Computer-assisted prescription: the future of nutrition care?

Authors: Jean-Charles Preiser, M.D., Ph.D.[1], Steven Laureys, M.D., Ph.D. [2,3], Arthur Raymond Hubert van Zanten, M.D., Ph.D. [4,5], André Van Gossum, M.D., Ph.D. [6]

Affiliations:

1. Erasme Hospital, Université Libre de Bruxelles, Brussels, Belgium
2. GIGA Consciousness/Coma Science Group and Brain Center, University and University Hospital of Liège, Belgium
3. International Disorders of Consciousness Institute, Hangzhou Normal University, China
4. Department of Intensive Care Medicine, Gelderse Vallei Hospital, Ede, The Netherlands.
5. Division of Human Nutrition and Health, Wageningen University & Research, Wageningen, The Netherlands.
6. Consultant in the Department of Gastroenterology and Clinical Nutrition Hopital Erasme /institut Bordet - Université Libre de Bruxelles, Belgium.

All authors contributed equally

Corresponding author:

Preiser Jean-Charles,

Medical Direction, Erasme Hospital

808 route de Lennik

B-1070 Brussels, Belgium

T +3225556591

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Despite the increasing recognition of nutrition status as a modifiable risk factor for life-threatening complications, the importance of nutrition care seems often overlooked by physicians due to a lack of specific interest and training in medical nutrition and/or by the complexity of prescriptions requiring several calculations (1). As a result, there is a lack of standardization and an extensive heterogeneity in the prescription of nutrition. Moreover, the application of nutrition therapy is also widely variable in terms of proportion of prescribed amount of nutritional formulas, time to reach the target and reasons for interruptions (2,3). The acquisition or aggravation of preexisting malnutrition can occur and increase the risk of complications, prolong the length of stay, increase mortality, and confer higher treatment costs (up to 10 % of the health expenditure)(4-6). The situation of a large discrepancy between the prescribed amount of nutrients and the actual delivery has been particularly well studied in Intensive Care Unit (ICU) patients (7,8), but also occurs in hospital wards (9–13), after hospital discharge (14) or when oral feeding is difficult in the context of swallowing disorders related to oncological conditions (e.g. head and neck tumors (15)), gastrointestinal or laryngeal diseases or malformations or a variety of neurological conditions with congenital or acquired brain damage in both children (e.g., cerebral palsy (16)) and adults (e.g. stroke, multiple sclerosis, motor neuron disease, myasthenia gravis, brain tumors, Parkinson's disease, dementia or chronic altered disorders of consciousness after coma, minimally conscious state or unresponsive wakefulness syndrome) (17) or locked-in syndrome (18) in both rehabilitation, nursing homes or home settings (19).

The use of computer-based decision-support systems seems well perceived by physicians (20,21) and can improve the quality of nutrition orders when medical nutrition (enteral or parenteral) is prescribed in ICUs, hospital wards and after hospital discharge (22). Implementing a decision support system in the field of clinical nutrition requires a clear understanding of the nutrition care workflow from ICU care to post-hospitalization follow-up. The experts of the American Society for Parenteral and Enteral Nutrition (ASPEN) have recently issued consensus recommendations for optimizing electronic health records for all aspects of nutrition care, from nutrition assessment, diagnosis, care plan and intervention, monitoring and evaluation (23).

Most institutions that wish to implement a digitalized system to aid nutritional management either choose to adapt their generic Clinical Information System (CIS) by customizing a module dedicated to nutrition or to develop specific applications based on generic programs like Microsoft Excel spreadsheets. Several teams (24–26), have demonstrated that the use of a nutritional module with a generic CIS consistently improves delivery of nutrition prescriptions compared to an unassisted prescription. These improvements include

shortening of the time required for computations and clerical reporting, nutrient delivery closer to the target, less weight loss, increase of the rate of days in compliance with caloric and protein targets. However, the development of the software needed for the customization of a generic CIS requires significant resources. This might not be affordable for several hospitals, nursing institutions and home settings. In addition, the use of the CIS is often restricted to the setting for which the software has been customized.

The recording of the actual volumes of nutritional products delivered by enteral and parenteral pumps can be problematic. Indeed, a clinically significant, undetected discrepancy between prescribed, recorded, and actual volume really delivered by enteral nutrition pumps have been reported (27) leading to almost 20% of ordered enteral nutrition not being provided and leading to a subsequent relevant daily caloric deficit. Discrepancies between volumes actually delivered and volumes recorded are also very frequent with the use of parenteral pumps (28). As a consequence, there is a need for an affordable software system able to obtain data of the nutritional status and delivered nutrition administered via pumps in real time.

Hence, a software dedicated to nutrition care ought to include **a clinical nutrition management system (CNMS)** and **a reliable recorder of the pump data.**

The CNMS should follow the patient's nutrition therapy journey in the hospital and can continue after discharge, at home or in rehabilitation facilities. It should integrate and organize nutritionally relevant data coming from multiple sources such as electronic health records, laboratories and feeding pumps in one centralized software system. Healthcare professionals should be able to screen patients for malnutrition risk using a user-friendly standardized, validated and digitalized tool – permitting to verify accordance with the latest updated internationally established scientific and medical recommendations and guidelines. The results would next be available throughout the hospital stay and subsequent pathway of care to all the involved caregivers (i.e., physicians, nutritionists, nurses and physiotherapists) and a new risk score can be calculated at any time. Nutrition goals expressed in calories and proteins should be defined and calculated by the software using formulas algorithms or data from indirect calorimetry. Once the targets are defined and validated by the clinical staff, an appropriate route of administration and prescribed products can be suggested. Once the nutrition support protocol is initiated, the follow-up through the software will compare prescribed calories and proteins versus actually delivered and provide feedback. The CNMS software should also be able to process complex and varied information (lab parameters, weight loss, scoring, etc.), so caregivers' focus can be pulled towards patients in need of support. It should offer decision-support insights for corrective and preventive actions.

At the time of hospital discharge, home care and community care providers can be informed of the patient's history and continue the nutrition therapy follow-up at home using the very same system with involvement of the home physician and ambulatory teams. The patient's nutritional journey is ongoing, and the data are accessible to all caregivers.

A group of clinical experts involved in intensive care, artificial home nutrition, and long-term alterations of consciousness listed the requirements and expectations of a CNMS:

- The list of relevant variables is flexible, customizable, visible, and actionable.
- Malnutrition scores and other calculation tools including body mass index and resting energy expenditure are included in the software.
- The current target vs. results view today is displayed (user-friendly graphical visualization) and required to adapt day-to-day nutrition prescription.
- The possibility to personalize the dashboard to allow an easy adaptation of the software according to the usage and the user profile (intensive care, home care, category of caregiver).
- There is a connectivity with nutrition pumps.
- The actual amount of nutrients administered (e.g. vitamins, amino acids) and the ratio of energy given by enteral and parenteral nutrition is visible.
- Alarms are set up for selected parameters (e.g. hypophosphatemia for the detection of refeeding syndrome). The alarm must remain a warning, with possible suggestions for intervention based on approved guidelines, but the decision to intervene and the choice of intervention must remain the practitioner's responsibility.

Such a system has been developed and tested in various settings worldwide (unpublished data).

However, significant hurdles and impediments can slow the implementation and use of CNMS, including the lack of supporting literature reporting data collected in reference institutions. Such dataset should include the impact of the use of CNMS on the workload and risk of error, and the quantification of cost-effectiveness (including the national impact of reimbursement, when applicable). Other issues to address include the compliance with the legal protective rules on privacy, the clearance by authorizing bodies (FDA or equivalent), the improvement of quality of care as judged by healthcare professionals and hospital accreditation programs. The interoperability with currently running CIS could be facilitated by the use of external modules.

In conclusion, a CNMS which combines a computerized and customizable decision support system and a pump data recorder can help to improve nutrition care by suppressing time-consuming tasks and offering actionable insights. It could be used for patients' follow-up in

hospital and home care settings, and it has the potential to federate more people around nutrition support as a critical pillar of the therapy. It also offers quality control, interesting future perspectives, and enhancements that could benefit all caregivers and, most importantly patients.

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