

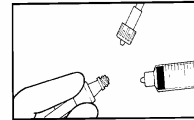
I needlefree connectors e la prevenzione delle infezioni da catetere: speranze ed evidenze

Mauro Pittiruti



Needle-free connectors

- Usati fin dal 1992
- NFC = cappucci a valvola che possono essere apposti a varie componenti della linea infusionale (raccordi, rubinetti, cateteri)



Needle-free connectors

- FDA Alert (April 1992):
 - '...strongly urged that needleless systems or recessed needle systems replace hypodermic needles for accessing I.V. lines....'

Needle-free connectors

- Sono stati progettati per (a) evitare gli aghi (e quindi ridurre il rischio di punture), (b) mantenere chiuso il sistema, (c) diminuire il rischio di contaminazione con materiale ematico o farmaci, (d) diminuire il rischio di ingresso di aria nella linea e.v., (e) evitare il 'back bleeding', etc....

But:

- Inizialmente, NON sono stati progettati per ridurre il rischio di infezioni catetere correlate (CRBSI)
 - ...ma possono avere un ruolo in questo ambito
- Inizialmente, NON sono stati progettati per ridurre il rischio di ostruzione del lume del catetere
 - ...ma possono avere un ruolo in questo ambito

Il problema è che...

- Il termine 'NFC' include molti presidi con caratteristiche molto differenti, con differenti implicazioni cliniche
- Unica caratteristica in comune:
'NEEDLE FREE'

Differenti presidii, differenti caratteristiche...



NFC Classification (Richardson, JAVA 2007)

1. Split septum caps
2. Luer access mechanical valve injection caps
3. Luer access mechanical valve with *positive displacement* injection caps
4. Luer access mechanical valve with *neutral displacement* injection caps

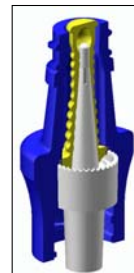
Split Septum caps (SS)

- no internal mechanical parts
- maximal fluid pathway
- no internal collection of debris
- used by direct connect or blunt cannula
- examples:
 - Interlink (Baxter)
 - Safeline (BBraun)
 - Q-Syte (BD)



Luer access mechanical valve injection caps (MV)

- internal mechanism activated by connection with syringe or IV set
- variable internal design
- possible internal collection of debris
- protection from entrance of fluids, bacteria and air (closed system: self closing fluid path)
- examples:
 - Clearlink (Baxter)
 - Clave (ICU)
 - Smartsite (Alaris)



Luer access mechanical valve with positive displacement injection caps (MVPD)

- MV with fluid reservoir which creates positive displacement of fluid at the time of disconnection
- Specifically invented for prevention of blood reflux = prevention of obstruction (= no need for heparin?)
- Variable internal design
- closed systems, with self closing fluid path
- Examples
 - Posiflow (BD)
 - Maxplus (Maximus)
 - CLC 2000 (ICU)
 - Ultrarite (BBraun)
 - Flolink (Baxter)
 - Smartsite Plus (Alaris)

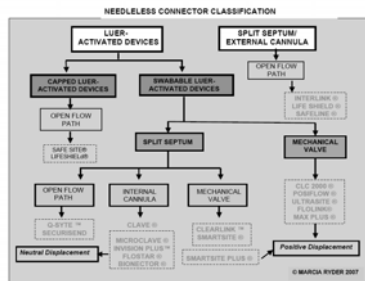


Luer access mechanical valve with neutral displacement injection caps (MVND)

- MV designed to prevent negative fluid displacement but without positive displacement of fluid.
- closed systems
- minimal dead space in the fluid pathway (reduction of blood, precipitants or debris)
- Examples
 - Invision Plus (Rymed)
 - MicroClave (ICU)
 - Bionecteur (Vygon)



NFC classification (Ryder 2007)



Different design has different impact on:

- Ability to visualize internal housing for blood or debris
- Ability to maintain internal sterility
- Difficulty in disinfecting the surface of the device
- Smooth vs. non-smooth surface
- Possible open space around the plunger
- Opaque vs. transparent housing
- Reliability of mechanical function
- Flow rates
- Possibility of flushing and priming

Quindi, SS, MV, MVPD, MVND possono avere diversi effetti su:

- Rischio di contaminazione della parte interna del presidio
 - cioè: effetto facilitante o inibente sulla incidenza di CRBSI
- Possibilità di prevenire il reflusso ematico dentro la linea infusionale
 - Prevenzione della occlusione del lume

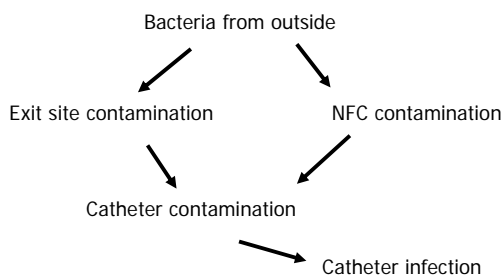
Che relazione c'è tra NFC e CRBSI ?

- Dati discordanti:
 - NFC very easily grow biofilm (Donlan 2001, Donlan 2002)
 - NFC may be associated with an increased risk of CRBSI (Jarvis 2005, Adams 2005, etc.)
 - NFC may have a protective effect over the risk of CRBSI (Bouza 2003, Casey 2007, etc.)

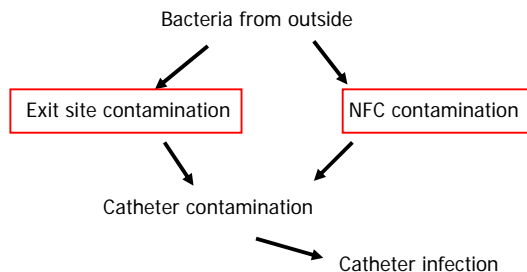
Alcune domande a proposito di NFC e CRBSI ...

- I NFC proteggono dalle CRBSI ?
- I NFC aumentano il rischio di CRBSI ?
- Da che cosa dipende il passaggio di batteri attraverso il NFC ?
 - Dalla struttura del presidio ?
 - Dall'uso appropriato/inappropriato del presidio ?

From contamination to infection...



From contamination to infection....



In altre parole:

- NFC = barriera contro l'ingresso di batteri ?
- NFC = reservoir di batteri ?

Closed system = more protective than open system ? (Ryder, 2007)

- Yes, but bacterial transfer through the system is not related exclusively to the feature of being an 'open system' or 'closed system', but also to other features of the product:
 - the access seal or septum configuration (flat, recessed, irregular)
 - mechanism of access to the flow path (external cannula, internal cannula, or mechanical valve)
 - flow path configuration (laminar vs turbulent flow)
 - residual volume
 - Internal surface area and displacement volume (negative, positive or neutral)

Design matters (Ryder, 2007):

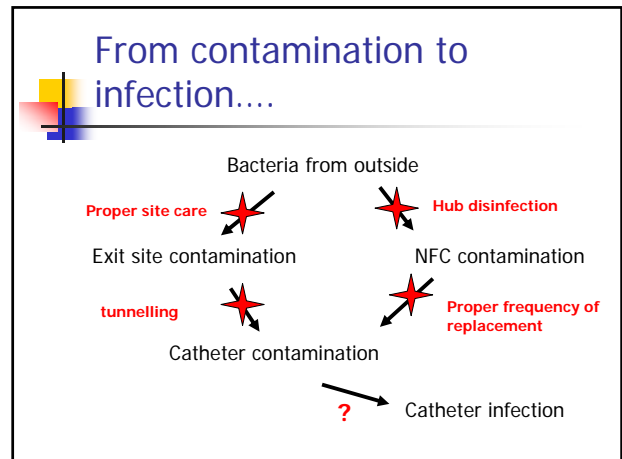
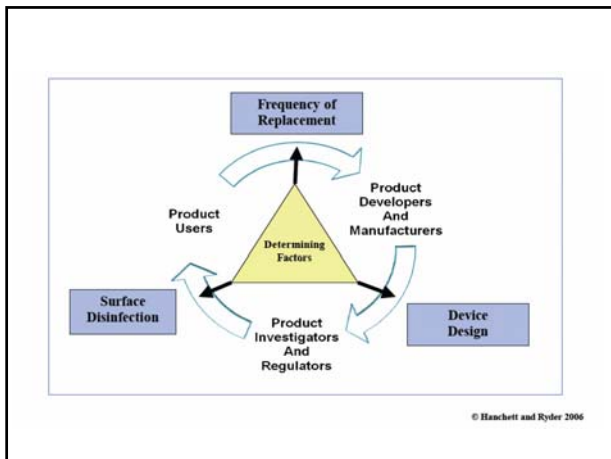
- The **residual volume** left in the connector after flushing and the **surface area of the internal compartment** affect the number of bacteria retained in the connector.
- The internal surface area allows for the attachment of organisms and subsequent biofilm formation.
- Irregular surface area decreases the complete clearance of blood with blood draws or blood product administration.
- **Negative displacement** allows residual blood within the catheter, promoting a conditioned surface for bacterial attachment and biofilm formation, and catheter occlusion.

Però

- ...il passaggio di batteri è anche correlato all' utilizzo appropriato del NFC
 - tipo di antisettico
 - modalità di utilizzo dell'antisettico
 - frequenza con cui è sostituito

L'uso inappropriato del NFC aumenta il rischio di CRBSI

- Uso inappropriato secondario a:
 - Lack of education (how to use and disinfect)
 - Lack of standardization of care
 - Lack of adherence to infection prevention strategies
- Key issues:
 - Surface disinfection
 - Frequency of replacement



Cosa ci dice la letteratura a proposito di NFC e CRBSI ?

Alcuni lavori hanno mostrato un effetto 'nullo' dei NFC (MV) sulle infezioni

- Seymour 2000
 - Same % contamination, NFC (Clave) vs. no NFC

Journal of Hospital Infection (2000) 43, 165-168
doi:10.1053/j.jhi.2000.07.016, available online at <http://www.elsevier.com/locate/jhi>

SHORT REPORT

A prospective clinical study to investigate the microbial contamination of a needless connector

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Alcuni lavori hanno mostrato un effetto facilitante dei NFC (MV) sulle infezioni

- Jarvis 2005
 - Increased % of infection after change of NFC (shift from SS to MV)
- Karchmer 2005
 - Increased risk of infection using MV (inappropriate use?)

Karchmer 2005

- Paper presented at SHEA annual conference 2005
- Wake Forest University School of Medicine
- Quantitative blood cultures through MV in 83 ICU pts: 17% were positive
- 31% of nurses did not use antiseptic swab while drawing blood from NFC

Con quali meccanismi un NFC può aumentare il rischio infettivo?

- Inappropriate disinfection of the NFC before use
 - Poor antiseptic policy (type/time)
 - External area difficult to swab
- Biofilm formation and bacterial growth inside the NFC
 - Irregular internal surface area
 - Relevant dead space (residual volume)
 - Negative displacement with backflow
 - Inappropriate policy of NFC replacement

Alcuni lavori hanno mostrato un effetto protettivo dei NFC (MV) sulle infezioni

- Bouza 2003
 - Clave reduces tip and hub colonization: 'Multivariate analysis showed that CLAVE use was an independent protective factor for tip colonization. CLAVE offered significant protection from catheter-tip and hub colonization'
- Yebenes 2003
 - SmartSite = reduced bacterial transfer
- Yebenes 2004
 - SmartSite = reduced CRBSI
- Trautmann 2004
 - Bionecteur = reduced bacterial transfer
- Casey 2007
 - Clearlink reduces internal contamination of stopcocks

Bouza 2003

Journal of Hospital Infection (2003) 54, 279-287
Available online at www.sciencedirect.com





www.elsevier.com/locate/jhin

A needleless closed system device (CLAVE) protects from intravascular catheter tip and hub colonization: a prospective randomized study*

E. Bouza^{a,*}, P. Muñoz^a, J. López-Rodríguez^b, M. Jesús Pérez^b, C. Rincón^b, P. Martín Rabadán^a, C. Sánchez^a, E. Bastida^b

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Received 11 October 2002; accepted 19 March 2003

Bouza 2003

Summary Hub colonization and subsequent intraluminal progression due to frequent opening and manipulation of intravenous systems is the cause of many catheter-related infections (CRI). A prospective, comparative, randomized study was performed to assess a new closed-needleless hub device (CLAVE[®]) compared with conventional open systems (COS). End-points were hub and skin colonization, catheter tip colonization, catheter-related bloodstream infection (CRBSI) and number of accidental needlesticks. All cultures were processed following standard semiquantitative microbiological techniques. The study involved patients who underwent heart surgery over an 11-month period in a post-surgical ICU. During the study period, 352 patients underwent major heart surgery and 1774 catheters were inserted. Overall, 865 catheters in 178 patients were allocated to the CLAVE system and 909 catheters in 174 patients to COS. The groups were similar regarding underlying conditions and risk factors for infection. Comparison of endpoint results in CLAVE and COS groups was as follows: incidence density per 1000 catheter-days of tip colonization: 59.2 versus 83.6 ($P = 0.003$); of hub colonization: 7.56 versus 24.66 ($P = 0.0017$); of skin colonization: 41.5 versus 58.9 ($P = 0.038$); and of CRBSI 3.78 versus 5.89 ($P = 0.4$). There was one accidental needlestick and one catheter-related aseptic endocarditis in the COS group. Multivariate analysis showed that CLAVE use was an independent protective factor for tip colonization. CLAVE offered significant protection from catheter-tip and hub colonization.

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Una meta-analisi ha suggerito un effetto protettivo dei NFC (MV) sulle infezioni

- Niel-Weise 2006
 - '...there was a trend for an advantage of the needleless closed devices in terms of less catheter-associated bloodstream infection, less catheter tip colonization and less hub inlet colonization'

Niel-Weise 2006

Journal of Hospital Infection (2006) 62, 406-413
Available online at www.sciencedirect.com





www.elsevier.com/locate/jhin

REVIEW

Is there evidence for recommending needleless closed catheter access systems in guidelines? A systematic review of randomized controlled trials

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Received 19 September 2005; accepted 11 October 2005
Available online 31 January 2006

Summary A systematic review was conducted to determine whether certain vascular access policies are better than others in terms of prevention of catheter-related infections. Publications were retrieved by a search of Medline, the Cochrane Library and Embase up to May 2005. All randomized trials and systematic reviews/meta-analyses of randomized trials evaluating the effect of vascular access policies (i.e. needleless closed systems, conventional closed systems or conventional open systems) on catheter-related infection in hospitalized patients with intravascular catheters in situ were selected. Two reviewers independently assessed trial quality and extracted data. Data from the original publications were used to calculate the relative risk or the incidence-density relative rate of catheter-related infection. Data for similar outcomes were combined in the analysis where appropriate using a random-effects model. Of the six studies reviewed, one was excluded. Five randomized controlled trials were included in the review. The quality of the trials and the way they were reported were generally unsatisfactory. Four trials compared needleless closed systems with conventional open systems. There was a trend for an advantage of the needleless closed devices in terms of less catheter-associated bloodstream infection, less catheter tip colonization and less hub inlet colonization. There were no possibilities for combining data because of clinical heterogeneity. One trial compared needleless closed systems with conventional closed systems and the evidence was inconclusive. From the point of view of infection prevention, there are no objections to use these new systems. However, there is insufficient evidence at this stage to recommend the needleless closed vascular devices.

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Alcuni lavori hanno mostrato un effetto facilitante dei NFC (MVPD) sulle infezioni

- Bradley 2004
 - Increase of infection after shift from MV to MVPD
- Maragakis 2006
 - Increase of CRBSI after switching from MV (Clave) to SmartSite Plus (MVPD)
- Salgado 2007
 - Increase of CRBSI after shift from SS (Interlink) to MVPD (SmartSite plus)
- Field 2007
 - Increase of CRBSI after shift from SS (Interlink) to other NFC (MV+MVPD)
- Rupp 2007
 - Increase of CRBSI after shift from SS (Interlink) to MVPD (SmartSitePlus)

Maragakis 2006

Increased Catheter-Related Bloodstream Infection Rates After the Introduction of a New Mechanical Valve Intravenous Access Port

Lisa L. Maragakis, MD; Karen L. Bradley, RN, BSN; Xiaoyan Song, MD, MS; Claire Beers, RN, MSN; Marlene R. Miller, MD, MSc; Sara E. Cosgrove, MD, MS; Trish M. Perl, MD, MSc

The technology of intravenous catheter access ports has evolved from open ports covered by removable caps to more-sophisticated, closed versions containing mechanical valves. We report a significant increase in catheter-related bloodstream infections after the introduction of a new needle-free positive-pressure mechanical valve intravenous access port at our institution.

Infect Control Hosp Epidemiol 2006; 27:67-70

Rupp 2007

Outbreak of Bloodstream Infection Temporally Associated with the Use of an Intravascular Needleless Valve

Mark E. Rupp,^{1,2} Lee A. Sholtz,¹ Dawn R. Jourdan,¹ Nedra D. Marlon,¹ Laura K. Tyner,¹ Paul D. Fey,² Peter C. Iwen,² and James R. Anderson²

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1408 • CID 2007:44 (1 June) • Rupp et al.

Alcuni lavori hanno studiato il ruolo della disinfezione dei NFC

- Casey 2002
 - internal colonization of NFC was 5% after disinfection with CHG 0.5% (Clave vs. Posiflow BD: no difference)
- Casey 2003
 - Study with Posiflow: disinfection with CHG 0.5% or Iodo-povidone is better than alcohol 70%
- Menyhay & Maki 2006
 - Study with microClave, Clearlink and Posiflow: Disinfection with 70% alcohol is associated with massive Bacterial transfer
- Kaler AVA 2007
 - In vitro study : disinfection with 70% alcohol vs. 3.15% CHG in alcohol, 15 sec
 - 4 NFC studied (MV and MVPD): SmartSite – SmartSite Plus – Q Site BD – CLC2000
 - Same results (zero bacterial transfer) for any device, after 15 sec Chlorascrub (3.15% CHG + 70% alcohol)

Kaler 2007



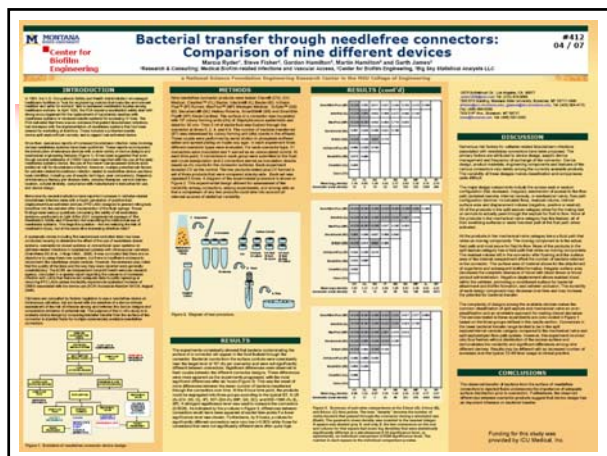
Conclusion

- We provide evidence that when access ports are subjected to the industry recommended disinfection time of 15 seconds with friction, alcohol alone or chlorhexidine/alcohol were equally effective in sterilizing MV ports inoculated with a 10⁵ CFUs suspension of microorganisms, regardless of whether the MVs were constructed using positive, negative, or neutral displacement technologies.

Un lavoro ha studiato il ruolo della diversa struttura del singolo NFC nel facilitare (o meno) la contaminazione batterica del sistema

■ Ryder 2007

- In vitro study, investigating the resistance to bacterial transfer of nine different NFC: Clave®, ICU Medical, Clearlink™ Baxter, Interlink® Baxter-BD, InVisionPlus™ Rymed, MaxPlus™ Medegen Medical, Q-Syte™ BD, Securisend® Halkey-Roberts, SmartSite® and SmartSite Plus® Alaris-Cardinal.
- Bacterial transfer occur in all NFC, but was more relevant in some devices if compared to others
- MV and MVND had greater resistance to bacterial transfer if compared to MVPD and SS



E cosa ci dicono le linee guida....?

Current guidelines

- Key issues:
 - Appropriate choice of the device
 - No recommendation
 - Aseptic cleansing prior to use
 - CDC 2002, INS 2006, EPIC 2007
 - Optimal interval for changing the cap
 - CDC 2002, INS 2006, AVA 2007, EPIC 2007

Appropriate use

- CDC 2002
 - 'HICPAC examined evidence that these devices may increase the risk for CR-BSI and concluded that **when they are used according to the manufacturers' recommendations**, they do not substantially affect the incidence of CR-BSI'

Aseptic cleansing before use

- INS 2007:
 - 'disinfect the hub before connecting'
- EPIC 2007:
 - 'When needle-free devices are used, the risk of contamination should be minimised by decontaminating the access port before and after use with a single patient use application of alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol) unless contraindicated by the manufacturer's recommendations, in which case aqueous povidone iodine should be used.'

Optimal interval for changing the NFC

- CDC 2002, INS 2006
 - change as same intervals as infusion set
- AVA 2006 (Hadaway, JAVA 2006)
 - Continuous infusion: (a) do not use NFC or (b) change NFC with the infusion set or (c) change NFC every other change with the infusion set (at least once per week)
 - Intermittent infusion: use NFC, change at least once per week

Optimal interval for changing the NFC

- EPIC 2007
 - If needle-free devices are used, the manufacturer's recommendations for changing the needle-free components should be followed.

NFC require vigilance

- EPIC 2007
 - The introduction of new intravascular devices that include needle-free devices should be monitored for an increase in the occurrence of device associated infection. If an increase in infection rates is suspected, this should be reported to the Medicines and Healthcare products Regulatory Agency [<http://www.mhra.gov.uk>]

Conclusioni...

Conclusioni

- 'NFC are here to stay...'
 - Molti vantaggi in termini di ridotto rischio di punture da ago e di contaminazioni da fluidi biologici e farmaci; meno manipolazioni; etc.
- Il controllo delle infezioni è però un aspetto fondamentale, e si basa su:
 - Scelta appropriata del tipo di NFC
 - Disinfezione appropriata del NFC prima dell'uso
 - Appropriata frequenza di sostituzione

Appropriate choice of the NFC

- Non ci sono dati conclusivi.
- Comunque, alcune caratteristiche sono da preferire:
 - 'Mechanical valve with neutral displacement' (MVND)
 - La superficie esterna deve essere facile da disinfettare
 - Minimo spazio morto interno
 - Minima irregolarità della superficie interna

Appropriate disinfection of the NFC before use

- Before and after use, swab the access port of the NFC with alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol)

(EPIC 2007)

Appropriate frequency of replacement

- Non ci sono dati conclusivi
- Stabilire un protocollo locale che non contrasti con le linee guida INS, AVA e EPIC guidelines e con le raccomandazioni del produttore

Il futuro...

What do we need in the future? (Meeting Barcellona, Sept. 2007)

- in vitro studies about bacterial transfer through different types of NFC, for a better definition of the structural features specifically associated with risk of contamination
- Evaluation of new 'treated' NFC (e.g.: silver-releasing NFC: V-Link)
- Assessment of the actual relationship between NFC contamination vs. risk of catheter contamination vs. risk of CRBSI
- Standardization of the technique of disinfection of NFC (type of antiseptic, time of disinfection)

What do we need in the future? (Meeting Barcellona, Sept. 2007)

- randomized clinical trials of NFC effect on CRBSI in different populations of patients (specially in populations with high rate of CRBSI in which the standard EB recommendations are already applied)
 - In all clinical trials, attention should be focused on the modality of use of the NFC
 - Results clinically obtained with a specific NFC should not be automatically extended to other NFC
- cost-effective analysis studies (economic models), dealing with NFC benefit for both infection and occlusion rate
- education campaigns for nurses and physicians, regarding appropriate use of NFC

What we really need, most of all:

EDUCATION

- Information
- Knowledge
- Wisdom



Information is not knowledge
Knowledge is not wisdom
Wisdom is not truth
Truth is not beauty
Beauty is not love
Love is not music
Love is not music
Music is the best

(Frank Zappa, 1978)



Grazie per la Vostra attenzione



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