CODAN

White Paper

Reducing Human Error in Infusion Therapy

Barcode Assisted Infusion (BAI), An Essential step towards increasing medication safety

The decisive connection

CODAN

White Paper

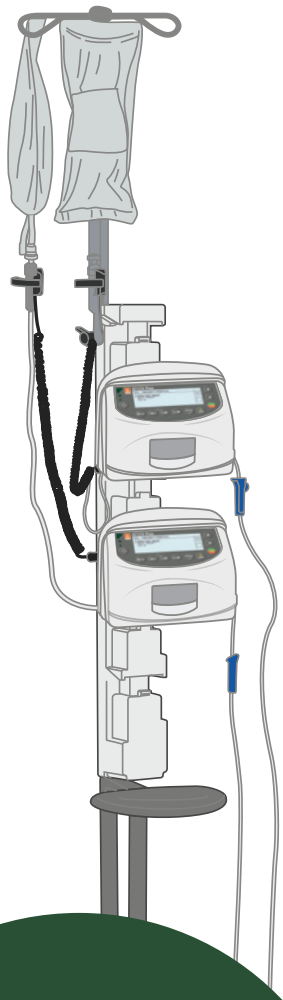
Reducing human error in infusion therapy

Learn how Barcode Assisted Infusion (BAI) can make infusion administration safer, protect your patients, save you valuable time, and help you improve the quality of care.

Medication errors are among the most common types of medical errors. Intravenous drugs are frequently regarded as high-risk for the patient. The reasons for this are their rapid onset and, thus, high potential to harm a patient. Inappropriate administration can amplify this risk. Cytostatics, in particular, can put vulnerable patients in immediate and severe danger, resulting in disability or death.

Strategies for medication error reduction are frequently aimed at reducing risk during the prescribing and preparation stages of the medication administration cycle. As a result, there is a limited focus on reducing administration errors, such as incorrect rate errors in infusion therapies.

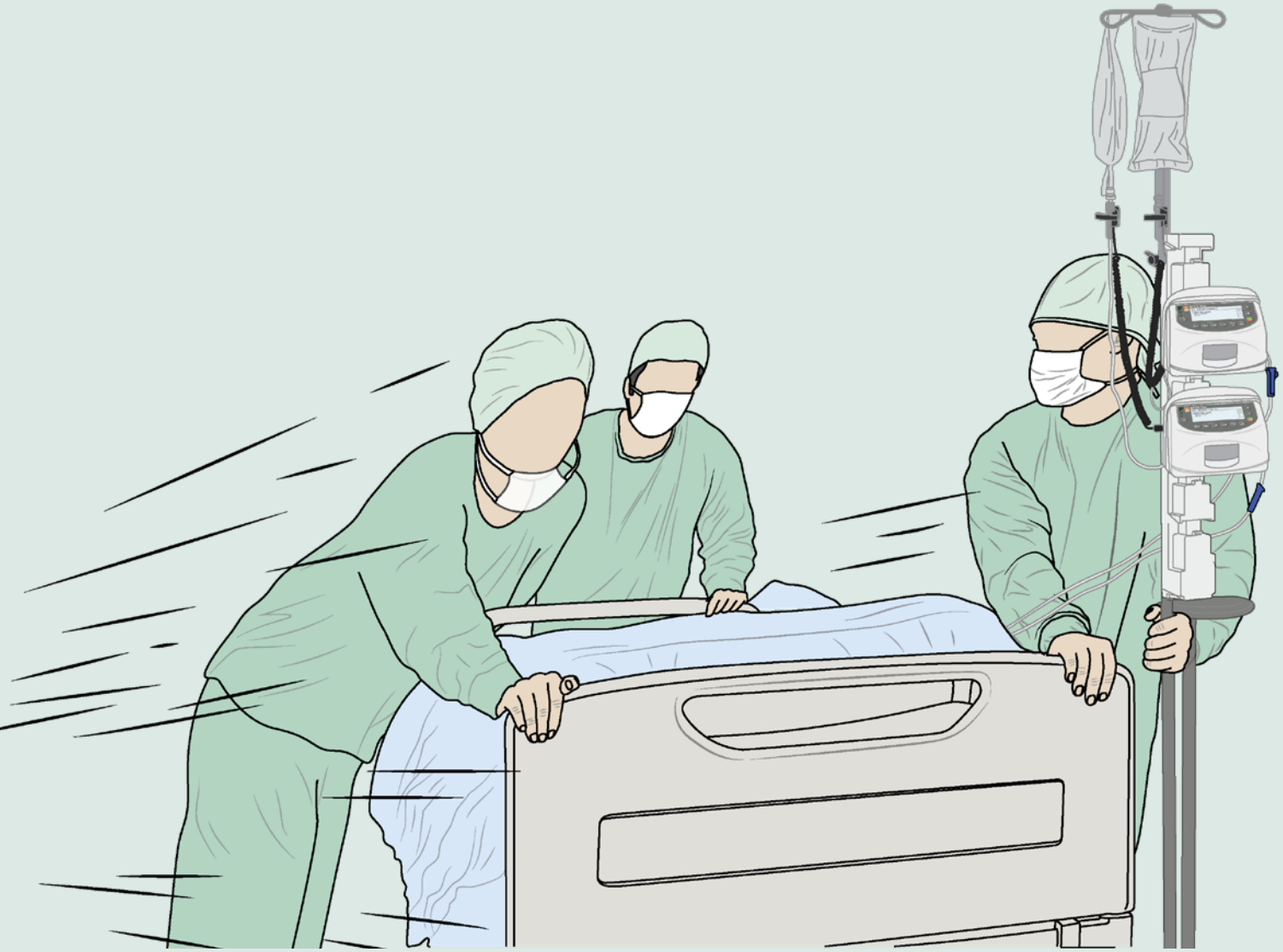
This whitepaper provides a comprehensive data analysis on medication administration errors, their prevalence, and their consequences. It focuses on intravenously delivered chemotherapy and discusses how technical solutions, like Barcode Assisted Infusion (BAI) therapy, can support healthcare workers in all care settings, especially those operating independently from central IT systems.



Did you know...
that between
38% to 68%
of all medication errors are found in the medication administration process?[7,9]

Medication errors – A significant cause for patient harm

It is well known that unsafe medication practices and medication errors account for a significant share of preventable patient harm, thus contributing to substantial healthcare costs, estimated at $42 billion each year[1]. According to a recent meta-analysis by Hodkinson et al., 1 in 30 patients are exposed to preventable medication harm, 25% of which is considered severe or life-threatening[2,3]. A British report estimated a total of 237 million medication errors between 2007 and 2016, and medication errors in the USA have been reported to result in 7000 patient deaths[4,5,6]. These studies prompt concern regarding the prevalence of medication errors, and highlights the need for a reliable solution to decrease medication administration errors and increase patient safety.



1 WHO 2017. (https://www.who.int/initiatives/medication-without-harm, accessed 02 May 2022)

2 Hodkinson A, Tyler N, Ashcroft DM, Keers RN, Khan K, Phipps D, Abuzour A, Bower P, Avery A, Campbell S, Panagioti M. Preventable medication harm across health care settings: a systematic review and meta-analysis. BMC Med. 2020 Nov 6;18(1):313. doi: 10.1186/s12916-020-01774-9. PMID: 33153451; PMCID: PMC7646069.

3 Slawomirski L, Klazinga N. Economics of patient safety: from analysis to action. Paris: Organisation for Economic Cooperation and Development. 2020. (http://www.oecd.org/health/health-systems/Economics-of-Patient-Safety-October2020.pdf, accessed 15 May 2022)

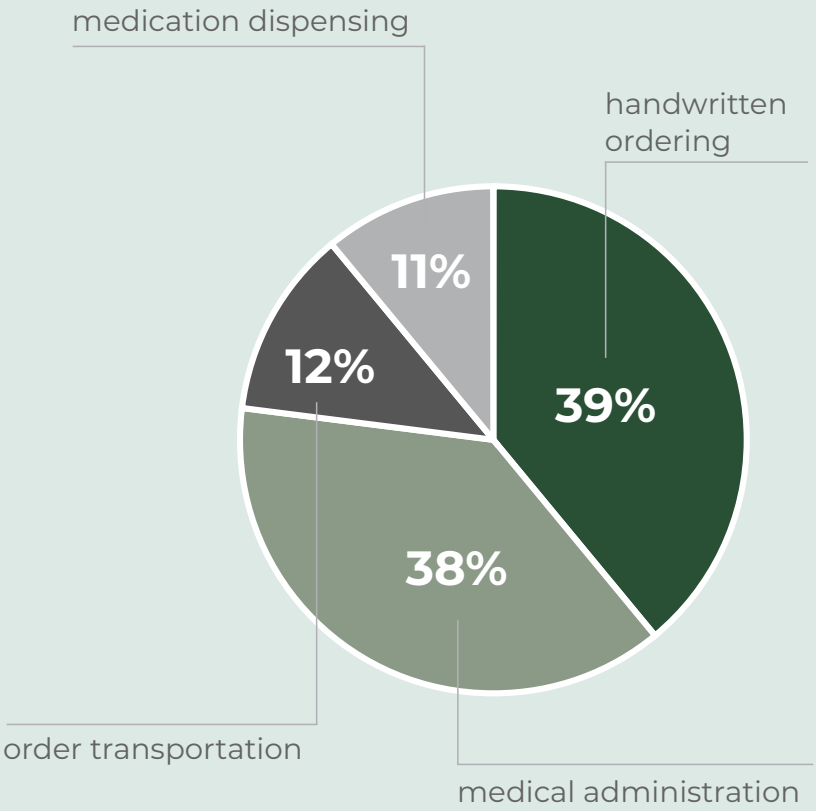
4 Bennett S. WHO launches a global effort to halve medication-related errors in 5 years. 2017. (https://www.who.int/news/item/29-03-2017-who-launches-global-effort-to-halve-medication-related-errors-in-5-years)

5 Ranchon F, Salles G, Späth HM, Schwiertz V, Vantard N, Parat S, Broussais F, You B, Tartas S, Souquet PJ, Dussart C, Falandry C, Henin E, Freyer G, Rioufol C. Chemotherapeutic errors in hospitalised cancer patients: attributable damage and extra costs. BMC Cancer. 2011 Nov 8;11:478. doi: 10.1186/1471-2407-11-478. PMID: 22067636; PMCID: PMC3262863.

6 Härkänen M, Vehviläinen-Julkunen K, Murrells T, Rafferty AM, Franklin BD. Medication administration errors and mortality: Incidents reported in England and Wales between 2007 – 2016. Res Social Adm Pharm. 2019 Jul;15(7):858-863. doi: 10.1016/j.sapharm.2018.11.010. Epub 2018 Nov 22. PMID: 30528260.

Medication administration is an important contributor to medication errors

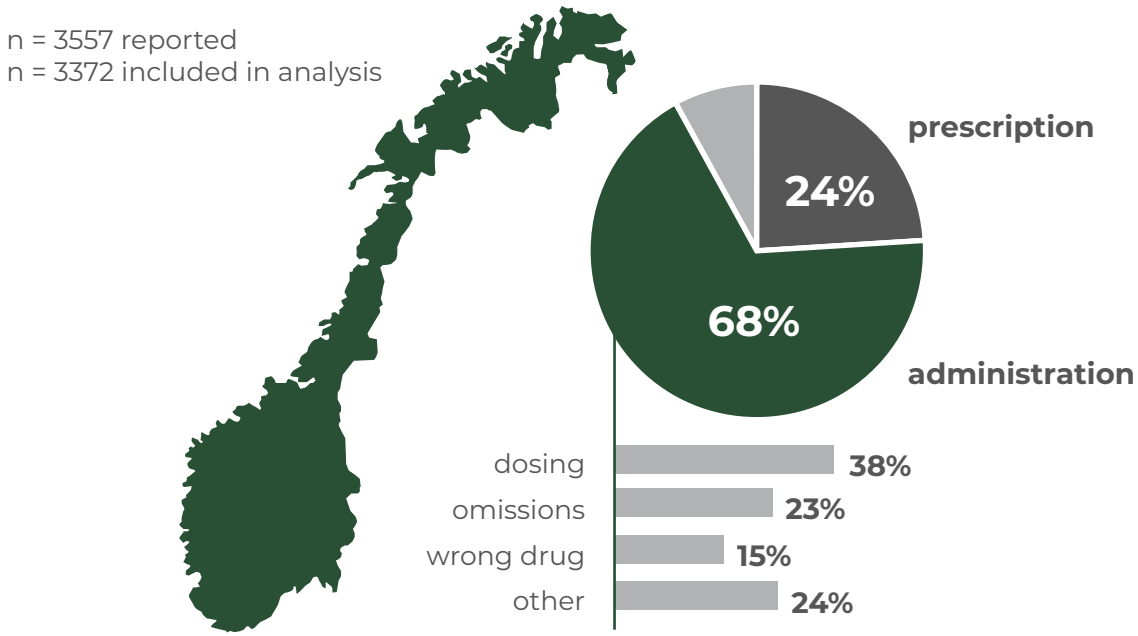
Medication errors occur in all phases of the medication cycle, including the prescribing, transcribing, dispensing, administration, and monitoring stages. However, administration errors account for a significant portion of errors, reported across studies from 1995 – 2021. Leape et al. found that 39% of errors were committed during handwritten ordering, 38% during medication administration, 12% during order transcription and 11% during medication dispensing[7]. In an outpatient oncology setting, a retrospective review of adult and paediatric visits found more medication administration errors (56%) than prescription phase errors (36%), further highlighting the importance of prevention[8].



Frequency of Medication Errors according to a study by Leape et al.[7]

7 Leape LL, Bates DW, Cullen DJ, Cooper J, Demonaco HJ, Gallivan T, Hallisey R, Ives J, Laird N, Laffel G, et al. Systems analysis of adverse drug events. ADE Prevention Study Group. JAMA. 1995 Jul 5;274(1):35-43. PMID: 7791256.

8 Walsh KE, Dodd KS, Seetharaman K, Roblin DW, Herrinton LJ, Von Worley A, Usmani GN, Baer D, Gurwitz JH. Medication errors among adults and children with cancer in the outpatient setting. J Clin Oncol. 2009 Feb 20;27(6):891-6. doi: 10.1200/JCO.2008.18.6072. Epub 2008 Dec 29. PMID: 19114695.



Reported Medical Errors in Norway (2016-2017)

New data (2021) demonstrates that most medication errors in Norway occurred during administration (68%) followed by prescribing (24%). The leading types of errors were dosing errors (38%), omissions (23%) and wrong drug (15%). Over half of all errors were harmful (62%), of which 5.2% caused severe harm, and 0.8% were fatal.[9]

Recent studies in the UK (2020) confirm these findings and underline that the medication administration process accounts for an important source of error to be reduced[10,11].

Over half (54.4%) of the 237 million medication errors estimated to occur in the UK each year are attributed to the administration stage; 7.6% of these were found to be associated with moderate or severe harm[12].

Specifically, intravenous medications are prone to errors on the part of the caregiver, as their preparation and administration have added complexity relative to other administration methods. Errors in the medication administration phase are especially critical, as there is a limited timeframe for correction and intervention before the drug potentially causes harm. Data from the UK shows that medication errors occurred in approximately 10% of intravenous medication administrations. Half of those errors were related to the administration phase with nearly 60% being wrong rate errors[13].

9 Mulac A, Taxis K, Hagesaether E, et al Severe and fatal medication errors in hospitals: findings from the Norwegian Incident Reporting System European Journal of Hospital Pharmacy 2021;28:e56-e61.

10 Westbrook JI, et al. BMJ Health Care Inform 2020;27:e100170. doi:10.1136/bmjhci-2020-100170

11 Michalek C, Carson SL. Implementing barcode medication administration and smart infusion pumps is just the beginning of the safety journey to prevent administration errors. Farm Hosp. 2020 May 1;44(3):114-121. English. doi: 10.7399/fh.11410. PMID: 32452311

12 Elliott RA, Camacho E, Jankovic D, et al. Economic analysis of the prevalence and clinical and economic burden of medication error in England. BMJ Qual Saf 2021;30:96–105.

13 Sutherland A, Canobbio M, Clarke J, et al Incidence and prevalence of intravenous medication errors in the UK: a systematic review. European Journal of Hospital Pharmacy 2020;27:3-8.

The human factor

Although Medication Errors (MEs) are multifactorial, they are most often related to human factors. As nurses and physicians often care for multiple patients in a demanding and stressful environment, various aspects, including high workload and staff shortages, can affect their personal and professional performance and lead to medication errors that jeopardize patient safety. Nursing staff shortages, working overtime, and high workloads that require multitasking and sometimes lead to inadequate attention in the care process have been recognized as important contributors to medication errors[14,15].

To reduce medication errors, nurses are trained to follow the “5Rs - Five Rights of Medication Administration”.

These principles were developed to ensure that the right patient receives the right drug, and the right dose via the right administration route, at the right time. Technological solutions have been implemented to support them in achieving those principles.

New technologies, including barcode-assisted medication preparation and administration, smart infusion pumps or closed-loop medication systems are acknowledged as solutions to increase patient safety and decrease the risk of human error by preventing medication errors before they reach the patient[16,17]. We will further discuss the critical role of Barcode Assisted Infusion (BAI) in the chemotherapy setting, where high-risk intravenous drugs are commonplace.

Factors that can cause Medication Errors

- High workload
- Staff shortage
- Stress / working overtime
- Inattentiveness owing to distraction or fatigue
- Routine behaviors
- Complexity of task
- Skill-set and training level
- Personal conditions (mental, emotional)

14 Eslamian J, Taheri F, Bahrami M, Mojdeh S. Assessing the nursing error rate and related factors from the view of nursing staff. Iran J Nurs Midwifery Res. 2010 Dec; 15(Suppl 1):272-7. PMID: 22069399; PMCID: PMC3208929.

15 Rapphold B, Metzenthin P, Oertle M, Küng K. Medication Errors Caused by Nurses and Physicians in a Swiss Acute Care Community Hospital: Frequency and Correlation to Nurses' Reported Workload / Von Pflegefachpersonen und Ärzten/-innen verursachte Medikamentenfehler in einem Schweizer Akutspital: Häufigkeit und Korrelation zur Arbeitsbelastung von Pflegefachpersonen. International Journal of Health Professions. 2018;5(1): 15-24. https://doi.org/10.2478/ijhp-2018-0002

16 Michalek C, Carson SL. Implementing barcode medication administration and smart infusion pumps is just the beginning of the safety journey to prevent administration errors. Farm Hosp. 2020 May 1;44(3):114-121. English. doi: 10.7399/fh.11410. PMID: 32452311.

17 Franklin BD, O'Grady K, Donyai P, et al. The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: a before-and-after study. Qual Saf Health Care 2007;16:279–84./ Goundrey-Smith SJ. Technologies that transform: digital solutions for optimizing medicines use in the NHS. BMJ Health Care Inform 2019;26:e100016

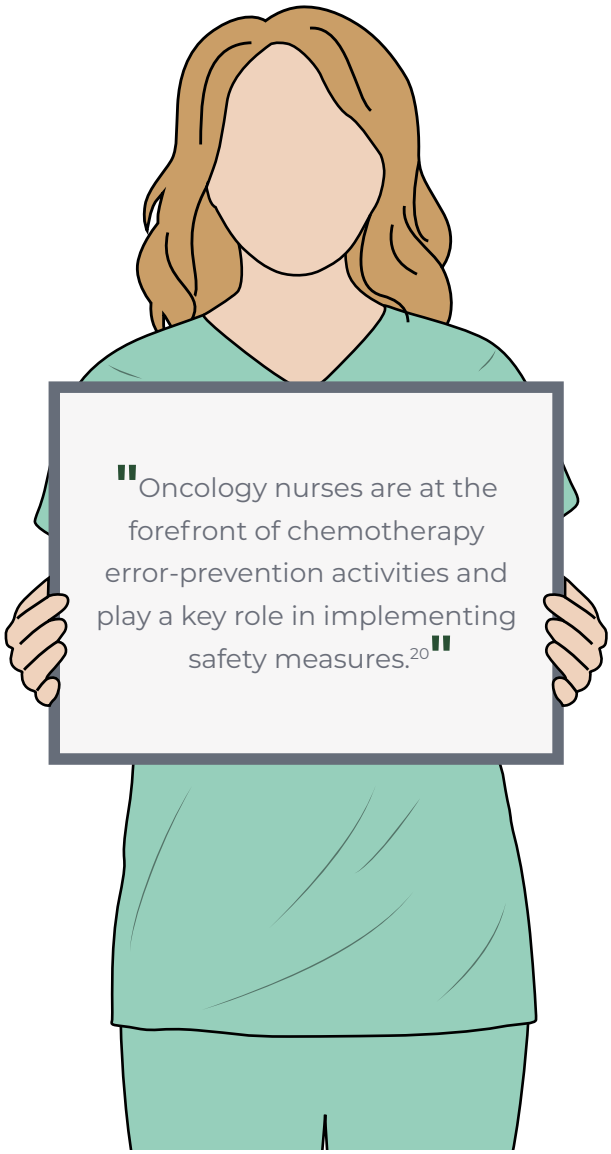
The special risk in chemotherapy infusion therapy

Chemotherapy-related medication errors pose a serious health risk among already immuno-compromised cancer patients given the narrow therapeutic index, complex dosing, and toxic nature of anticancer drugs[18]. Furthermore, they are typically delivered via intravenous infusion pumps directly into the bloodstream, further underscoring the notion of intravenous medication administration as high-risk. Medication errors at the point of administration are the most prevalent at 68% of intravenous (IV) medication errors. In conjunction with the high-risk element, 98% of IV medication administration errors are not detected[19].

A survey found that 80% of oncology nurses reported at least one error during chemotherapy medication preparation and administration. The most common errors were incorrect dose prescriptions or orders (65.7%) and non-compliance with the administration sequences during chemotherapy (50.5%).
There were an estimated 4.1 errors per month due to an improper administration sequence (range 1-20 errors). The nurses justified that their negligence was attributed to a heavy workload (49.7%) and an insufficient number of staff (36.5%)[21].

To administer IV chemotherapy drugs, nurses often use manually programmed infusion pumps, which is a complex, time-consuming process prone to human error. IV infusion programming errors have a greater likelihood of causing serious injury or death compared to other medication errors. As soon as the nurse presses the “start” button - the infusion is administered to the patient regardless of possible programming errors unless the device can detect them automatically, which is not a common feature in infusion pumps[22].

One solution to facilitate manual infusion pump programming and reduce the number of button presses is to implement Barcode Assisted Infusion (BAI) technology. It drastically reduces the possibilities of nurse handling errors and increases patient safety.



18 Dorothy A, Yadesa TM, Atukunda E. Prevalence of Medication Errors and the Associated Factors: A Prospective Observational Study Among Cancer Patients at Mbarara Regional Referral Hospital. Cancer Manag Res. 2021;13:3739-3748 https://doi.org/10.2147/CMAR.S307001

19 https://insights.omnia-health.com/hospital-management/streamlining-safety-barcode-medication-administration-intravenous-medications

20 Macias M, Bernabeu-Andreu FA, Arribas I, Navarro F, Baldominos G. Impact of a Barcode Medication Administration System on Patient Safety . Oncol Nurs Forum. 2018 Jan 1;45(1):E1-E13. doi: 10.1188/18.ONF.E1-E13. PMID: 29251293.

21 Ulas A, Silay K, Akinci S, Dede DS, Akinci MB, Sendur MAN, et al. Medication Errors in Chemotherapy Preparation and Administration: a Survey Conducted among Oncology Nurses in Turkey [Internet]. Vol. 16, Asian Pacific Journal of Cancer Prevention. Asian Pacific Organization for Cancer Prevention; 2015. p. 1699–705. Available from: http://dx.doi.org/10.7314/APJCP.2015.16.5.1699

22 Bruce SD. Before you press that button: a look at chemotherapy errors. Clin J Oncol Nurs. 2013 Feb;17(1):31-2. doi: 10.1188/13.CJON.31-32. PMID: 23372093.

Barcode assisted medication administration makes chemotherapy safer

Evidence in support of barcode-assisted medication administration is plentiful. Studies have shown that barcode-assisted methods can detect medication errors before they harm oncology patients by reducing the incidence and severity of medication administration errors and increasing the safety of the care process[23,24,25,26].

Barcode Assisted Infusion (BAI) is one distinct solution aimed to support the intravenous chemotherapy administration process. It automates pump programming, a frequent source of human error thereby increasing patient safety.

It was estimated that about 3,200 potential medication administration errors (MAEs) per year were prevented with this system. This finding is especially important, as chemotherapy is increasingly performed on an outpatient basis for patient convenience and administrative cost savings. Measures and solutions that can be easily implemented in such settings are needed[27].

In an onco-haematology outpatient unit, the implementation of a barcode-assisted system resulted in an 85% reduction in medication administration errors[27].

Barcode-assisted systems, like CODAN's Barcode Assisted Infusion (BAI) solution, are independent of hospital infrastructure or central IT systems. They are easy to implement and provide a reliable technical solution.

23 Fernandez MH, Bautista MM, Mateos MR, et al PS-048 A bar code assisted chemotherapy administration system in cancer patients European Journal of Hospital Pharmacy 2016;23:A234-A235.
24 Truitt E, Thompson R, Blazey-Martin D, NiSai D, Salem D. Effect of the Implementation of Barcode Technology and an Electronic Medication Administration Record on Adverse Drug Events. Hosp Pharm. 2016 Jun;51(6):474-83. doi: 10.1310/hpj5106-474. PMID: 27354749; PMCID: PMC4911988.
25 Bonkowski J, Carnes C, Melucci J, Mirtallo J, Prier B, Reichert E, Moffatt-Bruce S, Weber R. Effect of barcode-assisted medication administration on emergency department medication errors. Acad Emerg Med. 2013 Aug;20(8):801-6. doi: 10.1111/acem.12189. PMID: 24033623.
26 Leung AA, Denham CR, Gandhi TK, Bane A, Churchill WW, Bates DW, Poon EG. A safe practice standard for barcode technology. J Patient Saf. 2015 Jun;11(2):89-99. doi: 10.1097/PTS.0000000000000049. PMID: 24618650.
27 Macias M, Bernabeu-Andreu FA, Arribas I, Navarro F, Baldominos G. Impact of a Barcode Medication Administration System on Patient Safety. Oncol Nurs Forum. 2018 Jan 1;45(1):E1-E13. doi: 10.1188/18.ONF.E1-E13. PMID: 29251293. https://ecamet.eu/wpcontent/uploads/Electronic%20scaning%20systems/Macias%202018.pdf

Barcode Assisted Infusion (BAI)
Benefits that extend across the entire care pathway

The advantages of BAI are evident for patients, caregivers and healthcare facilities alike. By reducing manual programming steps and preventing transcription errors, BAI increases safety at the bedside and improves efficiency in daily workflows. Beyond individual users, BAI supports entire units and facilities by providing reliable processes that can be implemented consistently across different care settings. Most importantly, it helps make infusion therapy safer for patients receiving high-risk medications such as chemotherapy.

BAI facilitates and standardises the chemotherapy workflow

The automatic setup of the infusion pump through barcode scanning reduces programming time and eliminates transcription errors. Standardised workflows support compliance with the “Five Rights” of medication administration and add another safety layer to the delivery of critical therapies.

BAI is innovative, reliable and accessible in all care settings

Designed for accessibility, BAI can be implemented in diverse hospital environments, medical care centres and outpatient practices.
It offers an efficient and cost-effective solution, making advanced infusion management more attainable for healthcare settings of all sizes.

BAI supports caregivers in delivering improved patient care

By reducing manual programming steps and saving valuable time, BAI helps nurses and physicians focus on direct patient care. Even in moments of high workload or fatigue, automated workflows provide added safety and reassurance. Benefit from simplified workflows, improved efficiency, and enhanced patient safety in oncology clinics, medical care centres and outpatient practices.

While BAI provides clear advantages as a stand-alone solution, its full potential unfolds when it becomes part of an integrated end-to-end workflow.
CODAN Cohesive Therapy Management (CTM) extends BAI by linking therapy planning, pharmacy preparation, pump programming and documentation into one coherent process.

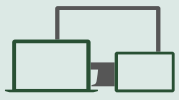
CODAN Cohesive Therapy Management: An Integrated Solution

CODAN Cohesive Therapy Management (CTM) provides a unified framework for infusion therapy that connects infusion pumps, barcode-assisted workflows and external therapy planning systems. By integrating prescription, preparation, administration and documentation into a closed-loop process, CTM helps healthcare institutions address one of the most persistent challenges in oncology: safe and reliable medication delivery.

Using ChemoCompile® as an example, CTM demonstrates how approved therapy orders can be transmitted simultaneously to the pharmacy for medication preparation and to the CODAN gateway for infusion pump programming. This dual pathway ensures that medication orders are always correct, only validated therapies can be administered, and treatments can only be applied in the prescribed order. At the same time, therapy modifications remain possible even minutes before administration - regardless of what has already been manufactured.

After infusion, the therapy data is documented directly back into the planning system, creating a complete and auditable dataset that supports treatment records, invoicing, audits and certification. The result is a end-to-end workflow that improves safety, efficiency and traceability across the entire treatment cycle.

System Benefits



Integrated therapy planning
Therapy orders flow directly from the planning system to both pharmacy and infusion pump, reducing errors and ensuring precision.

Efficient workflows
Barcode-driven pump programming standardises setup, saves time and reduces cognitive workload for staff.

Comprehensive data management
All therapy data is consolidated within the planning system, providing a single source of truth for treatment history, invoicing and reporting.

Enhanced patient safety
Only approved therapies can be applied, in the correct order, with full traceability and reduced risk of manual errors.

Flexibility in practice
Therapy changes can be applied shortly before administration without wasting prepared medication, supporting both safety and cost efficiency.

End-to-end capability
A standardised data flow for infusion therapy

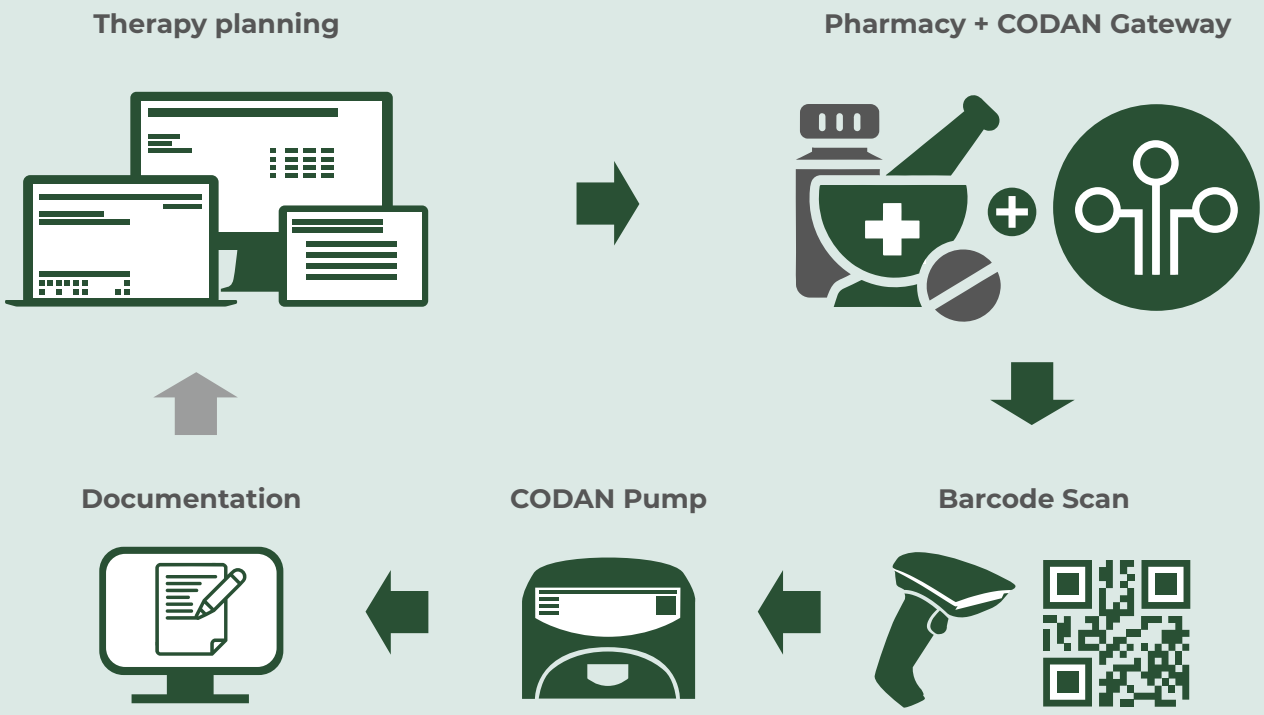
1. Prescription & approval
- Therapy order is created and authorised in the planning system.
- The approved order is transmitted simultaneously to the pharmacy for preparation and to the CODAN gateway for pump programming.

2. Preparation at bedside
- Patient, medication and staff identifiers are verified using a handheld barcode scanner or the CODAN Scan application.
- The approved order data is securely transferred to the infusion pump.

3. Pump programming & administration
- Infusion parameters are applied automatically from the gateway to the pump.
- Medications can only be administered in the prescribed sequence.
- Settings are verified by staff before the infusion is started.
- Therapy changes made shortly before administration are reflected directly in the pump programming.

4. Documentation
- Therapy completion is documented directly back into the planning system.
- Consolidated data can be used for patient records, invoicing, audits and certification.

End-to-end integration



Executive Summary

Medication errors remain a leading cause of preventable harm, with infusion therapies such as chemotherapy carrying particular risk. Manual pump programming is complex and error-prone, increasing workload for staff and jeopardising patient safety.

Barcode Assisted Infusion (BAI) reduces these risks by automating pump setup through barcode-driven workflows. It standardises processes, improves accuracy and efficiency, and is accessible across hospitals, medical centres and outpatient practices.

The greatest impact is achieved when BAI is embedded into **CODAN Cohesive Therapy Management (CTM)**. Here, approved therapy orders are transmitted simultaneously to the pharmacy and to the infusion pump, ensuring accuracy, adherence to the prescribed order and enabling last-minute therapy changes. Documentation flows directly back into the planning system, creating a single, auditable dataset for patient records, invoicing and compliance.

Through CTM, CODAN supports an end-to-end workflow from prescription to administration and documentation. When combined with therapy planning applications such as ChemoCompile®, this integration extends to a closed-loop process that enhances patient safety, supports caregivers with simplified handling, and enables healthcare facilities to achieve greater efficiency, cost savings and process security.

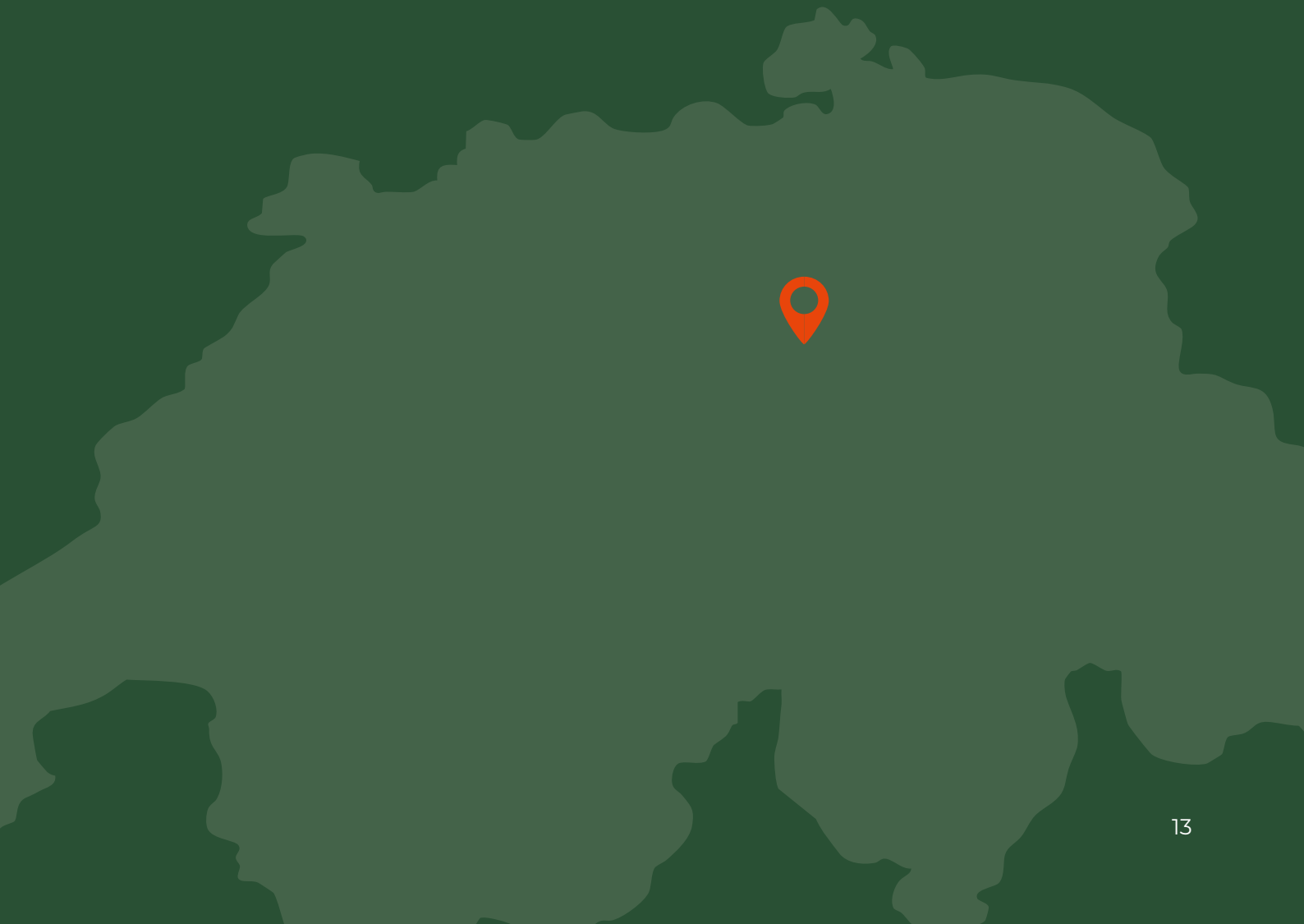
CODAN ARGUS, based in Baar, Switzerland, is one of the international CODAN Companies and a leading infusion technology specialist.

We have been developing, producing and selling Swiss made technology solutions for infusion therapy for more than 50 years. Our worldwide renown infusion technology systems stand for quality, reliability, precision and unrivalled user-friendliness.

Thanks to our global network within the CODAN Sales companies and carefully selected international distributors, we understand local customer needs and provide advanced infusion technology systems and superior services to end-users such as hospitals, clinics and doctor's offices all around the world. We continuously strive to develop long-term relationships with our clients. Therefore, we genuinely focus upon our customer interests to provide them with innovative, easy to use and reliable products. From our partners perspective, we are a trusted and loyal business partner in the infusion technology business.

For healthcare professionals who want to safely administer critical fluids to patients, CODAN ARGUS is a trusted partner, offering infusion pump technology that improves patient safety through standardisation of care and high precision in medication infusion and which is backed by over 50 years of experience.

Discover what Barcode Assisted Infusion (BAI) can do for your infusion therapy workflow. Go to codanargus.com or contact your CODAN representative.



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The decisive connection