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Evaluation of postoperative complications in the older population

Mateusz Sitkowski[1, 2], Jakub Kenig[3]

[1]*Doctoral School in Medical and Health Sciences, Jagiellonian University Medical College, Krakow, Poland*
[2]*III Chair of General Surgery, Jagiellonian University Medical College, Krakow, Poland*
[3]*Department of General, Gastrointestinal, Oncologic Surgery and Transplantology, I Chair of General Surgery, Jagiellonian University Medical College, Krakow, Poland*

Evaluation of the frequency and severity of postoperative complications is an integral part of establishing the clinical utility of a specific treatment. They define the possible consequences resulting from the chosen method of treatment, and thus the potential risks associated with this choice. Thanks to the analysis of complications, it is possible to evaluate patients' safety, identify a problem in the course of surgery within a given hospital and surgical team or carry a financial analysis. Not only is the frequency of occurrence important, but so is the severity of complications. Therefore, in recent years we have seen the development of several new tools for assessing postoperative complications such as the Clavien-Dindo scale, the Accordion Severity Grading System, the Postoperative Morbidity Index or the Comprehensive Complication Index. Analysis of the above-mentioned scales may contribute to the development of clear algorithms for the management of older patients at increased risk of severe complications and higher mortality, which subsequently may lead to increased efficacy and safer treatment in this population.

Key words: postoperative complications, elderly, Accordion Severity Grading System, Postoperative Morbidity Index, Comprehensive Complication Index

Evaluation of the frequency and severity of postoperative complications is an integral part of establishing the clinical utility of a specific treatment. They define the possible consequences resulting from the chosen method of treatment, and thus the potential risks associated with this choice. Thanks to the analysis of complications, it is possible to evaluate patients' safety, identify a problem in the course of surgery within a given hospital and surgical team or carry out a financial analysis [1]. Not only is the frequency of occurrence important, but so is the severity of complications. Moreover, in the long term, for a proper analysis of a given operating procedure and its modifications, it is important to report on complications in a repeatable manner [2]. In this way the decision-making process is based on evidence of higher quality. Unfortunately, for many years, scientific studies on postoperative complications focused on various data and, in many cases, did not provide information on the severity of a given complication [1, 3]. This often chaotic and, above all, inconsistent way of informing has eliminated the possibility of comparing results between work carried out on the same procedures.

Chronological age alone is no longer recognized as a reliable factor predicting the postoperative course. Significantly

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more important are elements of the Comprehensive Geriatric Assessment such us: functional activity, the presence of comorbidities, polypragmasia, nutritional, cognitive, and psychosocial status, which can allow one to determine the frailty status (being a surrogate of biological age) [4–7]. During surgery it is essential to limit the extent of trauma: conducting scheduled surgery, positioning the patient in a safe way, using minimally invasive surgical techniques, limiting intraoperative blood loss (even at the expense of prolonged surgical time), avoiding hypothermia and many more [5, 8]. These elements are particularly important in the older population with cancer, where the most important factors determining overall survival are the pathological stage of the cancer and the occurrence and severity of complications [9]. Therefore, understanding the role of the complication and their proper evaluation is crucial across this population [10].

Clavien-Dindo scale

The first notable attempt at standardization of reporting complications was proposed in the 1990s in Toronto by Clavien et al. [11]. Negative results of surgery were divided into complications, sequelae, and failures to cure. In terms of severity, the grades were distinguished depending on the treatment method needed due to the complication, and the incidence of permanent disability or death [12]. The authors did not try to create a numerical scale. The Toronto 1992 complication grading system (T92) was a 4-grade scale with the grade 2 divided into levels A and B (pharmacological or surgical treatment needed). The first grade included all complications that could be resolved by interventions at the patient's bedside, without the need to intervene in the operating theater. The second grade had two subcategories and featured potentially life threatening complications. In the case of complications that left a permanent mark on the patient, they were classified into the third grade. In the event of a patient's death, the case was allocated to grade 4 [11].

The above scale was the first attempt at organizing a way of communicating the severity of complications; the proposed system became widespread. Unfortunately, due to the imprecise definitions and unclear descriptions in these classification systems, much of the work published in the past are difficult to compare or unreliable. Researchers in various fields of surgery modified the T92 scale and adapted it to a specific procedure, a patient's disease, or type of complication. However, T92 modified scales differ significantly and through the multiplicity of cut-off points, comparisons between studies are often impossible [12].

The development of the Clavien-Dindo scale led to clearer structuring on this issue. The 5-grade classification includes 7 levels of severity of complications (tab. I) [12, 13]. The refinement of the T92 scale consisted of additional information on the need to use general anesthesia in the treatment required to deal with the complication, and whether it was necessary to admit to the Intensive Care Unit (ICU) due to organ failure [12, 13]. This modification significantly improved the reporting of postoperative complications, but the obvious drawbacks of this scale should also be noted. The Clavien-Dindo scale only reports one, i.e. the most serious, complication of a patient after treatment [3, 14]. Other, less serious complications are ignored and the patient's picture after treatment is incomplete. Similar modifications by various researchers, as with the T92 scale, were made to the Clavien-Dindo scale [2]. The most common modification reduced the number of severity levels to make it simpler and less complex, or to adapt it to a particular disease. Moreover, only recently scales were proposed which would provide statistical information about the severity of complications, however, there is still no consensus on the common use of the selected scale.

Defining an appropriate tool for assessing postoperative complications in patients, regardless of their health status or age group, remains a research problem. As research shows, the demand for a universal tool in this matter is growing, which

Table I. Dindo et al. Classification of Surgical Complications [7]

Grade		Definition
I		Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions.
II		Requiring pharmacological treatment with drugs other than such allowed for grade 1 complications. Blood transfusions and total parenteral nutrition are also included.
III	a	Requiring surgical, endoscopic or radiological intervention not under general anesthesia.
	b	Requiring surgical, endoscopic or radiological intervention under general anesthesia.
IV	a	Life-threatening complications (including CNS complications) requiring IC/ICU management. Single organ dysfunction (including dialysis).
	b	Life-threatening complication (including CNS complications) requiring IC/ICU management. Multi-organ dysfunction.
V		Death of the patient.
suffix d		If the patient suffers from a complication at the time of discharge, the suffix "d" (for "disability") is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication.

CNS – central nervous system, IC – intensive care, ICU – intensive care unit

can be seen in the number of citations of publications on the scales of postoperative complications. The demand for such a tool is great across multiple fields, not only general surgery, but in every operational field with many scientific publications reporting on a demand in urology and gynecology [12, 15, 16]. When considering the universality of a given scale, it is fundamental for it to be possible to use both in large studies and in those with a smaller number of patients or complications so that the results are comparable. For this reason, in recent years we have seen the development of several new tools for assessing postoperative complications such as the Accordion Severity Grading System (ASGS), the Postoperative Morbidity Index (PMI) or the Comprehensive Complication Index (CCI).

Accordion system

In a 2009 study, Strasberg et al. proposed a new scale based on the modification of the T92 and Clavien-Dindo classifications under the name the Accordion Severity Grading System. Since the introduction of the two previous scales, their use has steadily increased over time, but reporting in individual studies was often inconsistent. Due to the authors' observations of the studies published in the past, they noted the frequent tendency to combine the levels or even shorten the Clavien-Dindo or T92 scales, which often correlated with the number of patients or their complications included [12, 17, 18]. Therefore, the Accordion system is slightly different, depending on the sample size. The contracted version for smaller studies includes 4 grades: mild, moderate, severe, death (tab. II). The expanded classification for larger studies, often with more complex operating procedures in the research, includes 6 grades. The difference comes from dividing grade 3 (severe complication) into 3 additional categories: invasive procedure without general anesthesia, invasive procedure under general anesthesia, organ system failure (tab. III) [12].

In order to simplify the scales, both versions of Accordion do not contain separate levels, which was often omitted in previously published scientific papers. The authors also proposed a graphical version of the scale presentation in the form of a table to facilitate clarity and standardize the format of reporting the severity of complications. A clear limitation of the table, as the authors noted, is that it is only feasible in single arm studies [12].

Accordion was the first response to the previous widely used and recognized classifications: T92 and Clavien-Dindo. It focused on introducing solutions that were more concise and adapted to the type and size of the study, hence the name of the scale – Accordion. In successively published papers, the ASGS turned out to be a good tool in assessing the severity of complications, and thanks to the systematization of the reporting method, it enabled reliable comparisons between them [19]. Its positive correlation with the length of hospital stay and the economic aspects of treatment was also assessed [20]. It is necessary to note some disadvantages of this classification. It is a system that evaluates the severity of complications based on the required form of treatment to counter the complication – similar to the previous scales. It is

Table II. Accordion Severity Classification of Postoperative Complications: Contracted Classification [6]

Mild complication	Requires only minor invasive procedures that can be done at the bedside, such as insertion of intravenous lines, urinary catheters, and nasogastric tubes, drainage of wound infections. Physiotherapy and the following drugs are allowed – antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.
Moderate complication	Requires pharmacologic treatment with drugs other than such allowed for minor complications, for instance antibiotics. Blood transfusions and total parenteral nutrition are also included.
Severe complication	All complications requiring endoscopic or interventional radiologic procedures or re-operation as well as complications resulting in failure of one or more organ systems.
Death	Postoperative death.

Table III. Accordion Severity Classification of Postoperative Complications: Expanded Classification [6]

Mild complication	Requires only minor invasive procedures that can be done at the bedside such as insertion of intravenous lines, urinary catheters, and nasogastric tubes, drainage of wound infections. Physiotherapy and the following drugs are allowed – antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.
Moderate complication	Requires pharmacologic treatment with drugs other than such allowed for minor complications, for instance antibiotics. Blood transfusions and total parenteral nutrition are also included.
Severe: invasive procedure without general anesthesia	Requires management by an endoscopic, interventional procedure or re-operation without general anesthesia.
Severe: operation under general anesthesia	Requires management by an operation under general anesthesia.
Severe: organ system failure	Such complications would normally be managed in an increased acuity setting, but in some cases patients with complications of lower severity might also be admitted to an ICU.
Death	Postoperative death.

not a quantitative classification in which the complication can be assigned a numerical value. Even though it is difficult not to match the appropriate form of treatment, its initiation depends on the subjective assessment of the patient's physician [20]. One of the ways to deal with the situation was proposed by Jung et al. [17]. Due to the precise determination of complications after gastrectomy due to gastric cancer, with the appropriate assignment of the method used to eliminate adverse effects, the possible ambiguity of the choice of the procedure by the surgeon was eliminated. It should be noted that the system can be adapted to many procedures in the field of surgery. It is better defined than its predecessors, but it cannot be specified as a fully universal scale.

An attempt to modify the Accordion Severity Grading System towards the quantitative scale was made by Porembka et al. using the severity weighting method before the actual publication of the original Accordion classification [18]. Questionnaires were sent to surgical outcome experts at US hospitals, containing 12 cases, corresponding to 6 levels of the expanded ASGS (2 cases for each level). As the system was not published then, experts were not able to follow it. They were asked to rate the cases on a scale of 0–100 (0 no complication, 100 death). After analyzing the returned questionnaires, it was decided to revise the Accordion scale due to the identification of a false-positive type error [18]. In their responses, the experts did not distinguish between single organ system failure and a need for reoperation under general anesthesia in a statistically significant manner. Thus, the criteria for grade 4 were improved and single-organ failure was included in it. It should be noted that the severity weighting method did not affect the interpretation of the contracted Accordion scale.

The study describing the modification of the expanded Accordion scale initiated the development of the Postoperative Morbidity Index (PMI). This revised system was still not a fully quantitative scale, but only a refinement of the Accordion Severity Grading System, another stage before the creation of a fully numerical scale.

Postoperative Morbidity Index

In another publication, Strasberg et al, based on deriving utility weights, proposed a new classification: the Postoperative Morbidity Index. In their study, they recommended the Index as a useful tool in the quantitative assessment of morbidity for surgical procedures [21]. Based on five surgical procedures and their possible extensions, the use of PMI was assessed. A selection of 636 cases were analyzed by 2 independent reviewers and complications were assessed based on the modified expanded Accordion Severity Grading Scale. The analysis included the following procedures: hernia repair, appendectomy, laparoscopic colectomy, hepatectomy, and pancreaticoduodenectomy. PMI scores were respectively: 0.005, 0.031, 0.082, 0.145, 0.150 [21]. The extension of the procedures had a significant impact on the change in the index value. When a hepatectomy was performed with a colectomy, the PMI increased to 0.468. It is worth mentioning that two reviewers evaluating the complications from selected cases using the Accordion Severity Grading System had an initial concordance above 98%. The very process of calculating the index is to match the grade to a given complication, taking into account its weight assigned to each of the 6 accordion levels (tab. IV).

Table IV. Accordion Classification System with Severity Weights [14, 17]

grade 1	0.110
grade 2	0.260
grade 3	0.370
grade 4	0.600
grade 5	0.790
grade 6	1.000

There are two ways to calculate and interpret the PMI. In the first case, the weights of complications of all patients of a given procedure are summed up and divided by the number of patients; in the second case, they are divided by the number of patients who had any complications at all. As a result, the first method informed us of chance of developing a complication after a given operation per case. The second method informed us of the estimated percentage of cases that might develop a complication, and, when it does occur, its severity is X [21].

PMI also facilitates observing the difference between surgical procedures, which differ both in the frequency of occurrence of a given complication as well as their severity for a given operation. Thanks to this new index, it is possible to identify trends in the occurrence of complications in given procedures and thus compare the quality of treatment within a given hospital over time [22]. It can also indicate the direction of successive studies due to differences in its values, as in the case of the modification of a procedure. Appropriate analysis and knowledge of the index scores by the attending physician gives a better opportunity to present to the patient the potential risk resulting from a given operation [23]. It was the first semi-quantitative scale which was not achieved in the previously described tools. M.K. Lee et al., who analyzed PMI in patients undergoing distal pancreatectomy, showed that the incidence of postoperative complications does not necessarily reflect the severity of these complications [24]. Thanks to the countability of this index, the results can be presented in a transparent manner.

Following the publication of the revised expanded ASGS and PMI, an implementation evaluation in urology procedures was undertaken. Based on the evaluation of complications in 654 cases from 11 urological procedures, using the expanded Accordion Severity Grading System, the PMI was calculated for each procedure. Beilan et al. positively verified the possibility of using the PMI as a tool to assess the severity of postoperative

complications within their institution [25]. They also pointed to the opportunity of using this as a signaling factor for the need for further studies to determine the causes of complications in transurethral prostatectomy.

Despite the positive feedback, PMI still has some limitations. It still takes into account only the highest grade of complication per patient. Thus, there is a possibility of misinterpretation of PMI in patients with many different complications. It is also not a tool that sufficiently assesses the risk and possible severity of a given complication in an individual patient. Remember that the index is based on the ACS-NSQIP system, which only reports complications of the procedure entered into the system as a template, and does not necessarily report all actual complications [26]. Moreover, possible differences in the characterization of complications between ACS-NSQIP and the institutional database have been demonstrated [27]. An attempt to interpret it in terms of a different type of surgery carries the risk of the subjective assessment of those persons conducting the study. Risk adjusted PMI may help to verify the reasons for the change in the index results, like the characteristics of patients or even the improvement of the quality of provided treatment.

Comprehensive Complication Index

The newly created scale proposed by Slankamenac et al. is the Comprehensive Complication Index (CCI) [28]. It is a system based on the Clavien-Dindo classification. Severity, unlike previous studies, has been analyzed and revised by both patients and doctors using the given questionnaires. Based on 30 selected cases, 227 patients and 245 doctors rated severity using a numerical analogue scale from 0 (best) to 100 (worst). Cases corresponded to the five most common complications in the Clavien-Dindo grades I–IVb. Grade V, with is the patient's death, which was omitted in the questionnaires.

The two main reasons for developing the CCI are for the scale to be fully quantitative rather than ordinal and to include all complications in a single patient. The second reason is to distinguish it from previously created scales, such as the Clavien-Dindo, Accordion or PMI. One of the main problems was trying to create an appropriate mathematical formula. It would have to differentiate between the series of moderate complications of a given case and the severity of single complication but with greater health consequences. For this purpose, a method known from economic sciences was used: "operation risk index" [28]. In using this method to assess the severity of postoperative complications, more severe complications were assigned higher severity values than lesser complications. The index was created from the summed values. Due to the theoretically countless possible number of complications and thus the high values that CCI could achieve, which would definitely reduce the usefulness and ease of reporting of the scale, the authors decided to transform it so that it was within the limits of 0–100. After all the modifications, the formula for calculating CCI is as follows: $CCI = \sqrt{}(CW1 + CW2 ... + CWX)/2$, where CW means complication weight. An online calculator to calculate CCI is available at https://www.assessurgery.com/about_cci-calculator/.

Slankamenac et al. validated the CCI from four different perspectives. The results presented in the study demonstrated that the CCI significantly differentiates patients with complications of varying frequency. The authors also postulate the usefulness of CCI in complications observed over a longer period of time in the case of studies in which the follow-up was taken into account, and not only complications during hospital observation. The structure of the CCI makes it possible to add in a way and to take into account complications occurring later. This is not possible for other classifications because they take into account only the most serious complication, which can potentially dramatically change the perception of a given procedure. If the complication was more severe than previously reported, the entire index changes its character, however, in the case of a less significant complication, it is not taken into account when it comes to other systems.

As with the previously described scales, the CCI can be used as a tool to assess the quality of treatment within an institution or between different centers. If it is used for benchmarking, risk-adjustment is also necessary. In some centers specialized in carrying out given procedures, the characteristics of patients admitted may affect the interpretation of the CCI.

Previous studies also proved the usefulness of CCI as a more sensitive tool than traditional endpoints in detecting between-group differences [29]. Based on the 3 RCTs developed in accordance with the CONSORT guidelines, the CCI was found to be a more sensitive tool in assessing the necessary sample size to demonstrate differences than the traditional primary end points. It was shown that CCI significantly correlated with length of hospital stay and ICU stay. The possibility of using CCI to estimate the costs of potential complications was also presented.

Several of the above opinions about CCI turned out to be controversial, especially the validation methodology was questioned. Of the 3 RCTs on which the CCI was validated, only 1 used overall morbidity as the primary end point, the rest were limited to the assessment of a specific complication. Booney et al. adequately pointed out that the scales that take into account all possible complications in a given patient may, in a way, mask the results of particular specific complications in different groups [30]. The statement concerned only the CCI scale, but this may be true in relation to all collective scales reporting complications.

In subsequent years, research studies have proven a better correlation of CCI with the length of hospital stay compared to the Clavien-Dindo scale [31], the usefulness of the CCI assessment in predicting the costs of abdominal surgery [32, 33], and the increased usefulness of CCI in assessing particularly

extensive surgery over a longer period of observation of patients (up to 3 months) [34].

The CCI is the first fully quantitative scale proposed to assess the severity of complications. The authors also proposed a scale that takes into account all complications of the patient. Its modification is much easier and takes into account a patient's treatment course from the very beginning. Despite the controversy in validation, CCI is the first classification to significantly change the way of reporting postoperative complications and their severity.

Postoperative complications and the use of scales in older patients

Consistency in reporting postoperative complications and their severity is particularly important in older patients. Biological age alters both the frequency and severity of complications. In patients with frailty syndrome, the force of a potentially harmless complication can initiate a significant disruption of body homeostasis (p6, p7). Postoperative complications are a better predictor of mortality than perioperative complications, further emphasizing the need for scales. The mere occurrence of a postoperative complication affects the health status and survival of the patient even months after surgery [37]. Many papers in the past have reported prolonged hospitalization, increased perioperative mortality, increased investigations and subsequent treatments due to complications, which obviously carried over to the burden of additional costs [38, 39]. According to the literature reviewed, 25–40% of elderly patients have postoperative complications [40–42]. The most common significant complications are neurological disorders, mainly postoperative delirium as well as pulmonary complications and renal impairment [36, 41, 43]. Prolonged recovery of activity or, in many cases, some degree of loss of organ function definitely affects the organism with reduced physiological reserves. Tahiri et al. showed that only 68% of patients with postoperative complications returned to preoperative function after 6 months [40]. A comparable result was reported by Lawrence et al. who showed 63% of patients returned to preoperative performance after 6 months [44]. Postoperative complications affect the subsequent functioning of the patient, unfortunately often with varying degrees of disability and thus a reduced subjective quality of life for the patient [45]. For this reason, the assessment of the elderly patient should be done on an individual basis with an in-depth analysis of comorbidities and preoperative activity [46, 47]. The analysis of the above-mentioned scales may contribute to the development of clear algorithms for the management of patients at increased risk of severe complications and higher mortality, thereby leading to increased efficacy and safety of treatment.

Currently, few studies address the use of the scales described above in patients with frailty syndrome. Artiles-Armas et al. demonstrated the correlation of frailty and CCI [48]. They also indicated efficacy in predicting the emergence of additional complications of greater severity when complications were initially present. The correlation of CCI with long-term overall survival in patients 65 years of age and older undergoing colorectal cancer resection has also been demonstrated [49]. In the same study, CCI was shown to have a similar predictive value for long term overall survival as that of CDC. Carli et al. used CCI to evaluate postoperative complications in frail patients when comparing the implementation of a prehabilitation program versus postoperative rehabilitation in patients undergoing resection for colorectal cancer [50]. It is necessary to include the follow-up in the reporting of surgical complications. If the assessment of complication frequency and severity is closed after the hospital stay, data on complications resulting from the implemented intervention are lost. Ommundsen et al. in their study indicated that if had it not been for a 30-day follow-up, they would not have known about the 19% of frail patients who had complications only after the end of their ward stay while expressing no symptoms during hospitalization [51]. Further studies and applications of indexes in frail patients are needed to compare their effectiveness. The next step should also be to determine the magnitude or ratio of intraoperative and postoperative complication scales. Such attempts have already been made, where Kinaci et al. found the predictive value of intraoperative complications described by the CLASSIC (Classification of Intraoperative Complications) scale relative to the postoperative complications described by the ASGS. The correlation was particularly pronounced in the higher grades [52]. The use of appropriate scales of postoperative complications and their severity unifies reporting and thus contributes to increased knowledge of the risks associated with a given operation. This is particularly important in frail patients, where the margin for error is even smaller and may be associated with irreversible functional deterioration in such a patient.

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Mateusz Sitkowski
Jagiellonian University Medical College
III Chair of General Surgery
ul. Prądnicka 35–37
31-202 Kraków, Poland
e-mail: mateusz.sitkowski@yahoo.com

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References

1. Krosch TCK, D'Cunha J. Comparing apples to apples: a call for unification of complication reporting across health systems. Semin Thorac Cardiovasc Surg. 2010; 22(4): 271–273, doi: 10.1053/j.semtcvs.2011.01.002, indexed in Pubmed: 21549265.
2. Martin RCG, Brennan MF, Jaques DP. Quality of complication reporting in the surgical literature. Ann Surg. 2002; 235(6): 803–813, doi: 10.1097/00000658-200206000-00007, indexed in Pubmed: 12035036.
3. Brennan MF. Postoperative complication reporting: more than mortality and morbidity. Ann Surg. 2013; 258(1): 8–9, doi: 10.1097/SLA.0b013e318297a1e7, indexed in Pubmed: 23728279.

4. Kenig J. Oncogeriatrics (part 2.). Normal and pathological ageing. Nowotwory. Journal of Oncology. 2019; 69(3-4): 146–149, doi: 10.5603/njo.2019.0027.
5. Fried TR, Van Ness PH, Byers AL, et al. Changes in preferences for life-sustaining treatment among older persons with advanced illness. J Gen Intern Med. 2007; 22(4): 495–501, doi: 10.1007/s11606-007-0104-9, indexed in Pubmed: 17372799.
6. Kenig J. Oncogeriatrics (part 4.) Pre-operative assessment of elderly patients with cancer. Nowotwory. Journal of Oncology. 2020; 70(1): 16–19, doi: 10.5603/njo.2020.0003.
7. Skorus U, Kenig J. Oncogeriatrics (part 5.) The role of comorbidities in older patients with cancer. Nowotwory Journal of Oncology. 2020; 70(2): 54–59, doi: 10.5603/NJO.2020.0013.
8. Kristjansson SR, Nesbakken A, Jordhøy MS, et al. Comprehensive geriatric assessment can predict complications in elderly patients after elective surgery for colorectal cancer: a prospective observational cohort study. Crit Rev Oncol Hematol. 2010; 76(3): 208–217, doi: 10.1016/j.critrevonc.2009.11.002, indexed in Pubmed: 20005123.
9. Kenig J. Oncogeriatrics (part 1.). Frailty in older adults with cancer. Nowotwory. Journal of Oncology. 2019; 69(2): 55–57, doi: 10.5603/njo.2019.0010.
10. Kenig J. Oncogeriatrics (part 3.) Influence of surgical trauma on older patients. Nowotwory. Journal of Oncology. 2019; 69(5-6): 163–167, doi: 10.5603/njo.2019.0030.
11. Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. Surgery. 1992; 111(5): 518–526, indexed in Pubmed: 1598671.
12. Strasberg SM, Linehan DC, Hawkins WG. The accordion severity grading system of surgical complications. Ann Surg. 2009; 250(2): 177–186, doi: 10.1097/SLA.0b013e3181afde41, indexed in Pubmed: 19638919.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004; 240(2): 205–213, doi: 10.1097/01.sla.0000133083.54934.ae, indexed in Pubmed: 15273542.
14. Li J, Moustafa M, Freiwald-Bibiza E, et al. Is It Feasible to Standardize a Composite Postoperative Complication Reporting System for Liver Resection? J Gastrointest Surg. 2020; 24(12): 2748–2755, doi: 10.1007/s11605-019-04457-w, indexed in Pubmed: 31792904.
15. Mitropoulos D, Artibani W, Biyani CS, et al. Validation of the Clavien-Dindo Grading System in Urology by the European Association of Urology Guidelines Ad Hoc Panel. Eur Urol Focus. 2018; 4(4): 608–613, doi: 10.1016/j.euf.2017.02.014, indexed in Pubmed: 28753862.
16. Radosa MP, Meyberg-Solomayer G, Radosa J, et al. Standardised Registration of Surgical Complications in Laparoscopic-Gynaecological Therapeutic Procedures Using the Clavien-Dindo Classification. Geburtshilfe Frauenheilkd. 2014; 74(8): 752–758, doi: 10.1055/s-0034-1382925, indexed in Pubmed: 25221343.
17. Jung MiR, Park YK, Seon JW, et al. Definition and classification of complications of gastrectomy for gastric cancer based on the accordion severity grading system. World J Surg. 2012; 36(10): 2400–2411, doi: 10.1007/s00268-012-1693-y, indexed in Pubmed: 22752074.
18. Porembka MR, Hall BL, Hirbe M, et al. Quantitative weighting of postoperative complications based on the accordion severity grading system: demonstration of potential impact using the american college of surgeons national surgical quality improvement program. J Am Coll Surg. 2010; 210(3): 286–298, doi: 10.1016/j.jamcollsurg.2009.12.004, indexed in Pubmed: 20193891.
19. Low DE, Kuppusamy M, Hashimoto Y, et al. Comparing complications of esophagectomy and pancreaticoduodenectomy and potential impact on hospital systems utilizing the accordion severity grading system. J Gastrointest Surg. 2010; 14(11): 1646–1652, doi: 10.1007/s11605-010-1325-5, indexed in Pubmed: 20824376.
20. Carrott PW, Markar SR, Kuppusamy MK, et al. Accordion severity grading system: assessment of relationship between costs, length of hospital stay, and survival in patients with complications after esophagectomy for cancer. J Am Coll Surg. 2012; 215(3): 331–336, doi: 10.1016/j.jamcollsurg.2012.04.030, indexed in Pubmed: 22683069.
21. Strasberg S, Hall B. Postoperative Morbidity Index: A Quantitative Measure of Severity of Postoperative Complications. J Am Coll Surg. 2011; 213(5): 616–626, doi: 10.1016/j.jamcollsurg.2011.07.019.
22. Tahkola K, Väyrynen V, Kellokumpu I, et al. Critical evaluation of quality of hepatopancreatic surgery in a medium-volume center in Finland using the Accordion Severity Grading System and the Postoperative Morbidity Index. J Gastrointest Oncol. 2020; 11(4): 724–737, doi: 10.21037/jgo.2020.04.03, indexed in Pubmed: 32953156.
23. Datta J, Lewis RS, Strasberg SM, et al. Quantifying the burden of complications following total pancreatectomy using the postoperative morbidity index: a multi-institutional perspective. J Gastrointest Surg. 2015; 19(3): 506–515, doi: 10.1007/s11605-014-2706-y, indexed in Pubmed: 25451733.
24. Lee MK, Lewis RS, Strasberg SM, et al. Defining the post-operative morbidity index for distal pancreatectomy. HPB (Oxford). 2014; 16(10): 915–923, doi: 10.1111/hpb.12293, indexed in Pubmed: 24931404.
25. Beilan J, Strakosha R, Palacios DA, et al. The Postoperative Morbidity Index: a quantitative weighing of postoperative complications applied to urological procedures. BMC Urol. 2014; 14: 1, doi: 10.1186/1471-2490-14-1, indexed in Pubmed: 24383457.
26. American College of Surgeons NSQIP Data User Guide 2015.
27. Epelboym I, Gawlas I, Lee JA, et al. Limitations of ACS-NSQIP in reporting complications for patients undergoing pancreatectomy: underscoring the need for a pancreas-specific module. World J Surg. 2014; 38(6): 1461–1467, doi: 10.1007/s00268-013-2439-1, indexed in Pubmed: 24407939.
28. Slankamenac K, Graf R, Barkun J, et al. The comprehensive complication index: a novel continuous scale to measure surgical morbidity. Ann Surg. 2013; 258(1): 1–7, doi: 10.1097/SLA.0b013e318296c732, indexed in Pubmed: 23728278.
29. Slankamenac K, Nederlof N, Pessaux P, et al. The comprehensive complication index: a novel and more sensitive endpoint for assessing outcome and reducing sample size in randomized controlled trials. Ann Surg. 2014; 260(5): 757–62; discussion 762, doi: 10.1097/SLA.0000000000000948, indexed in Pubmed: 25379846.
30. Boney O, Moonesinghe R, Grocott M. Reply to Slankamenac et al's Comprehensive Complication Index Validation Study. Ann Surg. 2016; 264(2): e11, doi: 10.1097/SLA.0000000000001288, indexed in Pubmed: 26079896.
31. Kim TH, Suh YS, Huh YJ, et al. The comprehensive complication index (CCI) is a more sensitive complication index than the conventional Clavien-Dindo classification in radical gastric cancer surgery. Gastric Cancer. 2018; 21(1): 171–181, doi: 10.1007/s10120-017-0728-3, indexed in Pubmed: 28597328.
32. de la Plaza Llamas R, Hidalgo Vega Á, Latorre Fragua RA, et al. The Cost of Postoperative Complications and Economic Validation of the Comprehensive Complication Index: Prospective Study. Ann Surg. 2021; 273(1): 112–120, doi: 10.1097/SLA.0000000000003308, indexed in Pubmed: 30985367.
33. Smeyers KM, Slankamenac K, Houben B, et al. Comparison of the Clavien-Dindo and Comprehensive Complication Index systems for grading of surgical complications after colorectal resections. Acta Chir Belg. 2021 [Epub ahead of print]: 1–8, doi: 10.1080/00015458.2021.1920682, indexed in Pubmed: 33910493.
34. Clavien PA, Vetter D, Staiger RD, et al. The Comprehensive Complication Index (CCI®): Added Value and Clinical Perspectives 3 Years "Down the Line". Ann Surg. 2017; 265(6): 1045–1050, doi: 10.1097/SLA.0000000000002132, indexed in Pubmed: 28486288.
35. Kenig J, Mituś J, Rapacz K. Oncogeriatrics (part 6.). The usefulness of routine preoperative investigations in the qualification of an older patient for elective surgery. Nowotwory. Journal of Oncology. 2020; 70(3): 101–104, doi: 10.5603/njo.2020.0022.
36. Kenig J, Szabat K. Oncogeriatrics (part 7.). Geriatric assessment for older patients with cancer. Nowotwory. Journal of Oncology. 2020; 70(4): 153–157, doi: 10.5603/njo.2020.0031.
37. Story DA. Postoperative complications in elderly patients and their significance for long-term prognosis. Curr Opin Anaesthesiol. 2008; 21(3): 375–379, doi: 10.1097/ACO.0b013e3282f889f8, indexed in Pubmed: 18458558.
38. Sieber FE, Barnett SR. Preventing postoperative complications in the elderly. Anesthesiol Clin. 2011; 29(1): 83–97, doi: 10.1016/j.anclin.2010.11.011, indexed in Pubmed: 21295754.
39. Gani F, Hundt J, Makary MA, et al. Financial Impact of Postoperative Complication Following Hepato-Pancreatico-Biliary Surgery for Cancer. Ann Surg Oncol. 2016; 23(4): 1064–1070, doi: 10.1245/s10434-015-5042-x, indexed in Pubmed: 26714947.
40. Tahiri M, Sikder T, Maimon G, et al. The impact of postoperative complications on the recovery of elderly surgical patients. Surg Endosc. 2016; 30(5): 1762–1770, doi: 10.1007/s00464-015-4440-2, indexed in Pubmed: 26194260.
41. Story DA, Leslie K, Myles PS, et al. REASON Investigators, Australian and New Zealand College of Anaesthetists Trials Group. Complications and mortality in older surgical patients in Australia and New Zealand (the REASON study): a multicentre, prospective, observational

study. Anaesthesia. 2010; 65(10): 1022–1030, doi: 10.1111/j.1365--2044.2010.06478.x, indexed in Pubmed: 20731639.
42. Hamel MB, Henderson WG, Khuri SF, et al. Surgical outcomes for patients aged 80 and older: morbidity and mortality from major noncardiac surgery. J Am Geriatr Soc. 2005; 53(3): 424–429, doi: 10.1111/j.1532--5415.2005.53159.x, indexed in Pubmed: 15743284.
43. Serafim RB, Dutra MF, Saddy F, et al. Delirium in postoperative nonventilated intensive care patients: risk factors and outcomes. Ann Intensive Care. 2012; 2(1): 51, doi: 10.1186/2110-5820-2-51, indexed in Pubmed: 23272945.
44. Lawrence VA, Hazuda HP, Cornell JE, et al. Functional independence after major abdominal surgery in the elderly. J Am Coll Surg. 2004; 199(5): 762–772, doi: 10.1016/j.jamcollsurg.2004.05.280, indexed in Pubmed: 15501119.
45. Gleason LJ, Schmitt EM, Kosar CM, et al. Effect of Delirium and Other Major Complications on Outcomes After Elective Surgery in Older Adults. JAMA Surg. 2015; 150(12): 1134–1140, doi: 10.1001/jamasurg.2015.2606, indexed in Pubmed: 26352694.
46. Kenig J. Oncogeriatrics (part 8.). Frailty screening tools. Nowotwory. Journal of Oncology. 2020; 70(5): 184–186, doi: 10.5603/njo.a2020.0039.
47. Kenig J, Krzeszowiak J, Kupniewski K. Postoperative functional results of older patients after pancreas and liver surgery. Nowotwory. Journal of Oncology. 2022; 72(3): 202–206, doi: 10.5603/njo.2022.0029.
48. Artiles-Armas M, Roque-Castellano C, Conde-Martel A, et al. The Comprehensive Complication Index is Related to Frailty in Elderly Surgical Patients. J Surg Res. 2019; 244: 218–224, doi: 10.1016/j.jss.2019.06.011, indexed in Pubmed: 31301477.
49. Wang D, Zhang J, Bai Z, et al. Associations of Postoperative Complications Assessed by Clavien-Dindo Classification and Comprehensive Complication Index with Long-Term Overall Survival in Elderly Patients after Radical CRC Resection. Clin Interv Aging. 2020; 15: 1939–1949, doi: 10.2147/CIA.S271969, indexed in Pubmed: 33116448.
50. Carli F, Bousquet-Dion G, Awasthi R, et al. Effect of Multimodal Prehabilitation vs Postoperative Rehabilitation on 30-Day Postoperative Complications for Frail Patients Undergoing Resection of Colorectal Cancer: A Randomized Clinical Trial. JAMA Surg. 2020; 155(3): 233–242, doi: 10.1001/jamasurg.2019.5474, indexed in Pubmed: 31968063.
51. Ommundsen N, Nesbakken A, Wyller TB, et al. Post-discharge complications in frail older patients after surgery for colorectal cancer. Eur J Surg Oncol. 2018; 44(10): 1542–1547, doi: 10.1016/j.ejso.2018.06.024, indexed in Pubmed: 30037638.
52. Kinaci E, Sevinc MM, Bayrak S, et al. Is the classification of intraoperative complications (CLASSIC) related to postoperative course? Int J Surg. 2016; 29: 171–175, doi: 10.1016/j.ijsu.2016.03.068, indexed in Pubmed: 27063858.