,378)</li> <li>• Hospitalization costs reduced 58% (\$366 to \$154)</li> <li>• The greatest impact in ICU</li> </ul>

In a qualitative study (USA) that explain that CMS payment policy on healthcare-associated infection should continue monitored and evaluated carefully. Some articles in the USA that result that the change in the rate of CAUTI was not significantly different before and after the policy and validity in identifying CAUTI is limited.

### Discussion

Based on the result of this systematic review, the analysis showed that most CAUTIs were completely asymptomatic and only 52% were diagnosed by the hospital laboratory [8]. After using intervention and prevention strategy for CAUTI in the USA, UK and Thailand have a good impact on the duration of urinary catheterization, length of stay, the cost for antibiotic and hospitalization cost.[1,2,4,5] However, 1 article with qualitative study in the USA, explains that CMS payment policy on healthcare-associated



infection should continue monitored and evaluated carefully [6] and the change in the rate of CAUTI was not significantly different before and after the policy and validity in identifying CAUTI is limited [7,10].

One review focused on initial indications for catheterization were classified as appropriate or inappropriate. The indication for catheterization was considered appropriate when the catheter was placed to manage urinary retention due to obstructive uropathy or drugs, or simply to manage difficulty voiding in patients for whom bed rest had been ordered. [1,4,15,16,17]

Table 3. Appropriate and Inappropriate Indications for Urinary Catheterization <sup>[4]</sup>

Appropriate indication
Urinary retention
Obstruction to the urinary tract distal to the bladder
Close monitoring of urine output in critically ill patients
Accurate measurement of urine output in an uncooperative patient (e.g., Because of intoxication)
The fluid challenge in patients with acute renal insufficiency
Preoperative insertion for patients going directly to the operation room
Comfort care in terminally ill patient
Urinary incontinence that poses a risk to the patient (e.g., Because of major skin breakdown or a nearby surgical site)
Inappropriate indication
No longer needed for monitoring of urine output
Unclear indication in patients for whom catheter serves no useful purposes
Urinary incontinence without significant skin breakdown
Neurogenic bladder for which intermittent self-catheterization is possible
Convenience of care
For administration of amphotericin B bladder irrigation
Staff are too busy to remove the catheter
Staff forgot to remove the catheter

This study compares limitation from inclusion article. One of the issues in limitations is for using claims data for public reporting involves the fact that billing codes are not trained or expected to collect and report diagnoses in a manner equivalent to generating surveillance dataset. UTI diagnoses may not always be listed in claims data that assess impact nonpayment for CAUTI is limited. <sup>[3]</sup> There cannot identify patients who were admitted to the hospital with an indwelling catheter and the inclusion of step-down patients for the first nine quarters of data collection. [5]

Limitation in this systematic review study is that lack of source journal search engine, explore more keywords of PICO-s in the identification, need to more selective when screening and choose study selection article, the article studied have different variables. This study prefers to use systematic review because of the identification and describe the cost and financial, economic impact in CAUTI.

#### *Prevention and intervention strategy*

From the result of the studies revied above bundles of interventions are also an important strategy, as part of a multimodal approach that focuses efforts on high-yield interventions.[15,16,17,18] For example, one strategy that includes several of the components from the bladder bundle implemented by the Michigan Health and Hospital Association (MHA) Keystone Center for Patient Safety & Quality is the 'ABCDE' approach[1]:

- Adherence to general infection control principles is important (example: hand hygiene, surveillance, and feedback, aseptic insertion, proper maintenance, education).
- Bladder ultrasound may avoid indwelling catheterization.

- Condom catheters or other alternatives to an indwelling catheter such as intermittent catheterization should be considered in appropriate patients.
- Do not use the indwelling catheter unless you must!
- Early removal of the catheter using a reminder or nurse-initiated removal protocol appears warranted.

Table 4. Catheter-Associated Urinary Tract Infection (CAUTI) Prevention Bundle [5]

Categories	Best Practice Intervention
1. Avoidance of unnecessary catheters	a. Education of ED staff on appropriate catheterization b. Creation of hospital-wide CAUTI prevention guidelines c. ED documentation system for catheter indication
2. Insertion using aseptic technique; maintenance	a. RN education in sterile technique for insertion and on using bladder scanner before insertion only when medically necessary b. Reinforcement of written order requirement for insertion c. Mandatory daily evaluation built into the electronic ordering system
3. Prompt removal; daily catheter review	a. Reinforcement of written order requirement for removal; prompt removal b. Physician notification if the patient fails to void
4. Outcomes measurement	a. Documentation of catheter patient days; data review for infection rates

Identifying and supporting an appropriate ‘champion’ who is influential among staff can be crucial to help overcome resistance to change behavior regarding catheter use and facilitate the adoption of preventive strategies. [4,15,17]

## CONCLUSION

Based on the result of this systematic review, CAUTI has a good impact in financial economic after intervention and prevention strategy in the USA, UK, and Thailand in the duration of urinary catheterization, length of stay, the cost for antibiotic and hospitalization cost.[1,2,4,5] Some article with qualitative study in the USA, explains that CMS payment policy on healthcare-associated infection should continue monitored and evaluated carefully [6] and the change in the rate of CAUTI was not significantly different before and after the policy and validity in identifying CAUTI is limited [7,10]. Cost impact in catheter-associated urinary tract infections (CAUTI) can preventable by reducing unnecessary urinary catheter use (appropriate indication), shortening catheter duration, bladder bundles intervention, supervision, and evaluation of the implementation.

Bundles of interventions are also an important strategy, as part of a multimodal approach that focuses efforts on high-yield interventions. CAUTI rates determined by claims data appear inaccurate and are much lower than expected from epidemiologic surveillance data. The financial impact of current nonpayment policy for hospital-acquired CAUTI is low. Claims data is currently not a valid dataset for comparing hospital-acquired CAUTI rates for public reporting or imposing financial incentives or penalties.

Reducing unnecessary catheter use often requires changing well-established habits and beliefs of nurses and physicians, the challenge of implementation should not be underestimated. Assess improvements in catheter use and appropriateness according to specified indications and to address any barriers to progress and sustainability. General healthcare providers should strongly consider employing interventions to avoid unnecessary catheter placement (such as catheter placement restrictions) and to prompt removal of unnecessary catheters by reminders and stop orders, with special consideration for nurse-initiated removal protocols.



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