



Medizingerätetechnik II

Modul "Beispiel Applikationssysteme"

Vorlesung Universität Stuttgart Juni 2014

CoE AIS Dr. Hans-Otto Maier
Melsungen, Juni 2014

Diese Unterlagen sollen das Mitschreiben während der Vorlesung nach Möglichkeit ersetzen. Sie enthalten die Inhalte der wesentlichen in der Vorlesung gezeigten Unterrichtsfolien.

Die Informationen sind nur zum internen Gebrauch durch den autorisierten Leserkreis bestimmt. Der berechtigte Leserkreis ist legalisiert durch einen erteilten Zugang zu den betreffenden Dateien im Intranet der Hochschule Furtwangen. Alle Rechte hinsichtlich einer - auch auszugsweisen – Weiterverwendung, insbesondere zur gewerblichen Nutzung bzw. Veröffentlichung sind allein dem Autor vorbehalten.

Der Autor hat sich bemüht, die Quellen aller Textelemente fremden Ursprungs – Texte, Bilder, Beispiele, Berechnungen – ordnungsgemäß anzugeben. Sollten ihm hier Fehler unterlaufen sein oder er unwissenderweise irgendwelche Urheberrechte verletzt haben, so bittet er ihm dies mitzuteilen (hans-otto.maier@bbraun.com). Er wird sich umgehend bemühen diese Fehler zu beheben. Konstruktive Anregungen, die der Verbesserung der Unterlagen dienen, werden gerne angenommen.



Table of Contents

- ⇒ Infusion Therapy – Historical Background and Goals
- ⇒ Pharmacological Background
- ⇒ Fluid Administration – IV Application Possibilities
- ⇒ IV System – Flow Resistance
- ⇒ Drug Plasma Concentration
- ⇒ Gravity Infusion
- ⇒ Pump-based Infusion – Infusion Pumps
- ⇒ Volumetric Pumps
- ⇒ Syringe Pumps
- ⇒ Communication
- ⇒ Patient Controlled Analgesia (PCA)
- ⇒ MRI Diagnose / Therapy
- ⇒ Target Controlled Infusion
- ⇒ Glucose Management



Infusion Therapy – Historical Background and Goals

- ...discovery of blood circulation by William Harvey in 1628
- ...first practical injections trials in animals 1656
- ...first blood transfusion in 1667 – sheep's blood was transfused to a human being
- ...in 1881 Landerer finally succeeded in introducing the method of intravenous injection to clinical practice
- ...clinical routine therapy since mid of 20th century
- ...to maintain and / or recover vital functions by
 - ⇒ fluid replacement – isovolemia
 - ⇒ parenteral nutrition – lipids, proteins, carbohydrates, vitamins, fundamental elements
 - ⇒ correcting electrolyte imbalance – regulation of osmotic pressure
 - ⇒ medications – fluids as carrier solution for drugs



Pharmacological Background

Drug passage through the body

⇒ administration

e.g. epicutaneous, oral, rectal or nasal administration,
intravenous, intraarterial, subcutaneous or intramuscular injection)

⇒ resorption

drugs which shall have an effect inside the body have to enter the blood circulation in order to be transported to the target region. The uptake of the drug into the blood is called resorption

⇒ distribution

once drugs are resorped, they are distributed all over the body by the blood stream. The amount of drug resorped determines the drug plasma concentration. The drug reaches the organs via diffusion from capillaries into surrounding tissue



Pharmacological Background

Drug passage through the body

⇒ biotransformation

in order to eliminate drugs from the body, most agents have to be transformed into molecules which can be excreted. Biotransformation mainly takes place into the liver but other organs like kidney and gut might also be involved.

⇒ excretion

Drugs are excreted by kidney, gastro-intestinal tract or lung depending on their chemical and physical characteristics.

Once a drug has entered the blood stream pharmacokinetic and pharmacodynamic processes can only be slightly influenced. Therefore it is mandatory to establish an adequate drug plasma concentration by choice of the right application form and dosage.

Fluid Administration – IV Application Possibilities

Gravity

Gravity infusion

(Pressure cuff)

Flow regulator



Pressure

Volumetric pump

Syringe pump

Elastomeric I.V. pump



Differences between the systems

- ⇒ Higher accuracy
- ⇒ Higher constancy
- ⇒ (Alarms)



IV Application Possibilities – Deviation in %

Gravity	Pressure	
Gravity infusion	± 50 Volumetric pump	± 5
(Pressure cuff)	Syringe pump	± 2
Flow regulator	± 10	

IV System – Flow Resistance

Infusion solutions have to pass through
 ⇒ the infusion set and
 ⇒ the cannula or catheter
 before entering the blood circulation.

Flow rate

$$I = \frac{\Delta p}{R}$$

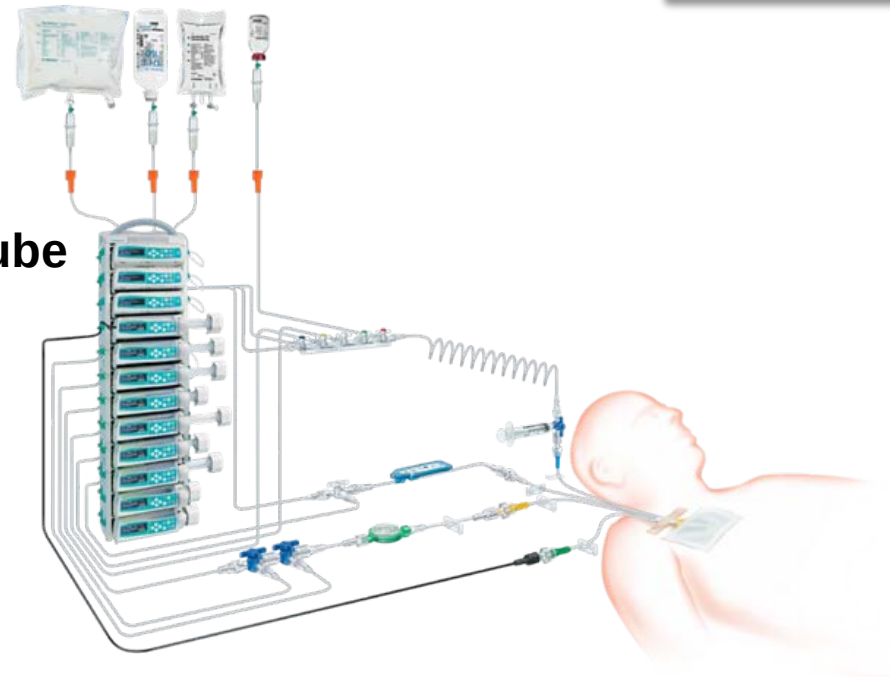
Resistance of a tube

$$R_{Tube} = \frac{8 \times l \times \eta}{\pi \times r^4}$$

Flow rate through the tube

$$\Phi = \frac{dV}{dt} = \Delta p \times \frac{\pi \times r^4}{8 \times l \times \eta}$$

Hagen-Poiseuille-Law – length (l), radius (r), viscosity (η) of the fluid





Drug Plasma Concentration

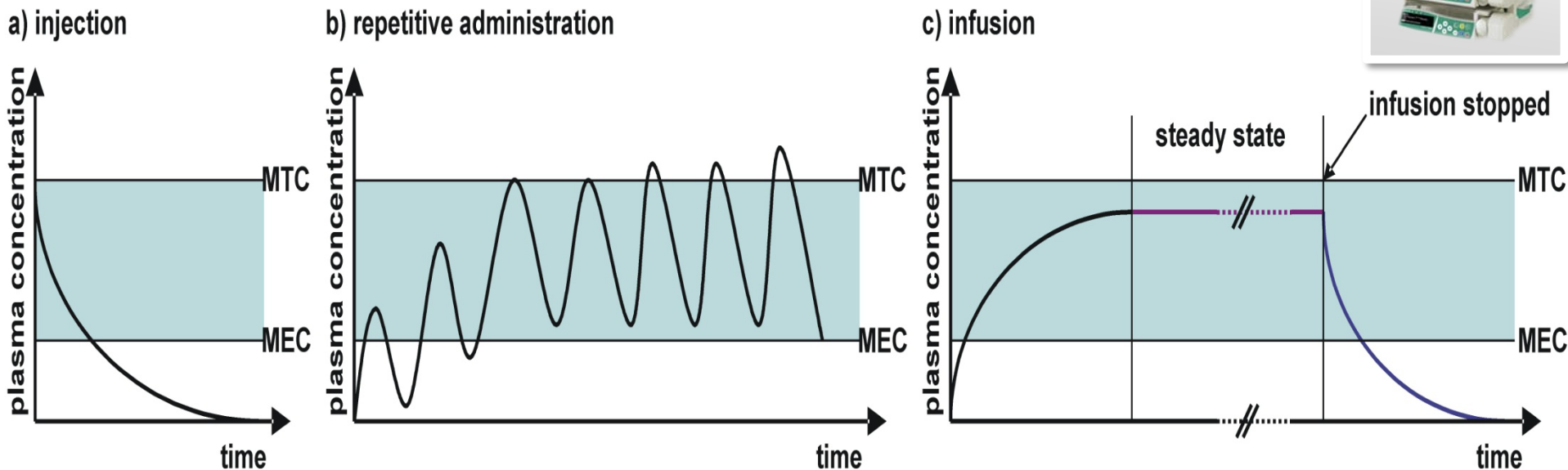
- ⇒ The plasma concentration of a drug determines its effect on the body.
- ⇒ To be effective a drug has to reach a certain plasma concentration called minimal effective concentration (MEC).
- ⇒ To avoid toxic actions of the drug, the drug plasma concentration must not exceed the minimal toxic concentration (MTC).

The safety of a drug is usually characterized by another parameter called therapeutic index. The therapeutic index is defined as:

$$\text{therapeutic index} = \frac{LD_{50}}{ED_{50}}$$



Drug Plasma Concentration



- a) drug plasma concentration directly reaches its maximum and then decreases continuously.
- b) in order to elevate drug plasma concentration for a prolonged period of time, drugs can be administered repetitively.
- c) shows drug plasma concentration during infusion with constant velocity. The plasma concentration slowly increases, reaches a plateau and remains at this level for the whole period of infusion therapy. Drug plasma concentration decreases slowly (depending on elimination processes) after infusion has been stopped.

Gravity Infusion

- ⇒ Gravity infusion is the simplest and cheapest kind of infusion therapy
- ⇒ It takes advantage of the hydrostatic pressure of the fluid administered

$$p_{hydro} = \rho \times g \times h$$



- ⇒ The most common way to regulate delivery speed of gravity infusion is the use of a roller clamp
- ⇒ They allow the compression of the tubing reducing its inner diameter
- ⇒ Constancy of adjusted flow rate is poor, since tubing material gives way to the pressure exerted by the clamp after a certain time:
 - ↳ diameter of tubing lumen decreases resulting in reduced flow rate
 - ↳ tubing changes its form leading to unintended modification of the flow rate





Gravity Infusion

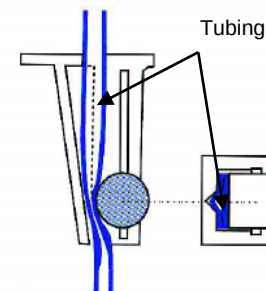
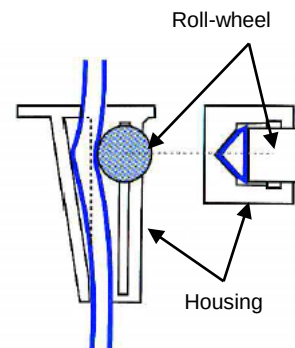
⇒ Different inner shape of the housing is responsible for the precision

⇒ Constancy of delivery is low if roller clamps are used: Flow rates deviate up to $\pm 50 \%$ within one hour

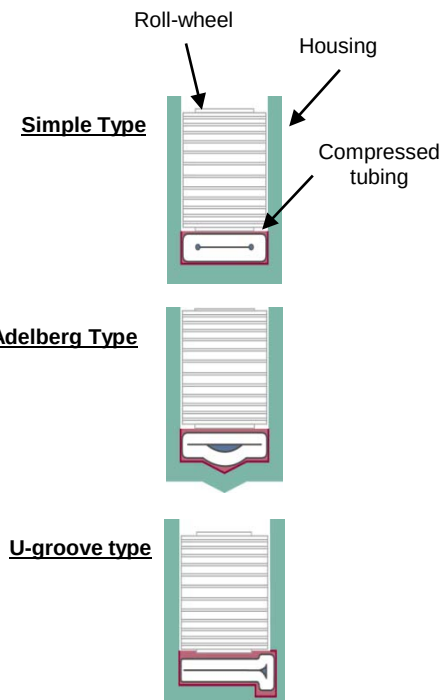
Roller clamp

- a) longitudinal section of a roller clamp (left)
topview (right) at the roller position;
b) topview of different types of roller clamps

a)



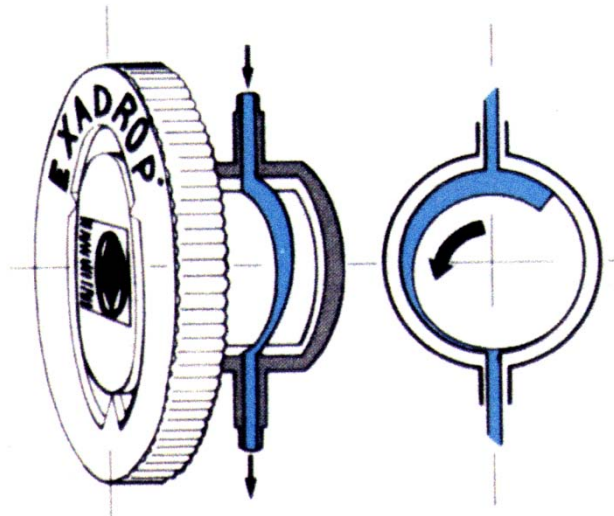
b)





Gravity Infusion

- ⇒ in order to increase constancy of flow rate, flow regulators (e.g. B. Braun's Exadrop®) should be used instead of traditional roller clamps
- ⇒ compared to traditional roller clamps flow rate constancy is much higher (deviation about $\pm 10\%$ within one hour) and there is no need for readjustment



Function principle of a flow regulator



Pneumatic Pressure Infusion

- ⇒ in gravity infusion, pressure applied is limited to the hydrostatic pressure exerted by the infusion solution
- ⇒ if higher pressure is needed, the simplest form of pressure infusion is pneumatic pressure infusion
- ⇒ equipment for gravity infusion is used but the infusion container (plastic container, no glass bottles) is compressed by an inflatable pressure cuff similar to a blood pressure cuff
- ⇒ pneumatic pressure infusion allows higher infusion rates than gravity infusion and is frequently used in rescue service for rapid and massive volume (e.g. blood) substitution



Pump-based Infusion

- ⇒ pump-based infusion allows fluid administration independent of the hydrostatic pressure of the liquid. Indications are:
 - ↳ hydrostatic pressure is not sufficient to overcome flow-resistance
 - ↳ need for high delivery accuracy and constancy
 - ↳ infusion has to be monitored automatically

Elastomeric Pumps

- ⇒ infusion solution is injected into the pump thereby stretching its flexible material
- ⇒ the pressure exerted by the stretched material is used for infusion
- ⇒ flow rate is restricted by a flow regulator
- ⇒ positive pressure from 0.7 to 0.83 bars are possible

Principle of an elastomeric pump



Infusion Pumps

- ⇒ two kinds of infusion pumps have to be distinguished: volumetric pumps and syringe pumps
- ⇒ volumetric pumps are used for infusion of large volumes with high flow rates (≥ 10 ml/h)
- ⇒ syringe pumps allow highest accuracy and constancy of administration even for very slow flow rates (< 1 ml/h) and are used if drugs have to be dosed very exactly
- ⇒ volumetric and syringe pumps have got many functions and features (e.g. alarm systems for occlusion of the line and air infusion, monitoring of infusion) enabling complex infusion therapy in a very safe manner

Automated Infusion Systems – Volumetric Pumps



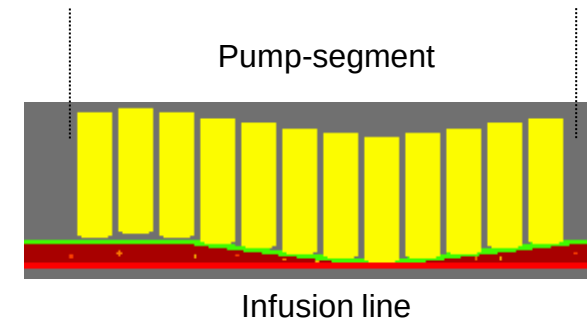
⇒ most volumetric pumps are peristaltic pumps

⇒ they are either equipped with a

↳ roller peristaltic element



↳ finger peristaltic element

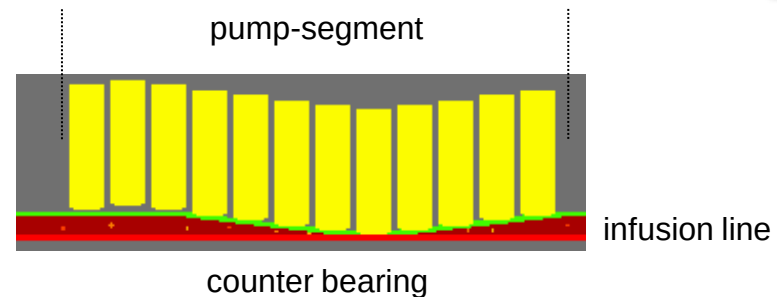


⇒ enabling directed fluid transport (from the container to the patient) with defined velocity



Volumetric “Finger” Pump

⇒ in peristaltic finger pump a stepper-motor-drives an eccentric shaft wavelike against the pump tubing segment



- that way that the peristaltic elements push the tubing against the counter bearing
- ⇒ liquid inside the pump tubing segment is thereby transported towards the patient
- ⇒ due to its elasticity, the pump tubing segment returns into its original shape after pushers release the tubing
- ⇒ the pump tubing segment is then refilled with infusion solution (originating from the infusion container) that will be transported during the next pump cycle
- ⇒ each full shaft revolution transports a defined delivery volume depending on diameter and length of the squeezed pump tubing segment

B. Braun Infusomat Space

- ⇒ Infusomat® Space has got two separate processors which are responsible for functionality and supervision of every single function
- ⇒ after the pump has been switched on, all functions of Infusomat® Space are tested by a self-test
- ⇒ failure detection during the self-test elicits an alarm and the respective problem has to be solved before infusion can be started

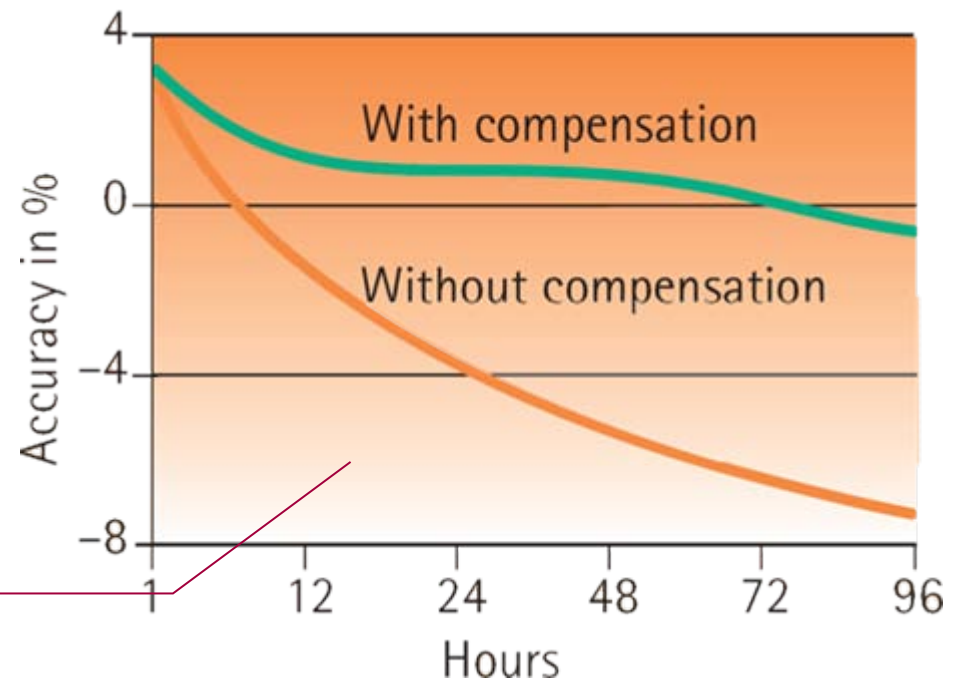




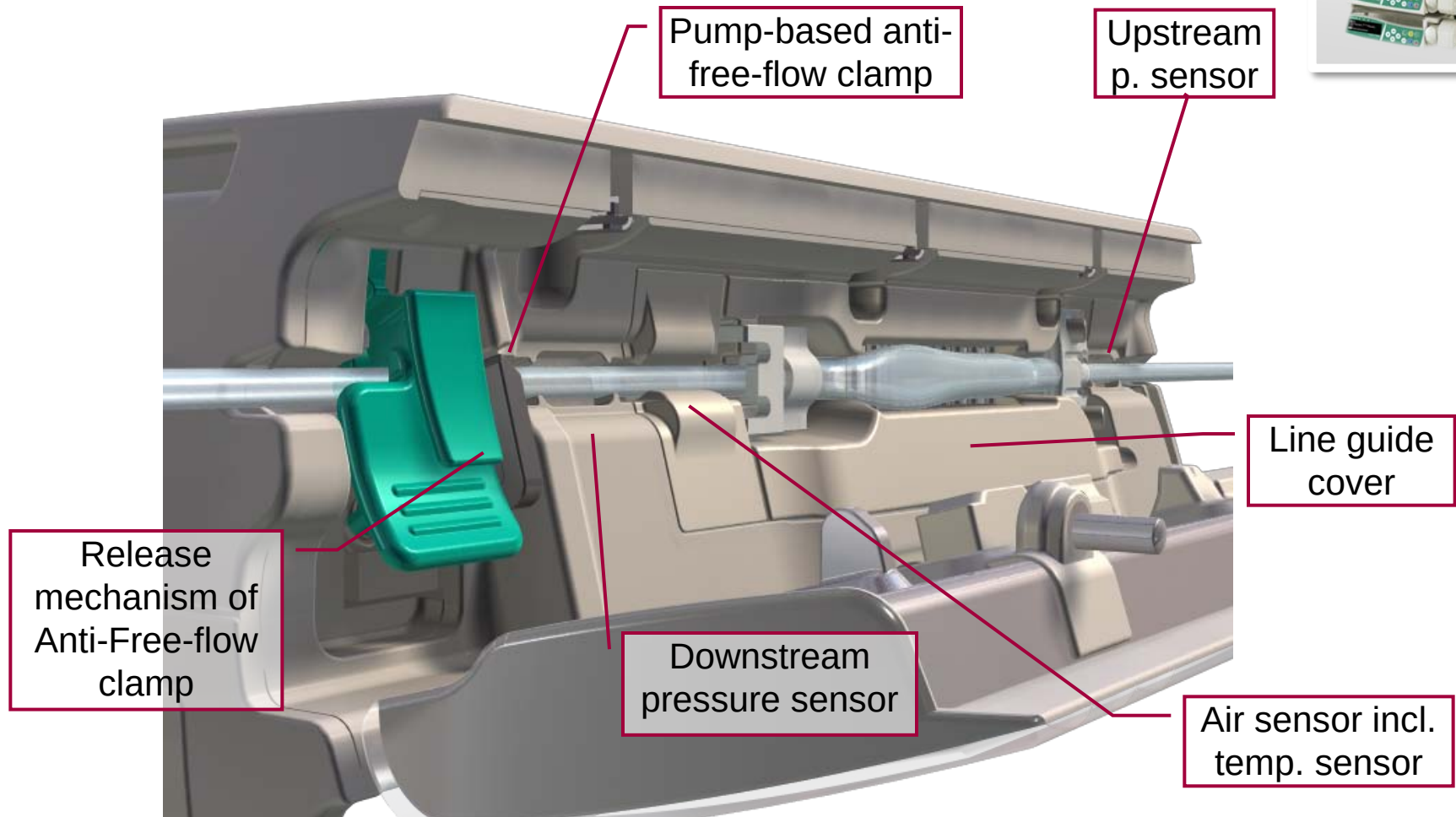
B. Braun Infusomat Space P

- ⇒ Delivery rate - compensation
- ⇒ Decreasing resilience (elasticity) of PVC infusion lines is compensated electronically
- ⇒ More consistent delivery rates during long-term infusions

Intrafix® Primeline, 100ml/h, 22°C



B. Braun Infusomat Space – Safety Features

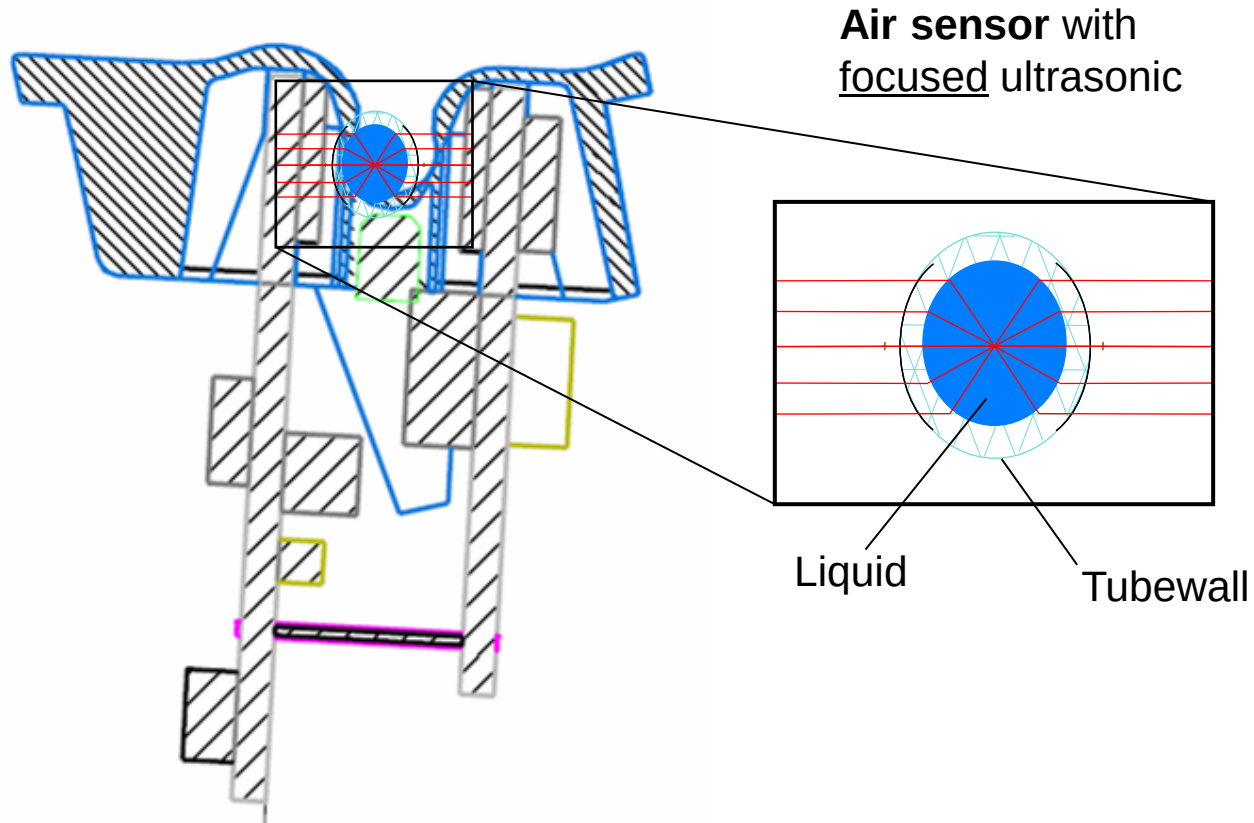




B. Braun Infusomat Space – Safety Features

- ⇒ pump-based anti-free-flow clamp avoids uncontrolled free-flow
- ⇒ upstream sensor detects negative pressure caused for example if the roller clamp of the infusion line has not been opened or infusion container runs empty
- ⇒ an air sensor is integrated in the volumetric pump to prohibit air infusion. This sensor triggers an alarm if air is detected in the line
- ⇒ the temperature sensor is necessary to compensate temperature depending material characteristics of PVC
- ⇒ downstream sensor detects increasing positive pressure (e.g. line has been kinked) and triggers an alarm in case a certain threshold is exceeded
- ⇒ lever of the release mechanism for anti-free-flow clamp can be used to manually open pump-based anti-free-flow clamp, e.g. for line removal

B. Braun Infusomat Space – Air Sensor

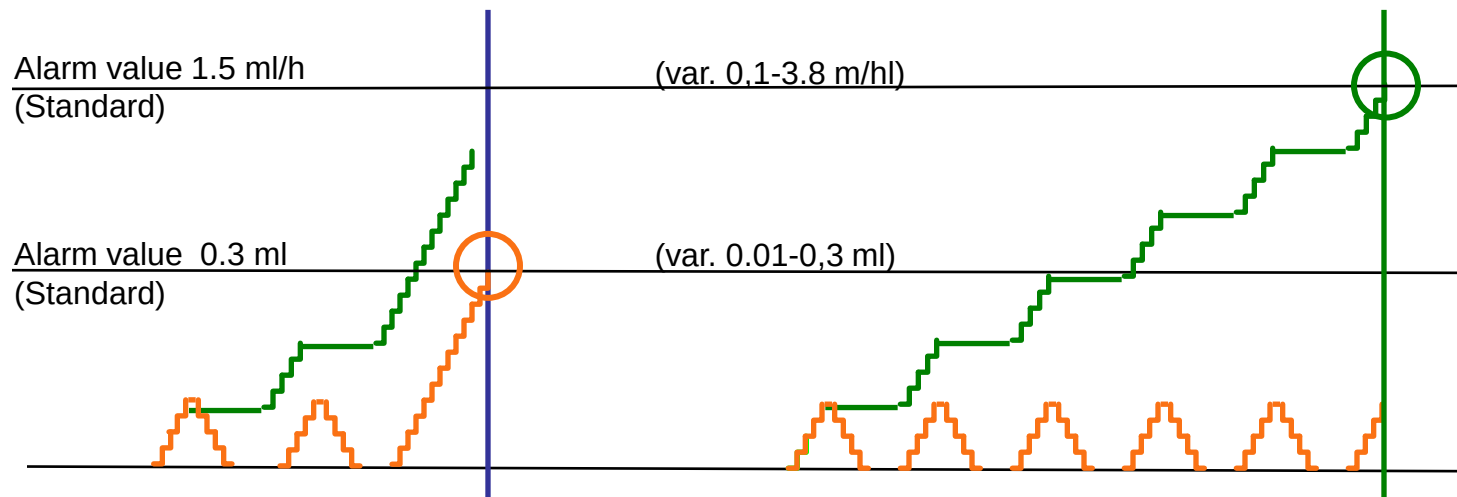




B. Braun Infusomat Space – Air Alarm

Single Bubble Alarm

Air Rate Alarm (1 h range)



The diagram illustrates the system architecture, showing the connection between various components and the central tube assembly. The components are organized into two main sections: the top section (control and monitoring) and the bottom section (sensors and actuators).

Top Section (Control and Monitoring):

- Power supply with monitoring:** Connected to the Watchdog and the Functional-Processor (M32) via FμP and CμP lines.
- Watchdog:** Connected to the Power supply with monitoring and the Acoustic alarm via Loudspeaker (>65dBa) via red lines. It also receives input from the CμP.
- Acoustic alarm via Loudspeaker (>65dBa):** Connected to the Watchdog and the CμP via green lines.
- Acoustic alarm via Loudspeaker (>65dBa):** Connected to the CμP via green lines.
- Alarm-/Signal-LEDs:** Connected to the User interface (Matrix) via red lines.
- Graphic display:** Connected to the User interface (Matrix) via red lines.
- User interface (Matrix):** Connected to the Alarm-/Signal-LEDs and the Graphic display via red lines. It also receives input from the FμP and CμP via red lines.

Bottom Section (Sensors and Actuators):

- Functional-Processor (M32):** Connected to the Control-processor (H8S) via serial synchron. It also has a 12MHz clock input.
- Control-processor (H8S):** Connected to the Functional-Processor (M32) via serial synchron. It also has a 7,37MHz clock input.
- Real time clock:** Connected to the Control-processor (H8S) via a 32kHz clock input.
- Downstream Sensor:** Connected to the FμP via a blue line.
- Temperature & Air Sensor:** Connected to the FμP and CμP Test via blue and green lines.
- Stepper motor output stage:** Connected to the FμP and CμP via blue and green lines. It is connected to the Pumpenkopf (Peristaltic) via a red line.
- Pumpenkopf (Peristaltic):** Connected to the Stepper motor output stage via a red line. It is connected to the Movement sensor (2 light barriers) via a red line.
- Movement sensor (2 light barriers):** Connected to the Pumpenkopf (Peristaltic) via a red line. It is connected to the FμP and CμP via blue and green lines.
- Upstream Sensor:** Connected to the FμP via a blue line.
- Drip Sensor:** Connected to the FμP via a blue line.

The central tube assembly consists of the **Tube**, **Pumpenkopf (Peristaltic)**, and **Front cover**.



B. Braun Infusomat

Function	Space	fmS	P
Delivery range [ml/h]	0.1-1200	0.1-999.9	0.1-999.9
Bolus rate [ml/h]	1200	999.9	999.9
Bolus: manual	✓	✓	✓
Bolus: volume preselection	✓	✓	✓
Bolus: rate calculation	✓	✓	✓
Battery operation time [h]	4 (100 ml/h)	3.5 (highest)	3 (highest)
Standby [h]	24	24	24



B. Braun Infusomat

Function	Space	fmS	P
Occlusion alarm [stages]	9	3	2
Occlusion alarm [bar] [± 0.2]	0.3 – 1.2	0.4 – 1.2	0.4 – 1.2
Volume preselection	✓	✓	✓
Time preselection	✓	✓	✓
Weight [kg]	1.4	3.1	3.1
Operating conditions [$^{\circ}$ C]	+10 ... +40	+10 ... +40	+18 ... +35
Dosage calculation	✓	✓	✓

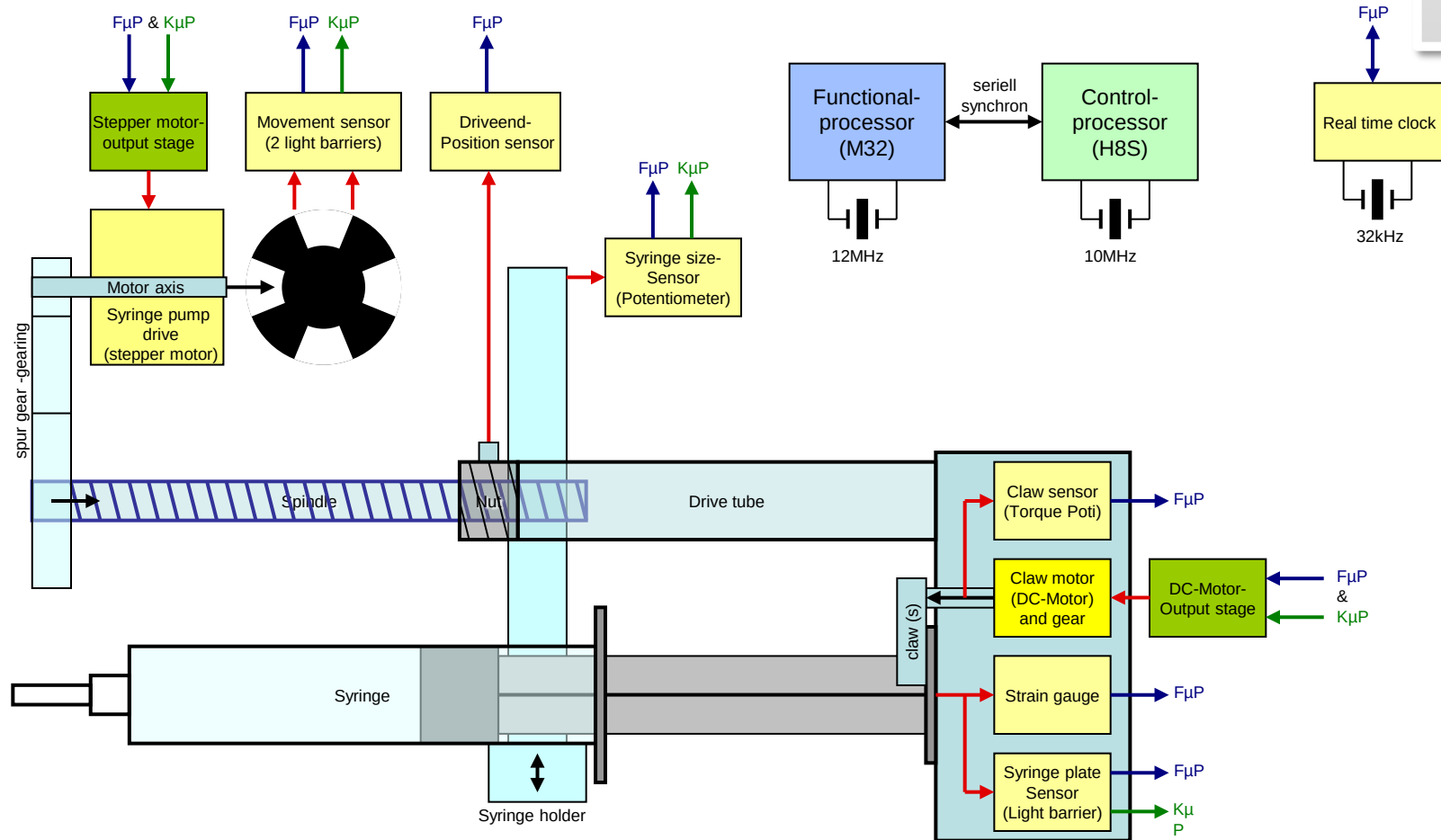
Syringe Pumps

- ⇒ syringe pumps are electrical pumps which empty an inserted syringe by means of a precision drive
- ⇒ these pumps are used if small volumes have to be infused with high accuracy
- ⇒ due to high flow-rate-exactness high-dosed drugs can be administered
- ⇒ syringe pumps are primarily found on intensive care units and operating rooms
- ⇒ dosing accuracy is around $\pm 2\%$. The smallest delivery rate that can be reliably realized with syringe pumps is 0.01 ml/h

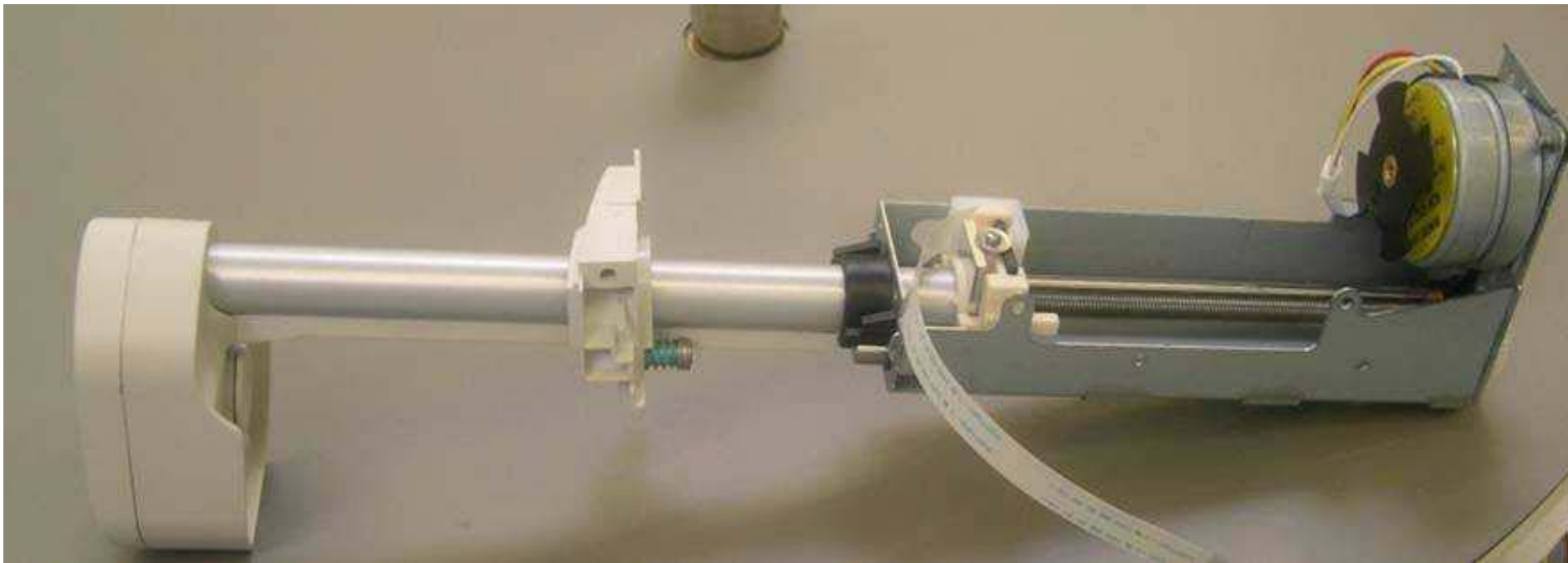




B. Braun Space Perfusor – Pump Principle

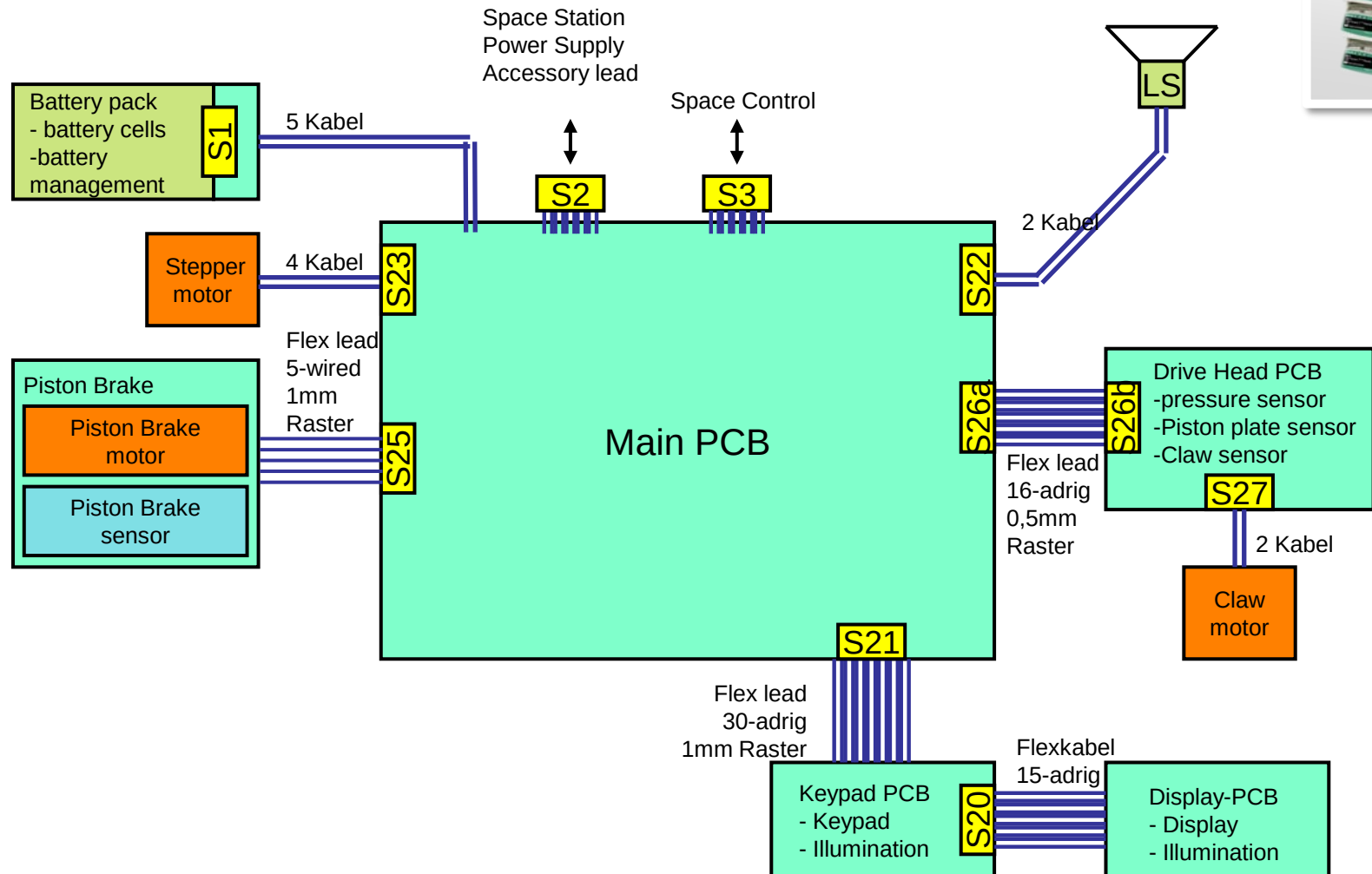


B. Braun Space Perfusor – Drive (Complete Unit)



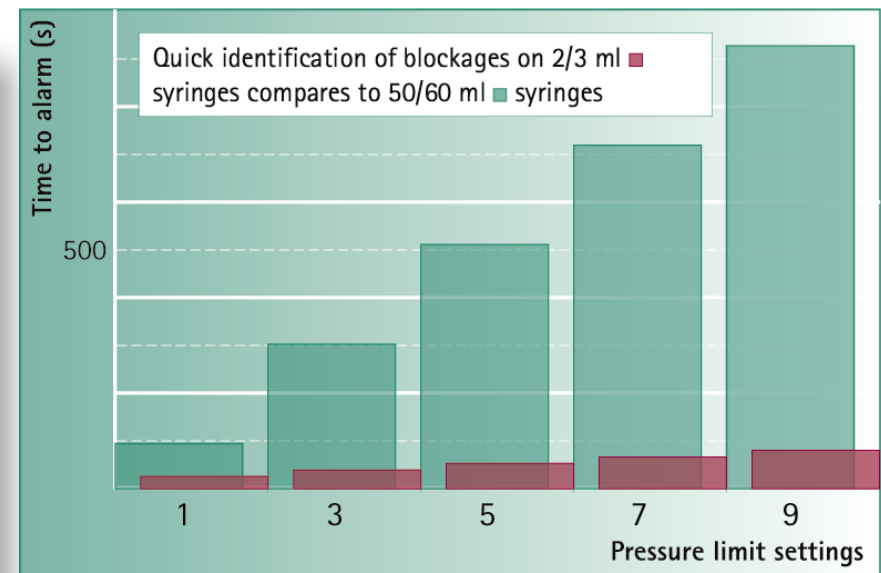
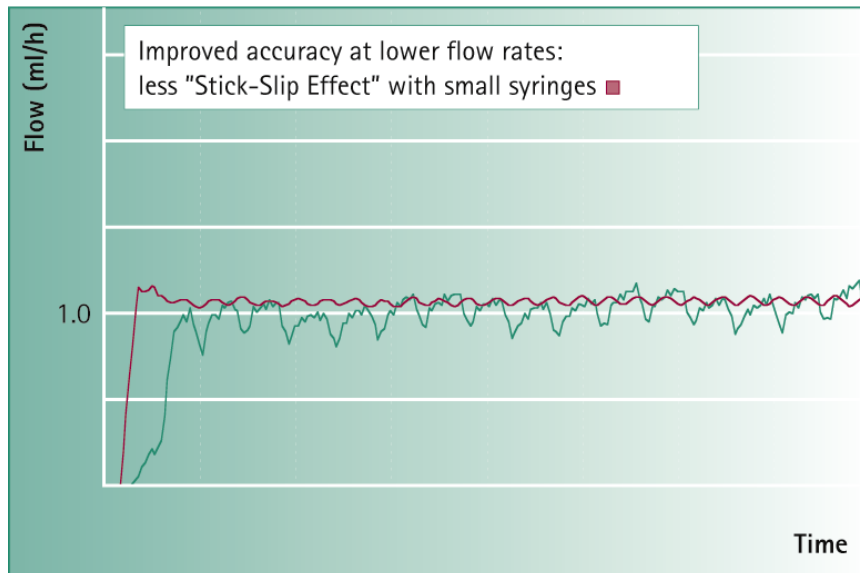
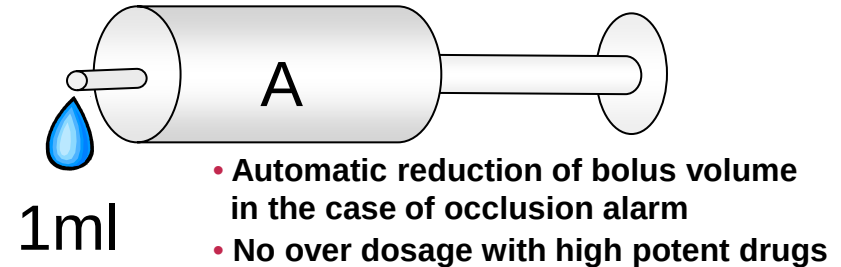
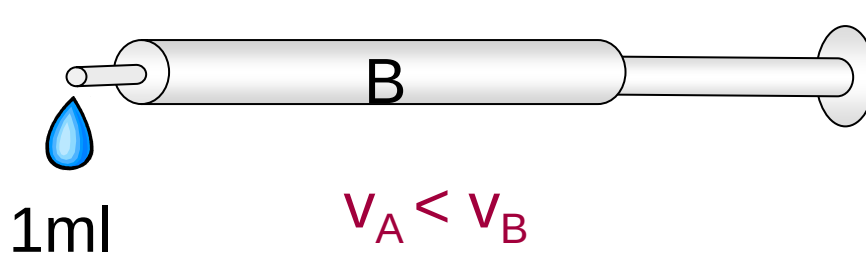


B. Braun Space Perfusor – Main PCB



B. Braun Space Perfusor – High Precision Application

The syringe size determines force and speed and therefore the amount of volume!



B. Braun Perfusor

Function	Space	fm	Compact S	Compact
Delivery range [ml/h]	0.01-999.9	0.1-999.9	0.01-200	0.1-99.9
Bolus rate [ml/h]	up to 1800	up to 1800	up to 1200	800
Bolus: manual	✓	✓	✓	✓
Bolus: volume preselection	✓	✓	✓	-
Bolus: rate calculation	✓	✓	-	-
Battery operation time [h]	8 (25 ml/h)	3.5 (25 ml/h)	10 ($\leq$ 10 ml/h)	10 ($\leq$ 10 ml/h)
Standby [h]	up to 24	up to 24	unlimited	unlimited
Dosage calculation	✓	✓		

B. Braun Perfusor

Function	Space	fm	Compact S	Compact
Occlusion alarm [stages]	9	9	3	3
Occlusion alarm [bar] [± 0.2]	0.2 – 1.2	0.2 – 1.0	0.3 – 1.2	max. 1.2
Volume preselection	✓	✓	✓	✓
Time preselection	✓	✓	✓	
Weight [kg]	1.4	3.5	1.6	1.5
Syringe-sizes [ml]	2, 5, 10, 20, 30, 50	(10)*, 20, 50	2, 5, 10, 20, 30, 50	20, 50
* with adapter				

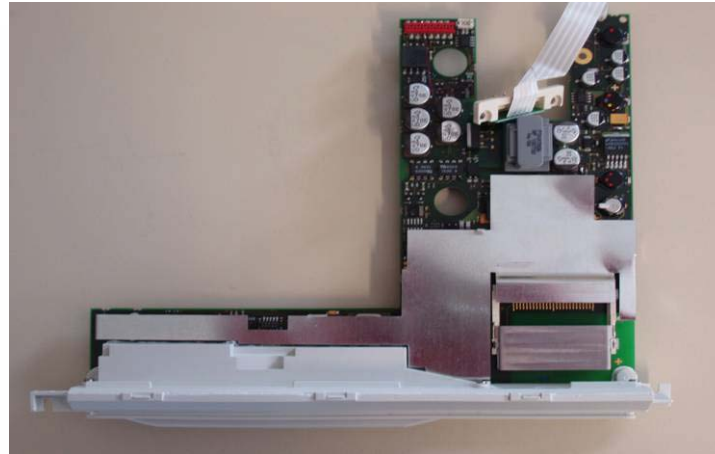
Communication



SpaceCom...

- ⇒ is a central communication interface for external devices with different physical connectors
- ⇒ provides an open structure which allows the integration of customized software solutions
- ⇒ offers full support of Windows-compatible hardware (e.g. USB Memory Sticks, Wireless LAN cards)
- ⇒ WLAN (802.11b and g standard are supported) available as option. The card can be re-installed at any time without opening the housing.

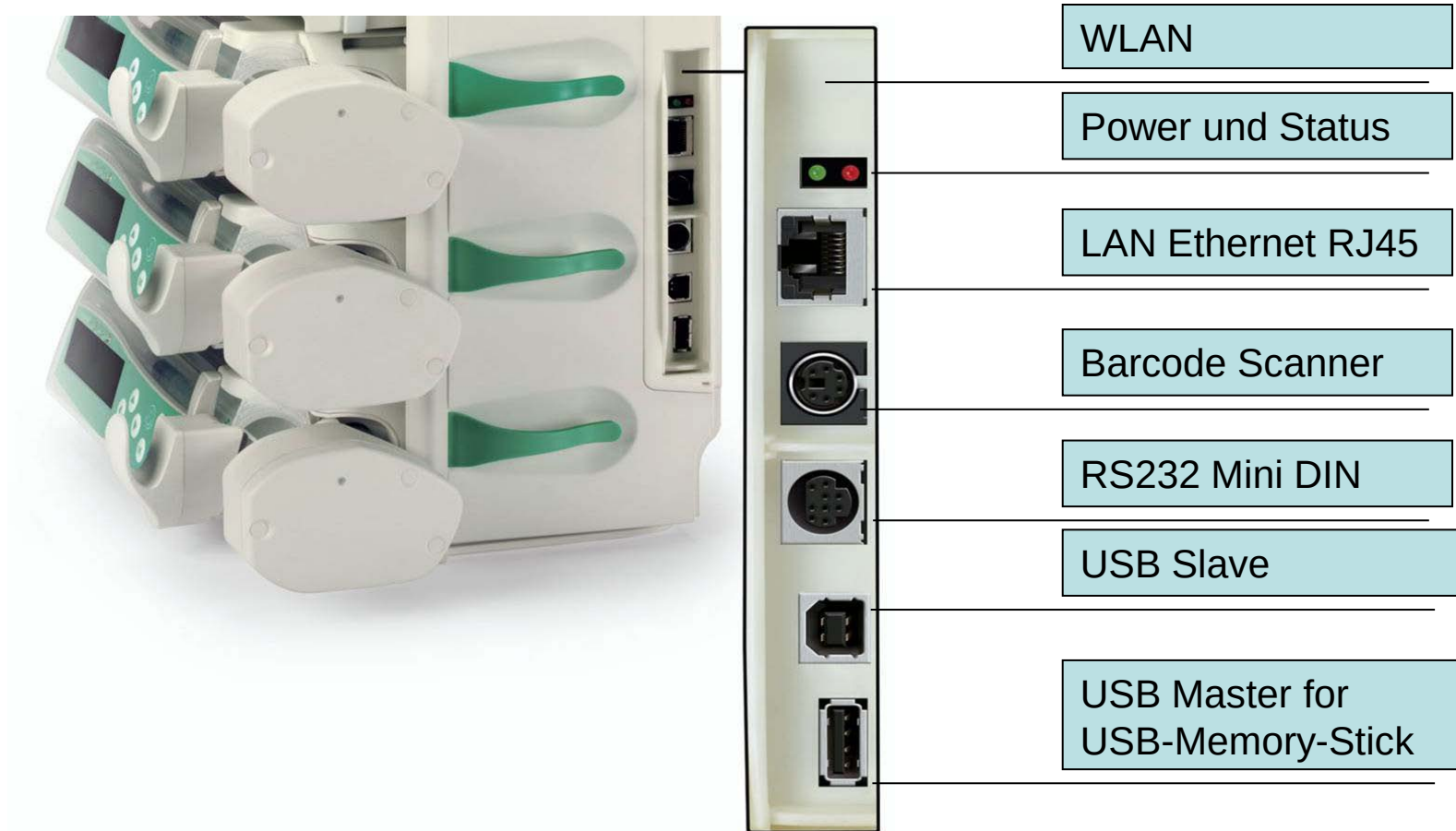
SpaceCom...



SpaceCom



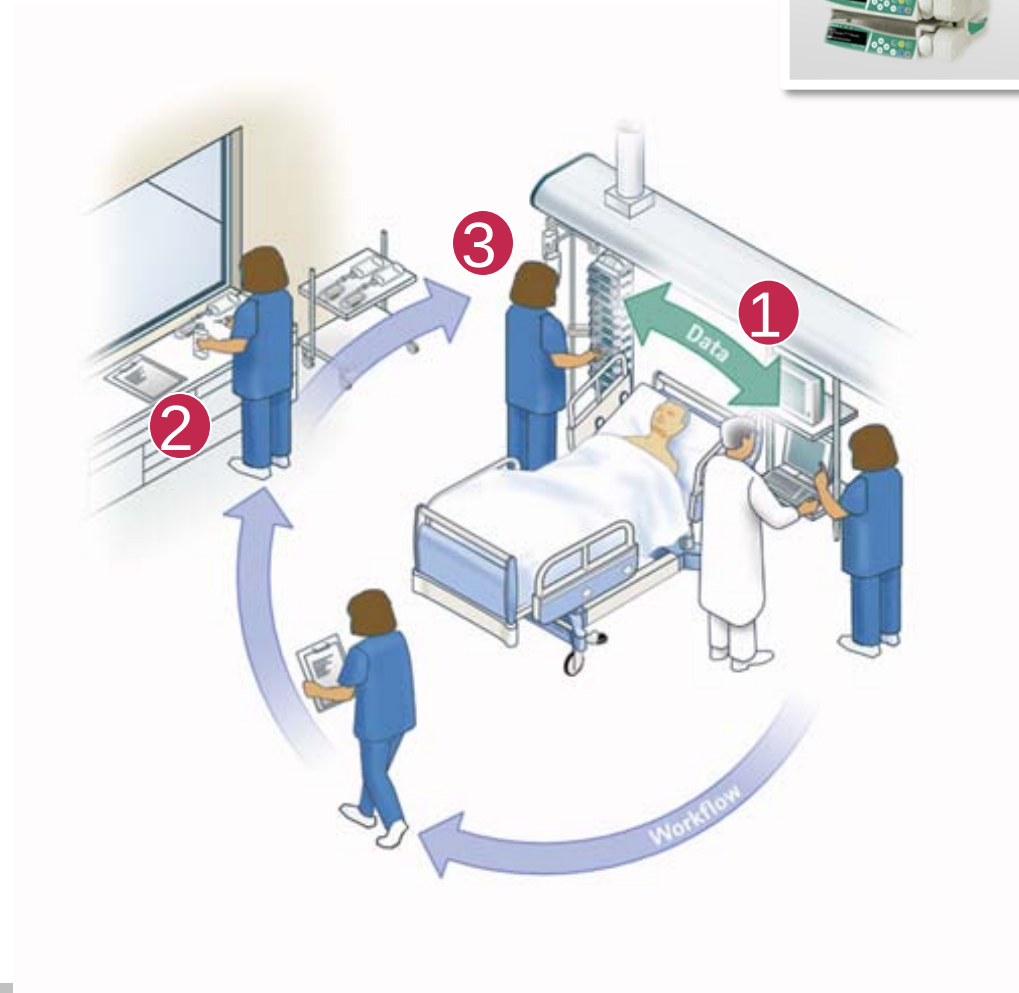
SpaceCom...



SpaceCom...

...proposal data
...send prescription from an
external computer to the pumps

- ① prescribe drugs send drug data to Space system
- ② prepare medication
- ③ activate infusion: start button



Space Online

all pump data can be visualized on a commercial PC without additional software

- ⇒ central monitoring of infusion therapy possible even from the doctor's office or a home-workplace
- ⇒ online access for the hospital technician
- ⇒ infusion data storage on USB stick for later analysis in Microsoft applications

The screenshot displays the B. Braun Space Online web interface. The top header includes the B. Braun logo and the text 'B. Braun Space'. Below the header, there is a navigation menu with 'Language' (set to 'english'), 'Status', 'History', and 'Service'. The main content area is divided into several sections:

- System information:** Displays 'Number of pillars: 2', 'Nr. of segments: 6', 'Nr. of segments/pillar: 3', and 'Number of active pumps: 13'. It also shows 'Selected Pump type: Perfusor', 'Pump software version: v0.2.1', and 'Pump serial number: 1234 567'.
- Legende:** A color-coded legend for pump status: green for 'Pump is running', yellow for 'Pump is on but not running (Stand by)', red for 'Pump has alarm', blue for 'Pump selected', and grey for 'Pump is off'.
- Type of pump:** Shows 'Infusomat Space' and 'Perfusor Space'.
- System structure:** A grid of buttons representing different drugs: Aminoplasmat, Dopamine, Lipofundin, Glucose, selected (blue), --- Alarm ---, Epinephrine, Fentanyl, KCl, Mivacurium, Dopamine, Dobutamine, and Clonidine.
- User / Date:** Shows 'User: Dr. Palstrick' and 'Date / Time: 2003-10-31 19:45'.
- Patient information:** Displays 'Patient name: Mustermann, Carla', 'Patient ID: 2945_CM220956', 'Bed/Room/Station: C094_385', 'Sex: female', 'Patient weight: 49 kg', and 'Date of birth: 220956'.
- Selected pump data:** Shows 'Drug name: Mivacurium', 'Rate: 0,15 ml/h', 'Infused volume: 12,4 ml', 'remaining volume: 37,6 ml', 'Infused time: 8,3 h', 'remaining time: 2,4 h', 'Dose rate: 0,25 mg/kg/h', 'Drug concentration: 2 mg/ml', 'Syringe size: 50 ml', 'Syringe volume: 50 ml', 'Profile type: continuous', 'Status information: running', and 'Alarm information: ok'.

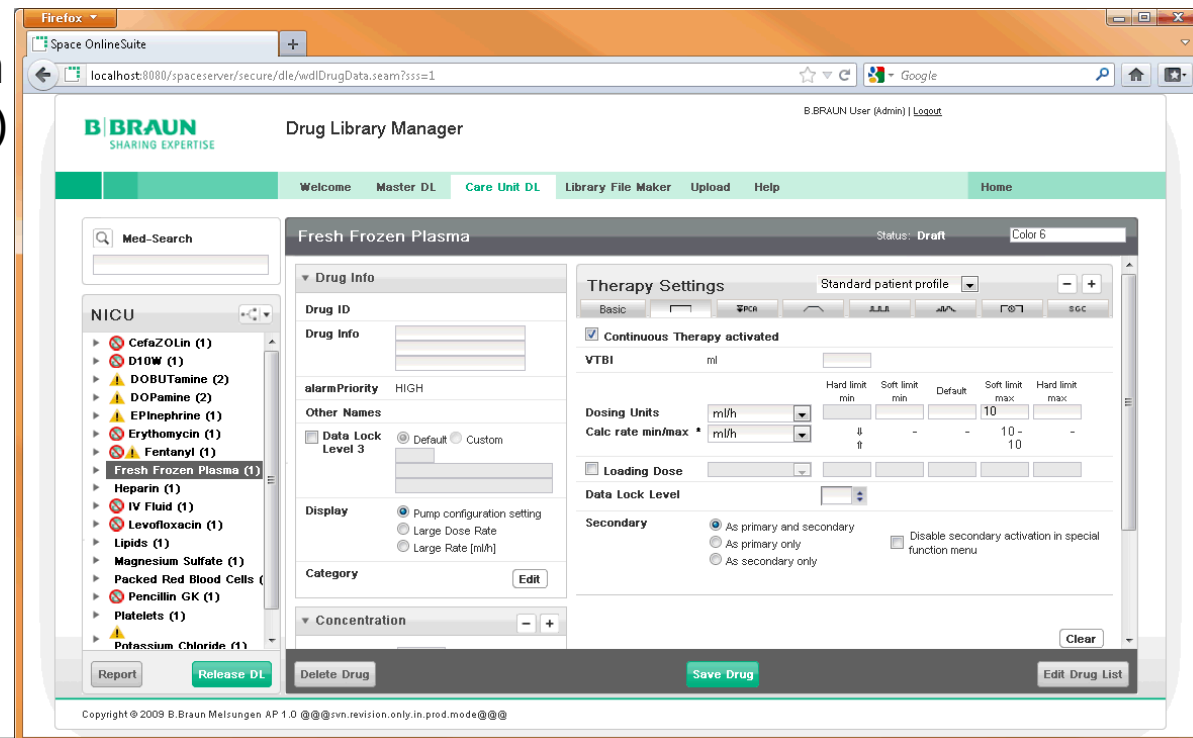
The interface is displayed in a web browser window with a status bar at the bottom showing 'Fertig' and 'Internet'.



Space Online

Drug library

- ⇒ presetting of dose, concentration and rate prevent medication errors
- ⇒ hard limits can not be overwritten
- ⇒ soft limits can be overwritten after confirmation (entry in history-protocol)
- ⇒ drug Library can be started directly after switch-on





Patient Controlled Analgesia (PCA)

the PCA idea assures an individual pain treatment for the patient and less workload for the nurses

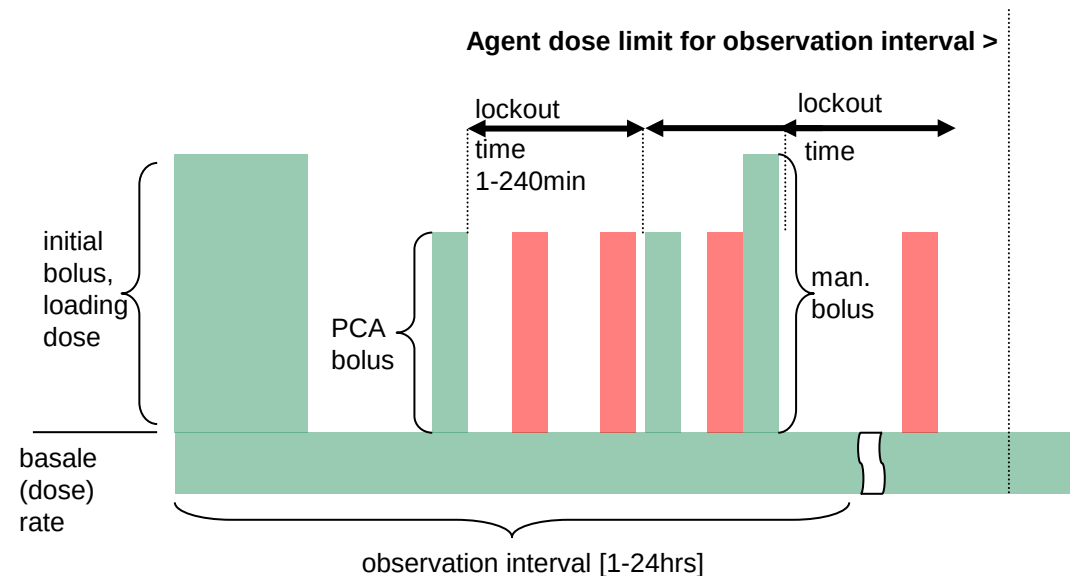
Traditional Pain Therapy	PCA-Prinziple
1. Patient has got pain 2. Patient calls nurse 3. Nurse comes to patient 4. Nurse fetches pain reliever(pills, analgesia syringe ,etc.) 5. Patient receives pain reliever from the nurse 6. Patient ist pain-free after 30 min at the earliest	1. Patient has got pain 2. Patient presses On-Demand button 3. Patient ist pain free after 2 min <pre> graph TD Patient([Patient]) -- "Pain" --> Pain[Pain] Patient -- "Analgesic demanded (by pressing button)" --> Pump[PCA pump] Doctor[Doctor's strategy] --> Pump Pump -- "Rapid onset of pain relief after intravenous injection" --> Patient </pre>

Optimal therapy success and minimal workload for the nurses staff.



Patient Controlled Analgesia (PCA)

This administering of a bolus can be supplemented by a basal rate (basic infusion). In order to avoid an over infusion special dosing algorithms watches the set maximum dosages and if necessary inhibits a bolus on demand within a certain period of time (so called lockout time). The adaptable parameter of such programs, together with a pump provided statistic, offers the physician the opportunity to optimize the therapy. (See figure)





Patient Controlled Analgesia (PCA)

PCA Definition

PCA Basics

Status: Evaluation of Therapy with A/D

$$A/D [x \text{ hours}] = \frac{\text{Number of PCA boli}}{\text{Number of attempts}} > 75\%$$

- ⇒ attempts/deliveries
- ⇒ the A/D proportion is calculated for the period of observation (x hours).
- ⇒ for a good PCA therapy, the A/D should be > 75%.
- ⇒ the longer the period of observation, the more meaningful the A/D.
- ⇒ space PCA shows A/D as an absolute number "8/6" and "75%".

Patient Controlled Analgesia (PCA)



Space PCA-Kit:

1. 1 On demand Button
2. 1 PCA-syringe holder lock
3. 1 Fixation band
4. 1 Fixation clip

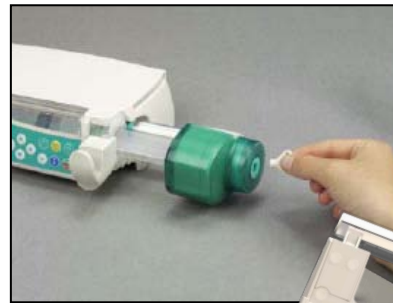




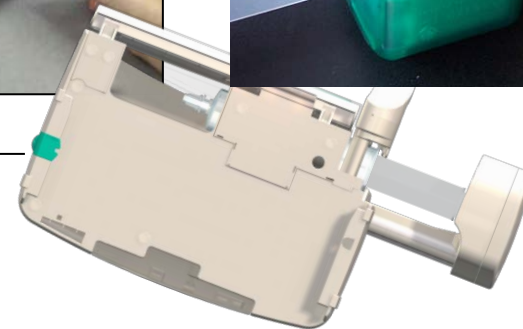
Patient Controlled Analgesia (PCA)

PCA-protection cap set:

- ⇒ for Perfusor Space
- ⇒ for a safe removal protection of 50 cc syringes
- ⇒ 4 caps in one set (incl. lock key new (green))



lock screw —
for syringe
holder!

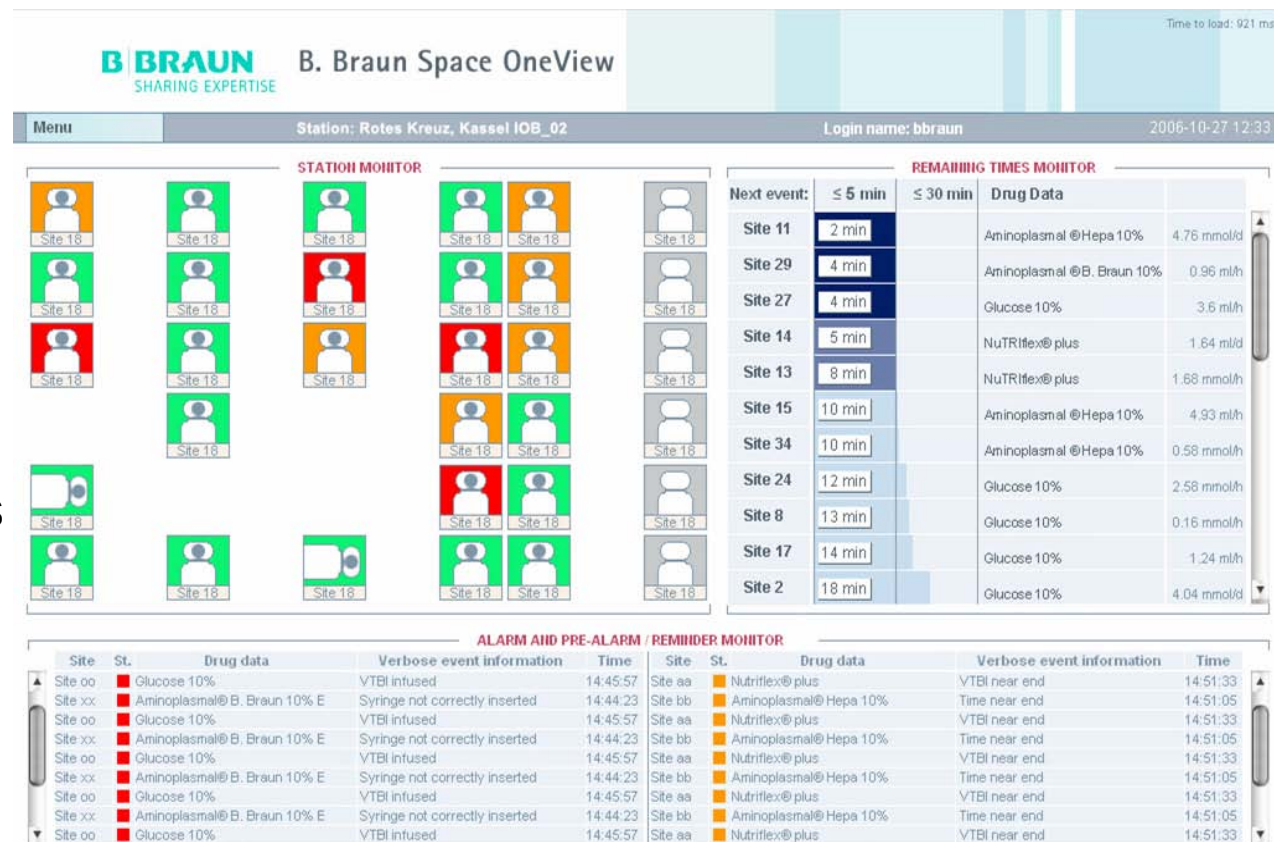


Space One View

Space – optimal alarm management features at pump, bed side and ward

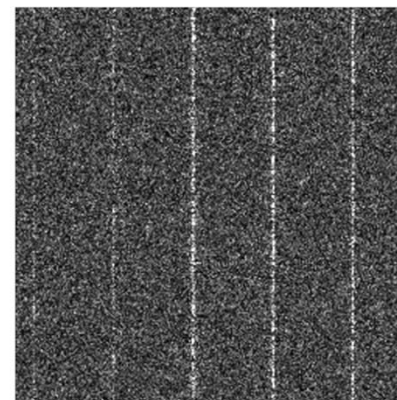
⇒ an intelligent alarm system supports the nursing staff with as many alarms as necessary, but as less as possible.

⇒ with B. Braun Space the customer receives an individual configurable alarm management system.



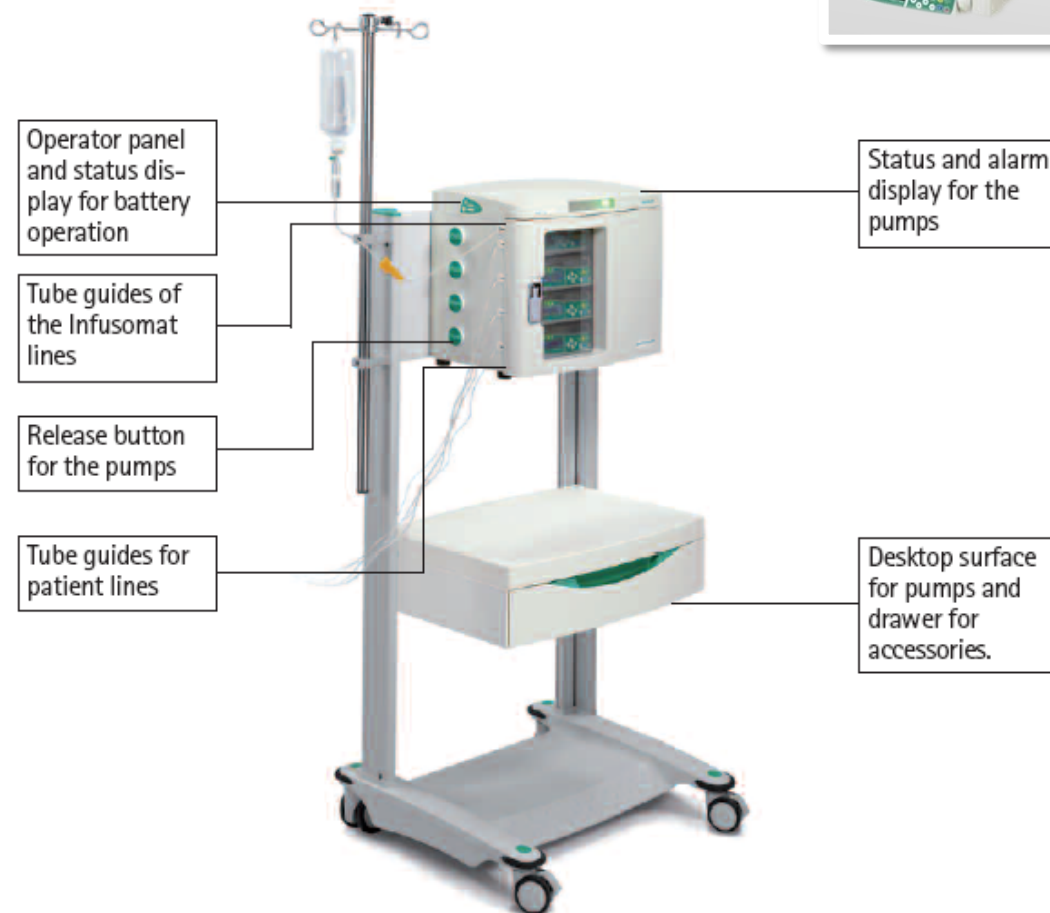
Space Station MRI

- ⇒ Space Station MRI protects the Space pumps against the very strong permanent magnetic field **and**
- ⇒ Space Station MRI protects the imaging process against disturbances caused by the electrical equipment (here infusion Space pumps)



Space Station MRI

- ⇒ Space Station MRI is designed for up to four Space pumps
- ⇒ One Space Station MRI is to be used on one patient





Space TCI

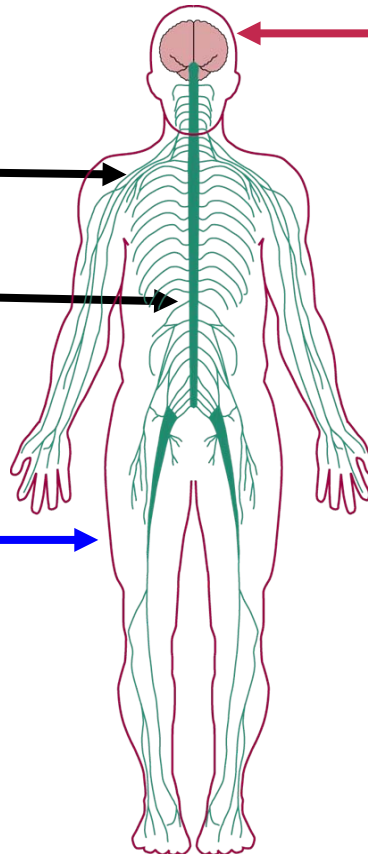
Forms of anesthesia

Regional anesthesia

- ⇒ Block of sensory nerve conductivity
- ⇒ Patient is conscious and pain-free

Local anesthesia

- ⇒ Block of superficial sensory nerves
- ⇒ Patient is conscious and locally pain-free



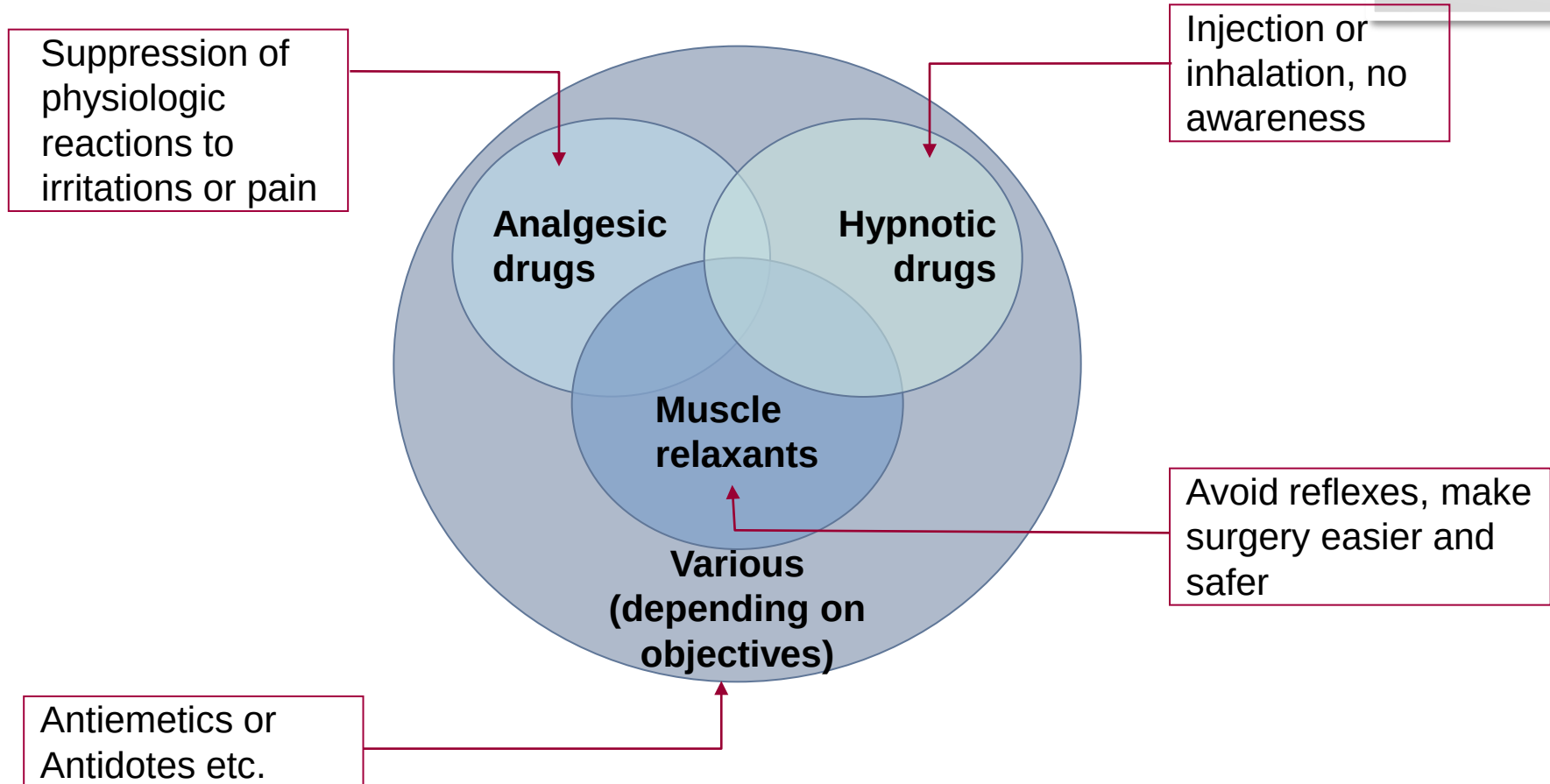
General anesthesia

- ⇒ Reduction of central nervous system (CNS) activity
- ⇒ Patient is unconscious and pain free
- ⇒ Muscle relaxation may be established

With Space TCI we are focusing on this kind of anesthesia

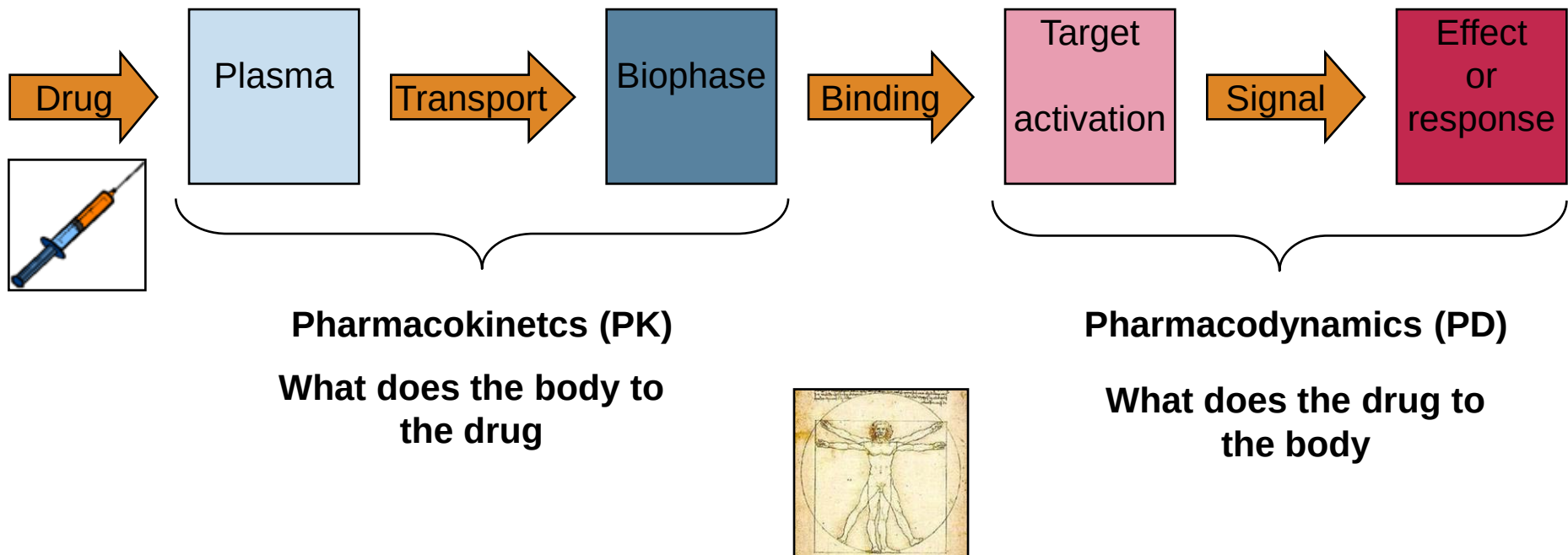


Space TCI – Drugs for General Anesthesia



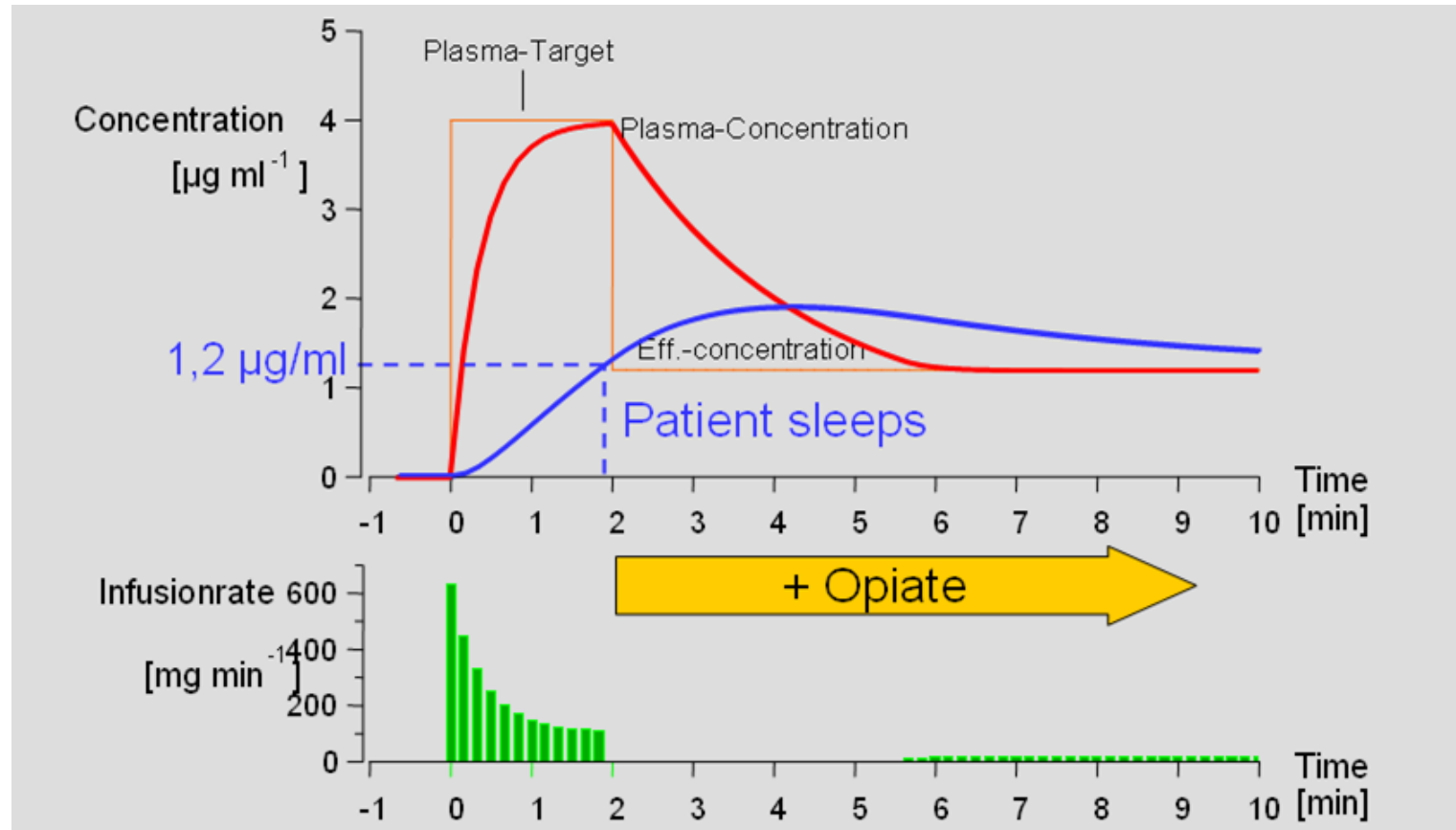


Space TCI – Medical Background



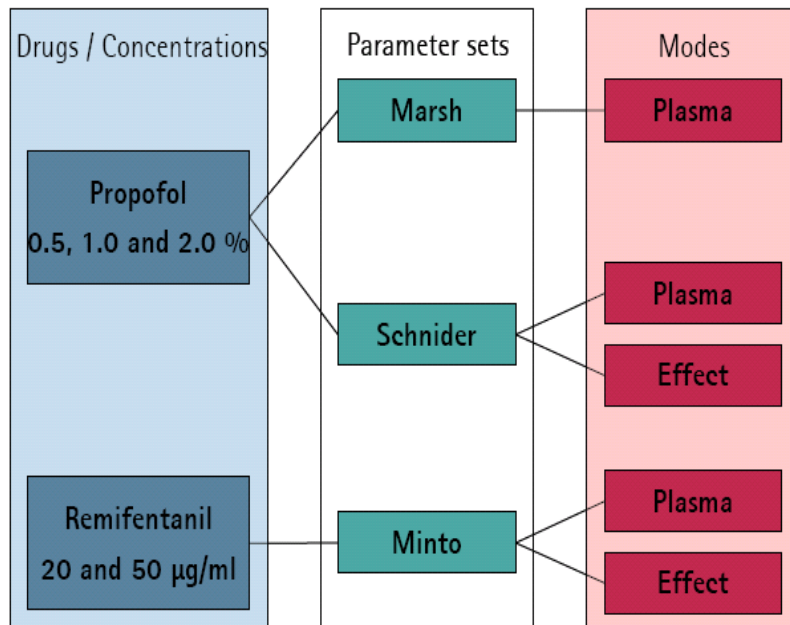


Space TCI – The Model





Space TCI



The TCI function includes the following performance:

Drugs: Propofol 0.5-/1.0-/2.0 %
Remifentanil 20-/50 ug/ml

Models: Marsh Propofol (Plasma)
Schnider Propofol (Plasma, Effect)
Minto Remifentanil (Plasma, Effect)

Pumps: Perfusor Space, Infusomat Space



Space TCI

Different kinds of therapies

⇒ **Balanced anesthesia:**

Combination of i.v. analgesic, volatile anesthetic and i.v. muscle relaxant

⇒ **Total intravenous anesthesia/ TIVA:**

Combination of i.v. analgesic, i.v. anesthetic plus i.v. muscle relaxant

⇒ **Combined anesthesia:**

Regional anesthesia for analgesia plus i.v. anesthetic agents. The additive properties of general and regional anesthetic techniques are brought together in combined anesthesia to minimize side effects of the individual techniques

Total Intravenous Anesthesia (TIVA)

Hypnotic
drug

Propofol

+

Analgesic
drug

Remifentanyl

+

Muscle
relaxant

Rocuronium

⇒ All drugs are administered intravenously during the maintenance phase

Advantages:

- ⇒ Comfortable, fast recovery
- ⇒ No hang- over
- ⇒ Less PONV (**P**Ostoperative **N**ausea and **V**omiting)
- ⇒ Good tolerance



Space TCI - Benefits

- ⇒ Dose titration to achieve a desired effect is facilitated
- ⇒ Simplification of dosage and improved ease of use
- ⇒ Advisory information on the calculated drug concentration is provided
- ⇒ Improved individualization of dosage if a complex PK model is available using covariates for age or other patient characteristics.
- ⇒ Provide much more stable concentrations
- ⇒ Supports to avoid over dosage
- ⇒ Very quick awakening





Space Glucose Control

Regulation of Blood Glucose

The homeostatic mechanism which keeps the blood value of glucose in a remarkably narrow range is composed of several interacting systems, of which hormone regulation is the most important.

There are two types of mutually antagonistic metabolic hormones affecting blood glucose levels:

1. **catabolic hormones** which increase blood glucose (such as **glucagon**, growth hormone, and somatostatin)
2. **anabolic hormone** which decreases blood glucose (e.g. **insulin**)

Space Glucose Control

How is blood glucose management done today?



Blood sample
has been taken



Measuring of blood
glucose value



Health care worker decides (due to own
experience or Protocols) about the further
Therapy (e.g. insulin infusion, etc)

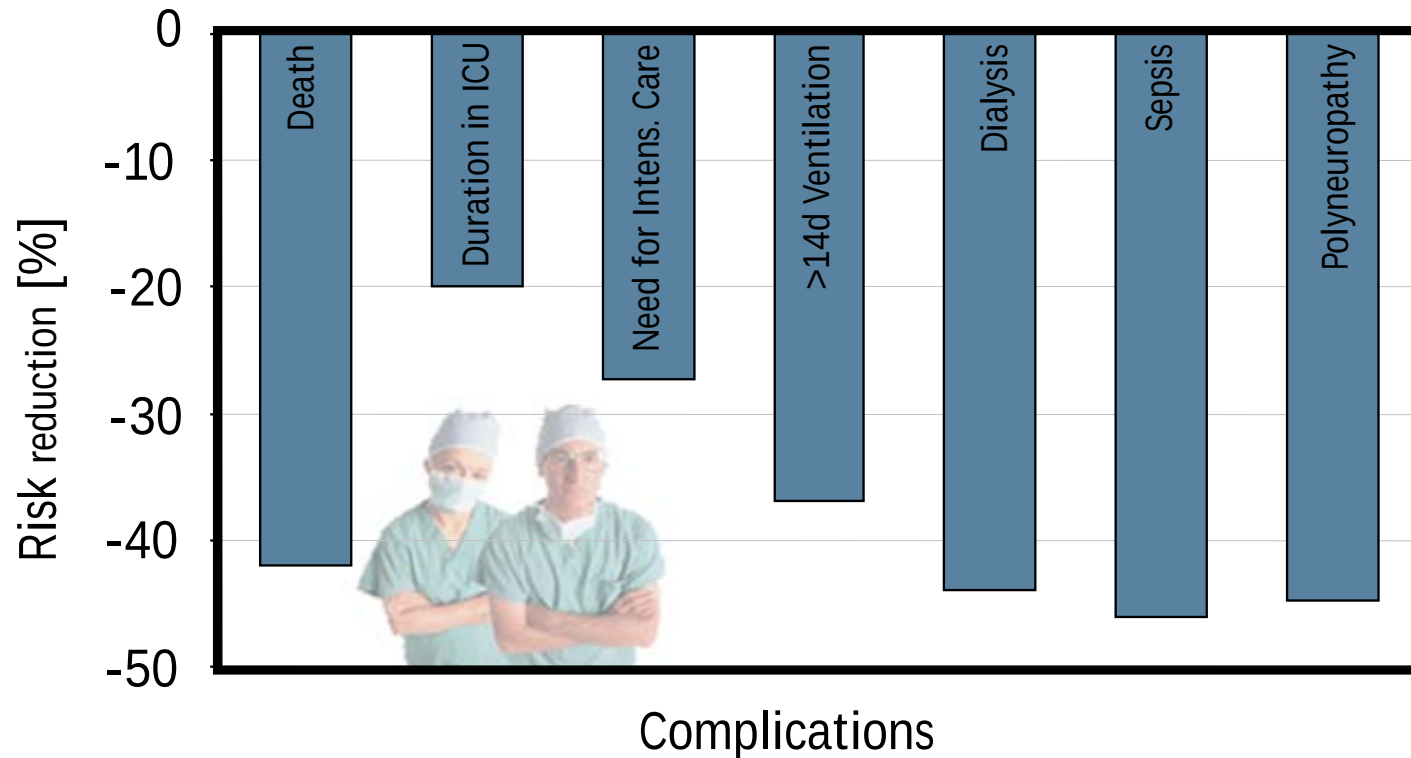


Insulin application if
required



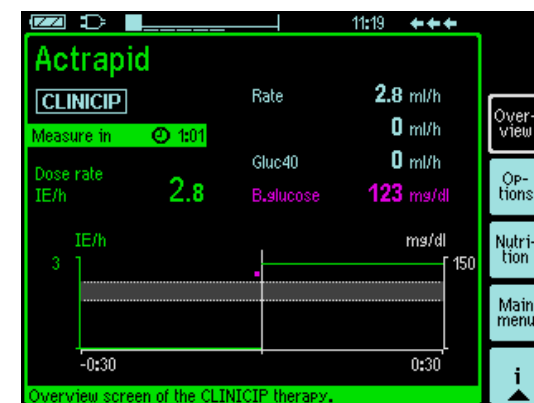
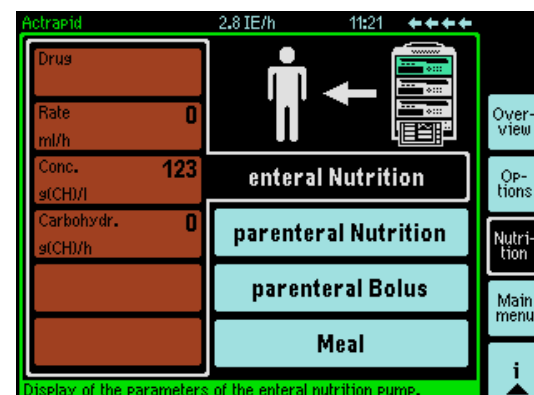
Space Glucose Control

Intensive Insulin Therapy in Critically Ill Patients



Greet van den Berghe, NEJM, 2001

Space Glucose Control



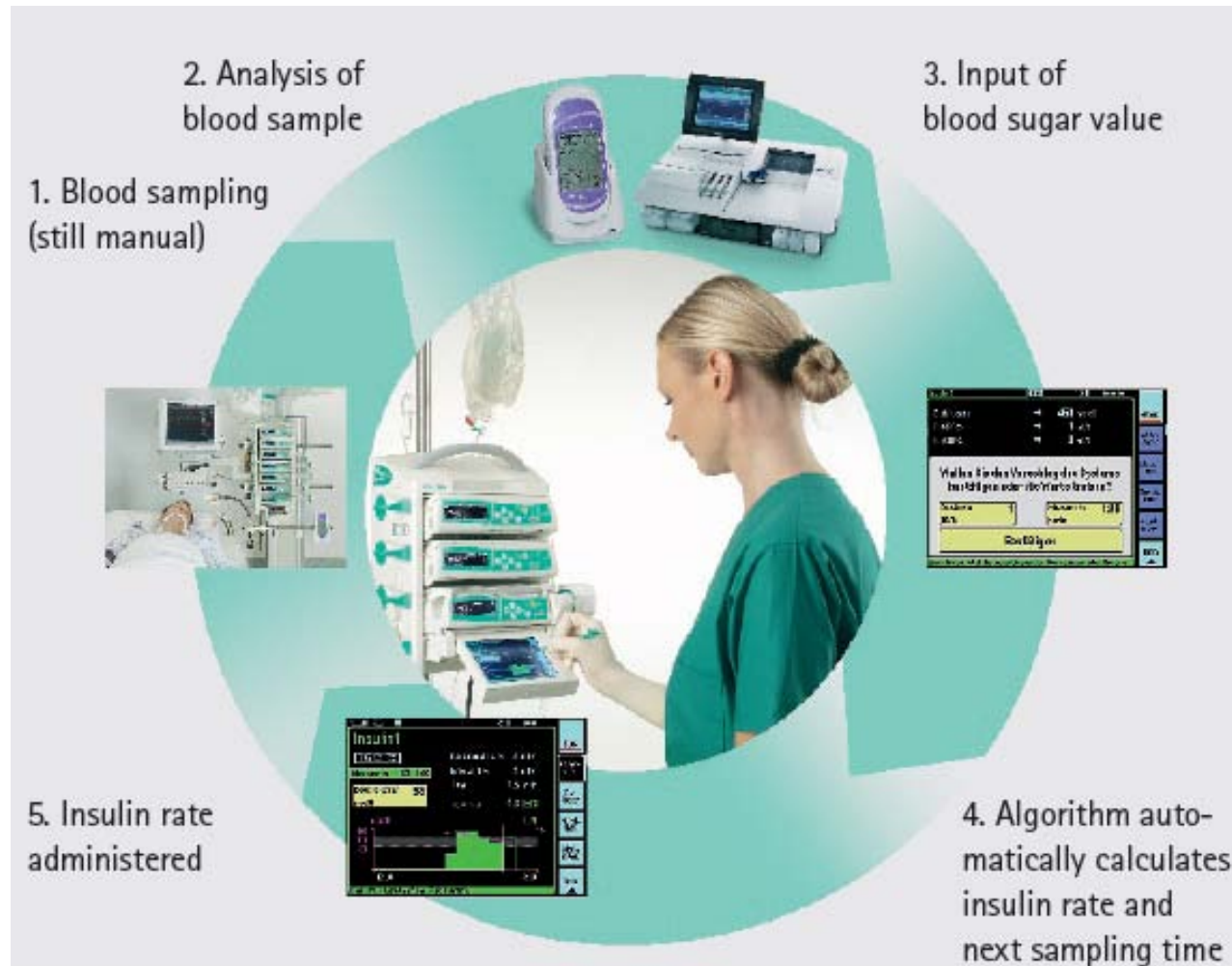


Space Glucose Control

Summary

- ⇒ The majority of Clinicians have accepted that Glucose Control is beneficial for Critically Ill Patients
- ⇒ But: Glucose Control is difficult to establish and therefore in general, not properly implemented.
- ⇒ Two Large scale multicentre trials have been stopped because GC could not be safely implemented.
- ⇒ **A technological solution is required to keep the blood glucose level in the normal range and avoid the risk of hypoglycemia**

Space Glucose Control

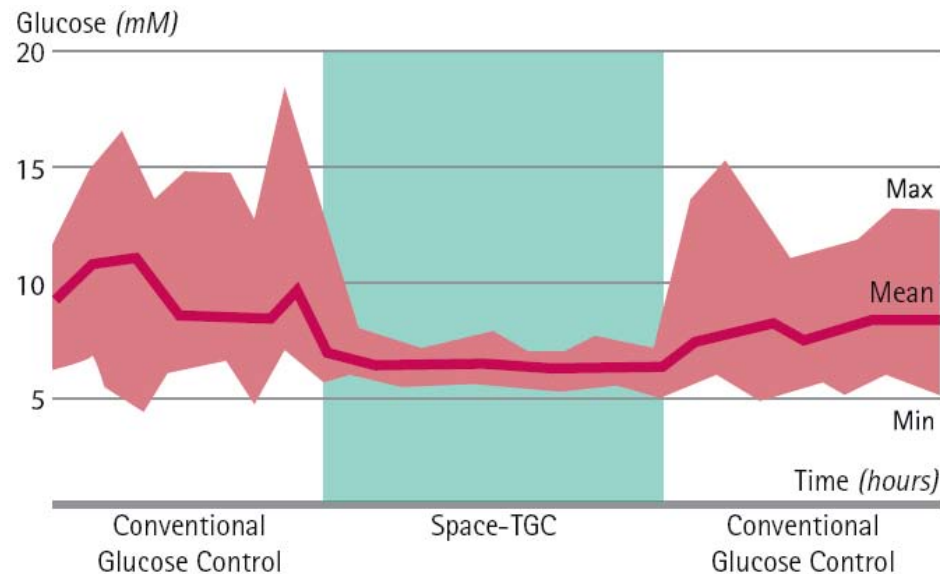




Space Glucose Control

SPACE-GC – The ideal solution for your intensive care patients!

SPACE-iGC has been designed by intensive care physicians and nurses to fit your personal needs.

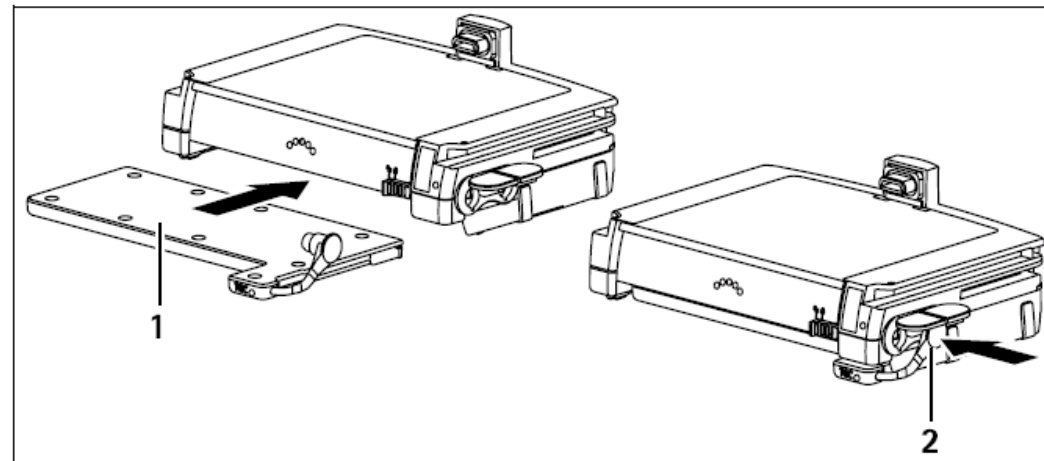


Space Glucose Control

The iGC Module



Assembly



1. Push in TGC Module 1.
2. Connect plug 2 with socket marked on the cover with the $\oplus$ symbol.



Space Glucose Control

- ⇒ 1 SpaceStation with SpaceCover
- ⇒ 2 Infusomat Space - Enteral nutrition pump
- ⇒ 3 Infusomat Space - Parenteral nutrition pump
- ⇒ 4 Perfusor Space - Insulin pump
- ⇒ 5 SpaceControl
- ⇒ 6 iGC module



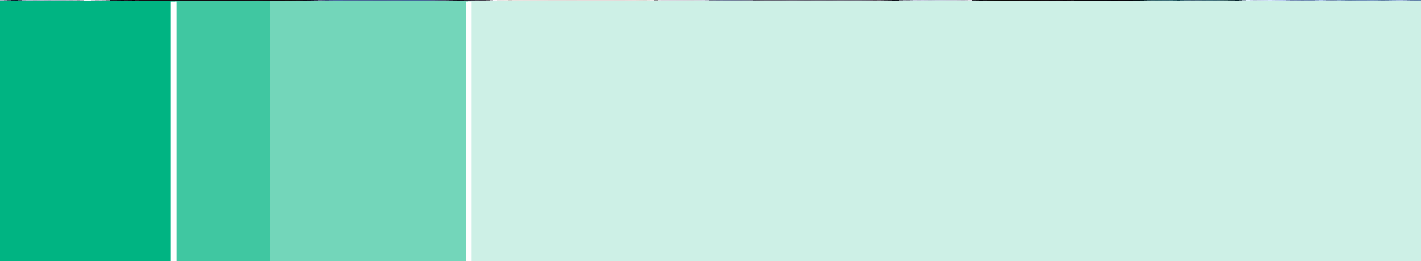


Quellen

- ⇒ B. Braun Training Documents Automated Infusion Systems
- ⇒ B. Braun Technical Instruction Documents Space
- ⇒ Kaushal R, et al. Medication errors and adverse drug events in pediatric inpatients. JAMA, 2001; 285:2114-2120.
- ⇒ Tourville J. Automation and error reduction: how technology is helping Children's Medical Center of Dallas reach zero-error tolerance. U.S. Pharmacist. June 2003; 28:80-86
- ⇒ St. John P. Drug Pump's Deadly Trail. Tallahassee Democrat. May 28, 200: A1
- ⇒ Phillips J, Beam S, Brinker A, et al. Retrospective analysis of mortalities associated with medication errors. Am J Health-Syst Pharm. 2001; 58:1835-1841
- ⇒ Mutschler, Arzneimittelwirkungen: Lehrbuch der Pharmakologie und Toxikologie, 8. Auflage, Stuttgart Wissenschaftliche Verlagsgesellschaft mbH, 2001
- ⇒ Riedemann, Schröder, PflegenIntensiv, 2. Jahrgang 1/05, Biblomed Verlag, Melsungen / Germany
- ⇒ B. Braun several Leaflets and Scientific Folders



Danke für Ihre Zeit.



B | BRAUN
SHARING EXPERTISE