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General management of nonagenarian patients: a review of the literature

Romain Rivoirard[a], Cyrus Chargari[b], Jane-Chloe Trone[c], Alexander Tuan Falk[d], Jean-Baptiste Guy[c], Houda Eddekkaoui[c], Rima Lahmar[c], Cécile Pacaut[a], Benoite Mery[a], Avi Assouline[e], Pierre Auberdiac[f], Guillaume Moriceau[a], Regis Gonthier[g], Aline Guillot[a], Yacine Merrouche[a], Nicolas Magne[c]

[a] Department of Medical Oncology, Lucien Neuwirth Cancer Institute, Saint Priest-En-Jarez, France
[b] Department of Radiotherapy, Instruction Armed Val-de-Grace Hospital, Paris, France
[c] Department of Radiotherapy, Lucien Neuwirth Cancer Institute, Saint Priest-En-Jarez, France
[d] Department of Radiotherapy, Centre Antoine Lacassagne, Nice, France
[e] Department of Radiotherapy, Clinical Centre of Porte de Saint Cloud, Boulogne-Billancourt, France
[f] Department of Radiotherapy, Clinique Claude Bernard, Albi , France
[g] Department of Clinical Gerontology, University Hospital of Saint-Etienne, Charity Hospital, France

Summary

The number of nonagenarian people in the world is steadily growing. This phenomenon will increase in future years: in 2050, world population prospects estimate 71.16 million people aged 90 years or older. The two main causes of death among people aged 85 years or more in Europe in 2003 were cardiovascular and cerebrovascular diseases and cancers. However, the elderly are often excluded from clinical trials; they are underrepresented in clinical registries and especially nonagenarians. Care (medical, surgical, oncology) of these very elderly is currently insufficiently based on scientific recommendations. For the physician, the choice to treat or not to treat very elderly patients (for fear of side effects) is difficult. Oncology is particularly affected by this problem. Here we review these different fields of internal medicine management of nonagenarian patients with a special focus on oncology and on comprehensive geriatric assessment as a base for all care decision taking.

Key words: *Cancer; nonagenarian; radiotherapy; chemotherapy; internal medicine; elderly*

Introduction

The European and American populations are an aging population. According to Eurostat data, life expectancy in Europe at age 65 has increased by three years for men between 1980 and 2008 (13.1 years vs 16.1 years) and 3.2 years for women between 1980 and 2008 (16.3 years vs 19.5 years) [1]. In USA, life expectancy at age 65 has increased by 4.3 years for men between 1970 and 2006 (13.1 years vs 17.4 years) and 3.3 years for women between 1970 and 2006 (17 years vs 20.3 years) [2]. The number of nonagenarian people in the world is growing steadily: from 6.714 million people in 1995, their number rose to 12.15 million people in 2010 [3]. This phenomenon will increase in future years: in 2050, world population prospects estimate a number of 71.16 million people aged 90 years or older (medium fertility variant) [4]. These results are largely explained by advances in medicine, hygiene, public health campaigns and improved living conditions. The two main causes of death among people aged 85 years or more in Europe in 2003 were cardiovascular diseases (ischaemic heart disease: 2822 deaths/100,000 inhabitants aged 85 and over, cerebrovascular disease: 2,381 deaths / 100,000 both sexes, hypertension and diabetes) and cancers [5]. These two causes are also found in USA.

However, the elderly are often excluded from clinical trials. They are underrepresented in clinical registries and especially nonagenarians. Care (medical, surgical, oncology) of these very elderly is currently not sufficiently enough based on scientific recommendations. For the physician, the choice to treat or not to treat very elderly patients (for fear of side effects) is difficult.

Oncology is particularly affected by this problem, with treatment such as chemotherapy or radiotherapy sometimes being very toxic for the elderly. Several studies have analysed the oncological management of elderly patients [6–10] and the usefulness of geriatric assessment in the field of oncology [11–12], but articles describing cancer care in nonagenarians are rare. The literature on developing optimal medical strategy in elderly persons aged 90 or more is dominated by the theme of ischaemic heart disease [13–15] and acute ischaemic stroke [16–17]. Some articles have also studied the topic of endoscopy among nonagenarians [18–19]. Cardiovascular surgery [20–22] and orthopaedic surgery [23–24] are the two surgical fields where nonagenarians are most often cited. Improvements in surgical and anaesthesia techniques have helped to facilitate operating in this fragile population. Therefore, studies on

the medical and surgical management of nonagenarians exist but no article has brought together these results.

The objective of the present study is to conduct a review of published studies that evaluated the medical and surgical treatment of nonagenarian patients, with a special focus on oncology. Results are organised in four parts: the first part is a brief presentation of geriatric assessment tools in general and in the field of oncology, the second part is a review of studies on the medical care of the nonagenarians, especially on cardiovascular disease (ischaemic heart disease, stroke); the third part is dedicated to surgical treatment of persons aged 90 or more (Cardiac and vascular surgery, orthopaedics and bone surgery, visceral surgery, ophthalmology). Finally, the fourth part presents all studies on the treatment of cancer in nonagenarian patients.

Methods

Research and literature review of studies (prospective and retrospective) were performed from the Medline database with the following keywords: *nonagenarian, elderly patients,>90 years of age or older, cancer, ischemic heart disease, stroke, heart failure, orthopaedicsurgery, radiotherapy*, *clinical trials.*

Results

Geriatric assessment

Geriatric assessment has been used in geriatric medicine since the 1980s [25]. In a conventional geriatric population, the purpose of geriatric assessment is to identify current health problems and to assist in medical decision making in order to reduce the adverse outcomes and optimise the functional status of older adults [26–28]. This assessment considers morbidity, activities of daily living, the autonomy (phone, grocery shopping, financial transactions, etc.), cognitive abilities, depression and anxiety, nutritional status and social integration.

There are many examples of questionnaires or instruments to assess these domains: Katz index for activities of daily living, Lawton scale for instrumental activities of daily living, Charlson Comorbidity Index, Cumulative Illness Rating scale for comorbidities, Mini Mental State examination for cognitive functioning, the Geriatric Depression Scale for depression, the Mini Nutritional Assessment and Body Mass Index for nutritional assessment. In oncology, performance status can be evaluated by the Eastern Collaborative Oncology Group Scale and the Karnofsky scale.

Unlike traditional geriatric assessment, evaluation conducted in the oncology setting is directly interventional, with the aim to help physicians to choose the best cancer treatment. [29]. Indeed, the geriatric population is a heterogeneous group and a patient's chronological age does not always correlate with underlying physiological status [30]. That is why there are several schemes for classification of elderly patients according to the evolutionary risk. For example, the fit-vulnerable-frail classification developed by Balducci and Stanta [31]. In Puts MT et al. [11], a systematic review of the use of geriatric assessment in oncology was conducted. The conclusions were that geriatric assessment among elderly patients with cancer in a hospital setting remained feasible and that some domains of geriatric assessment were associated with oncological outcomes, such as treatment toxicity and mortality.

On the other hand, it has not been demonstrated that geriatric assessment had a significant impact on future cancer treatment decision making. There was a lack of consensus on what domains needed to be included in geriatric assessment and how the instruments should best be used in oncology. Moreover, there was no uniform recommendation to classifying patients in different risk groups. There was also a lack of information about the psychometric properties of the tools used in the different geriatric assessments in the studies. Finally, the overall quality of studies in the field of geriatric oncology was poor to moderate and should be improved, with focus on the realisation of randomised controlled trials.

In Hamaker ME et al. [12], the authors aimed to assess which of the frailty screening methods available show the best sensitivity and specificity for predicting the presence of impairments on Comprehensive Geriatric Assessment (CGA) in elderly patients with cancer. Of the 14 studies analysed, the Geriatric 8 (G8) and Triage Risk Screening Tool (TRST 1 +) had the highest sensitivity for frailty (respectively, 87% for G8 and 92% for TRST1 +) but both had poor specificity and negative predictive value. The conclusions were that available frailty screening methods had insufficient discriminative power to select patients for further assessment and it appeared beneficial to perform a complete geriatric assessment of every elderly patient.

Medical treatment of nonagenarian patients

Cardiovascular disease and more particularly ischaemic heart disease among nonagenarians is the most studied disease in the literature. In the article of Biondi Zoccai G et al. [13], a review of 18 articles (1082 patients) on the subject of effectiveness and tolerance of percutaneous coronary intervention (PCI) was detailed [32–49]. Among these studies, there was a great variability in patient selection, as well as features and results. The percentage of nonagenarian patients included and showing a ST-elevation myocardial infarction (STEMI) varied from 0% [37] to 100% [32, 34, 37, 39, 47] depending on the studies. Implantation of drug-eluting stents remained very different between articles (from 5% [39] to 100% [32] of patients). Most of the patients had a multivessel coronary artery disease [34, 36, 40, 46, 48]. Clinical results were accordingly highly variable, despite a median short-term (in-hospital to one month follow-up) mortality of 14% and a long term (six month to longer follow-up) mortality of 18%. The long term rate of major adverse cardiac events (usually defined as the composite of death, myocardial infarction or target lesion revascularisation) was not much higher than the long term death rate alone, suggesting that in these patients, restenosis does not seem to be a major clinical issue. The conclusion of this review of the literature was that PCI is feasible in carefully selected nonagenarians.

The recommendations encourage prescribing maximal medical therapy including aspirin, an angiotensin-converting enzyme inhibitor, a beta-adrenergic receptor blocker, a P2Y12 blocker and a statin before PCI. The radial access

should be encouraged, because the risks of fatal and non-fatal complications (bleeding, dissection, perforation or thrombosis) are less important than femoral access. Finally, bare metal stents are recommended for PCI because they have a superior safety profile. Some articles recently published confirmed these results with the increasingly frequent use of PCI in nonagenarians with STEMI [14–15].

In the article of Skolnick AH et al. [50], results based on a large population of 5,557 patients aged 90 years or older with non-ST-segment elevation acute coronary syndrome confirm that increasing adherence to guideline recommended therapies was associated with decreased mortality. Koster NK et al. [51] analysed the echocardiographic data by gender among nonagenarians with cardiovascular disease: 431 consecutive nonagenarians underwent transthoracic echocardiography (73% women vs 27% men). Men were more likely to have coronary artery disease (45% vs 36%, p = 0.03), an impaired left ventricular (LV) ejection fraction (51% vs 40%, p <0.04), a lower mean LV ejection fraction (50% vs 54%, p = 0.01), and regional wall motion abnormalities (31% vs 19%, p = 0.009), whereas women were more likely to have hypertension (76% vs 52%, p = <0.0001), LV hypertrophy (82% vs 72%, p <0.001), severe left atrial enlargement (31% vs 16%, p = 0.004), moderate to severe mitral annular calcification (22% vs 10%, p = 0.006), and tricuspid regurgitation (70% vs 51%, p = 0.002).

In the article of Seo KW et al. [52] it was shown that the frequency (42/43 (97%) vs 9/51 (17%), p <0.0001) and width (0.52 ± 0.17 mm vs 0.05 ± 0.13 mm, p <0.0001) of mitral annular calcification (MAC) were significantly higher among nonagenarians compared with younger subjects (36 ± 9 years), suggesting that MAC is an indicator of degenerative changes of the heart associated with age. However, the study of Van Bemmel T et al. [53] noted that the nonagenarian population had a high prevalence of significant valvular heart disease (57/81 patients; 70%), in the presence of preserved systolic left ventricular (LV) function without LV dilatation. The presence of significant valve disease did not impact negatively on the ability to perform activities of daily living, assessed by the Groningen Activity Restriction Scale (GARS). The authors therefore advised caution before initiating any medical or surgical intervention in these valvulopathies among nonagenarians.

As regards ischaemic stroke in patients aged 90 years or more, some studies have observed the effect of thrombolysis in emergency among this population (intravenous tissue plasminogen activator: tPA) [16, 17, 54–56]. The retrospective study of Mateen FJ et al. [54] showed that only two of the 22 patients included and treated with tPA had a favourable outcome (9% of patients) after the follow-up of 30 days. Effective outcome of intravenous tPA was quantified using the Barthel Index (BI) and modified Rankin Scale (mRS). Thirty-day survival was 55% and 90-day survival was 41%.

In the articles of Sarikaya H et al. [17] and Mateen FJ et al. [55], safety and functional outcome in nonagenarian patients treated by thrombolysis have been evaluated and compared to the outcome of octogenarian patients. In Sarikaya H et al., forty six nonagenarians (mean age 92, range 90–99 years) and 238 octogenarians (mean age 83, range 80–89 years) were eligible. Only six of 42 nonagenarians (14%) achieved a favourable outcome at three months, whilst clinical outcome was favourable in 30% of octogenarians (p = 0.034). In addition, patients aged 90 years or more had a higher incidence of mortality at three months than did patients age 80 to 89 years (45.2% vs 22.1%, p = 0.002).

In contrast, *post hoc* analysis of the Canadian Activase for Stroke Effectiveness Study (CASES) [55] showed similar functional outcomes at 30 days in nonagenarians as compared with octogenarians (30% vs 26% p = 0.647) and the rates of symptomatic intracerebral haemorrhage (nonagenarians 7% vs 4% octogenarians, p = 0.359) and 90-day mortality (52% vs 33%, p = 0.087) were not statistically different.

In conclusion, the various authors agree that these few studies do not allow judgment of the efficacy and safety of intravenous thrombolysis in nonagenarians with an ischaemic stroke. Poor outcome and death rates are higher among these patients and access to thrombolysis should be reserved for carefully selected nonagenarians. Randomised controlled trials (IST-3 TESPI) should provide conclusive results on the efficacy and safety of thrombolysis among the nonagenarians and octogenarians.

In the field of gastroenterology, several publications have examined the feasibility of therapeutic endoscopic retrograde cholangiopancreatography (ERCP) [18, 19, 57–61]. Indeed, the incidence of choledocholithiasis increases with age, and as life expectancy is rising, it is expected that the prevalence of advanced age patients with bile duct stones will correspondingly increase. Most studies have compared the efficacy and tolerance of ERCP among nonagenarians and among younger patients (aged 70–89 years) [19, 57, 58, 61]. The overall results show a profit / risk ratio favourable for ERCP, with no ERCP related death. The post endoscopic retrograde cholangiopancreatography complication rates were low in both groups (4.7% to 12% in nonagenarians according to studies and 7 to 8.4% in younger patients, with no statistically significant difference).

On the other side, in the article of Christoforidis E et al. [19], complete bile duct stone clearance was achieved in 24.2% of nonagenarian patients and in 90.8% of younger patients (p <0.001). These results are not found in other studies with complete clearance of biliary stones systematically superior to 62% in patients aged 90 years or more.

Surgical treatment of nonagenarian patients

Some studies have evaluated the feasibility and safety of many cardiac surgical procedures [20–22] and vascular interventions, particularly the repair of aneurysms and carotid endarterectomies [62–73].

Concerning the treatment of abdominal aortic aneurysms (AAA), it has been shown that endovascular repair (EVAR) is associated with lower perioperative morbidity and mortality compared to open surgery for abdominal aortic aneurysm (AAA) in a patient population aged less than 90 years [62]. In the literature, the EVAR technique was analysed in nonagenarians [62–68]. In the study of Baril et al. [63], 18 male nonagenarians were included. Immediate technical success was 100%. There were two (11%) peri-

operative (<30 days) deaths. Mean survival in patients who expired during the follow up period beyond the first 30 days was 34 months (range 8–78). Survival times following successful hospital discharge seems to be significant. In Geibüsch P et al. [64], the goal of their article was to present short and midterm results of EVAR in octogenarians and nonagenarians and to compare this results to a younger patients group (total n = 967 patients, 279 patients older than 80 years). Surgical success rate was higher in the group of octogenarians (252 patients) compared to the group of nonagenarians (27 patients): 96% versus 85% respectively. Thirty-day mortality was significantly higher for patients >80 years old (2.8% vs 1.0% for younger patients; p = 0.044). Survival in nonagenarians at one and three years was 96.3% ± SE 4% and 60.6% ± SE 10.4%.

In conclusion, EVAR in octogenarians and nonagenarians is a feasible technique that is associated with a significantly higher but still low perioperative mortality compared to younger patients. The author indicates that age >80 years should not be an exclusion criteria for EVAR. These findings are confirmed for nonagenarians in the two articles of Prenner SB et al. [65] and Goldstein et al. [66]. Among results of this last study, we can see that cumulative survival rates at 12–, 24–, and 36–month reach 83%, 64%, and 50%, respectively. Survival seemed to be better in patients with <5 comorbidities. On the other side, Jim J et al. [67] found a higher mortality rate at one month (5.6%) and one year (41.2%), which raises the question of possible EVAR futility in this very aged population.

The carotid endarterectomy (CEA) is an important therapeutic option in addition to drug treatment in patients with symptomatic carotid stenosis (stenosis + ipsilateral stroke or transient ischaemic attack <6 months). This procedure can also be proposed for asymptomatic carotid stenosis (stenosis >60%). Nevertheless, few data are available on the effectiveness of CEA in nonagenarians. In the article of Lichtman JH et al. [69], 6,446 CEA in patients 90 years or more were observed over a period of seven years (1993–1999). The annual number of operations increased from 481 in 1993 to 1,257 in 1999 for nonagenarians. The observed rate of CEA growth was greater than the population growth over this time interval for this age group. Perioperative mortality was 3.3% among nonagenarians. Long term mortality increased by approximately 10% per year after the operation, and was 56% in the nonagenarian group at five years. Perioperative mortality rates remained relatively stable over the seven year period, but were higher than those reported from randomized trials that excluded very elderly patients. Perioperative mortality was 3.1% among 64 patients in one study [70] and 30 day mortality rates ranged from 0 to 6.3% in other studies [71–72].

The efficacy and safety of cardiac surgery in nonagenarians has been discussed in many studies [20, 21, 22, 74–87]. Increasing life expectancy and improvement in operative techniques as well as postoperative care have contributed to an increasing number of elderly and very elderly requiring cardiac surgical procedures. The main operations studied were: coronary artery bypass grafting (CABG), aortic valve replacement (AVR) and CABG +AVR association [20, 21, 22, 80, 81, 83, 84, 85]. According to studies, postoperative mortality rate at 30 days ranges from 5% of the patients studied [75] to 20% of the patients [81]. Mortality was detailed by type of surgery in some studies [20–22].

In the article of Bridges CR et al. [20], in 1,097 patients, the operative mortality was 11.8% in nonagenarians who underwent CABG, 11.4% for AVR and 12% for CABG + AVR association. The main postoperative complications were: cardiac arrhythmia, stroke, post-operative bleeding, renal failure, respiratory failure, pneumonia, infection (sepsis, wound infection), myocardial infarction and surgical reintervention [21, 75, 80, 83, 84]. In some cases, risk factors for mortality after surgery were identified: emergency cardiac surgery, chronic renal failure, low preoperative ejection fraction, mitral regurgitation, antecedent of stroke, antecedent of surgery, antecedent of myocardial infarction, combined procedures (CABG + AVR, for example) and a history of peripheral vascular disease [20, 22, 75, 81, 85, 86]. However, cardiac surgery led to a significant improvement in the quality of life experienced by patients, with decreased dyspnoea and pain of coronary origin [22, 79, 81].

Two studies have analysed the transcatheter aortic valve implantation (TAVI), a possible alternative to conventional surgery in nonagenarians with severe comorbidities [74, 87]. In the first study [74], among the 11 patients in the study, all causes and cardiovascular mortality was 27.3% (n = 3) and 9.1% (n = 1), respectively (30 follow up). In the second study [87], the effectiveness of TAVI technique was compared between a first group of patients <90 years and a second group aged 90 years or more. The rate of procedural success and 30 day and 6 month mortality were not different between the two age groups (96% vs 100%, p = 0.58, 6% vs 15%, p = 0.22, and 14% vs 27%, p = 0.14, respectively).

A further study has evaluated the safety of pacemaker implantation among nonagenarian patients and they have been compared to younger patients [82]. Among the 115,683 patients in the study, 12,917 were aged 90 years or more. The unadjusted mortality and complication rates in patients aged 70 to 79 years were 0.60% (confidence interval [CI] 0.53%–0.67%) and 5.61% (CI 5.40%–5.82%), respectively, and in patients aged >90 years were 1.87% (CI 1.63%–2.11%) and 6.31% (CI 5.89%–6.72%). Multivariable analysis revealed that severe comorbidity (odds ratio 5.00, 95% CI 4.05–6.17) was a greater predictor of mortality than increasing age (odds ratio 2.81 per decade, CI 2.35–3.35) (all p <0.001).

In the field of orthopaedic surgery, most studies have focused on hip fractures among patients aged 90 years or more [23, 88–103]. Most of these fractures occur after one or more falls in people with osteopenia or osteoporosis, the consequences of these injuries are a loss of independence and increased mortality [95]. The majority of studies analysed the 30 day mortality or in hospital mortality, after orthopaedic surgery. The results ranged from 4.7% to 24% according to studies [91, 92, 94, 95, 98]. Transfusion requirements during and after surgery ranged from 31% [90] up to 80% of nonagenarians [89]. The rate of postoperative complications remained high among this vulnerable population: 12% [92] to 63% of nonagenarians [101]. Predictor factors of mortality were: cognitive impairment, dependen-

ce on others and especially for personal toilet, extracapsular fractures, an ASA score >2 [88, 96, 103].

In the article of Hagino T et al. [93], the authors have examined the walking ability and survival of patients aged 90 years and older who sustained proximal femoral fractures, and they have compared these findings with those of younger patients reported in previous studies. The results showed that among a total of 56 nonagenarians, 45 were able to walk with or without a cane before the injury. On discharge, 22 patients were ambulatory, and thus, the rate of regaining walking ability was equal to 49%. On the other side, among the ten patients who have received only conservative treatment, all of them failed to complete the rehabilitation programme and were wheelchair-bound (n = 5) or bed-bound (n = 5) on discharge. Some predictive variables for independent and efficient walking after surgery were identified: bowel control, absence of cognitive impairment, a favourable Barthel score and the coexistence of low comorbidities [88, 102].

The subject of total knee arthroplasty in nonagenarians was developed in a few articles [89, 90, 95, 104–107]. Unlike hip arthroplasty, post-operative mortality was moderate: 0% to 5% of patients in the different studies [95, 105, 106]. However, the rate of post-operative medical complications remained high with rates greater than 20% [105, 106].

In the article of DePalma MJ et al. [108], the efficacy, safety and the new fracture occurrence after percutaneous vertebroplasty (PV) among 123 nonagenarians presenting with osteoporotic vertebral compression fracture (VCF) was evaluated. This was a prospective study. PV had high efficiency for pain control with a mean visual analogue scale score decreasing from 7.6 at baseline to 1.2 one month after the PV. No complications were encountered during the follow up period. Thirteen new fractures after PV were observed (10.6%). According to the authors, the PV for VCF appeared effective and safe.

Few results are available for gastrointestinal surgery among patients aged 90 years or more [109–116]. The main interventions were hernia surgery, colorectal cancer surgery, biliary lithiasis surgery and surgery of the oesophagus and stomach [109, 110, 112, 113, 116]. The operations were performed as an emergency in 69%–72% of cases [109, 110, 114]. The in-hospital mortality rate ranged between 9.4% and 24% of patients in the studies [109, 113–115]. The postoperative complications rate remained significant affecting 41 to 71.7% of the nonagenarian patients [109, 113]. Mortality after surgery seemed related to elements such as the ASA score, emergency surgery and the severity of the disease, according to Arenal JJ et al. [109].

In the study of Racz J et al. [113], one of the objectives was to evaluate the performance of the physiologic and operative severity score for enumeration of mortality and morbidity (POSSUM) and Portsmouth POSSUM (P-POSSUM) as predictors of mortality. These two systems incorporate both physiologic parameters and details related to the surgical procedure, but they used different regression equations to predict mortality. The results of the study showed that the POSSUM and p-POSSUM have significantly over predicted mortality as compared to observed mortality, particularly in higher risk groups, so these scoring systems were not reliable predictors of in-hospital mortality for nonagenarians.

Very few studies have analysed the surgical management of nonagenarians with cancer. In the study by McCorkle R et al. [117], 375 elderly patients who had undergone cancer surgery were included. Among these patients there were some nonagenarians. For this interventional study, all patients were divided into two groups according to the type of postoperative ambulatory monitoring. One group, consisting of 190 patients received specialised home care, while the second group, consisting of 185 patients received usual care at home. The study showed that specialised home care by advanced practice nurses has an impact on survival. The hazard ratio for death in the usual care group was 2.04 (CI 1.33–3.12, p =. 001) after adjusting for stage of disease and surgical hospitalisation length of stay. This difference in survival was particularly noticeable among patients with late stage disease. For example, 2-year survival among late stage intervention group cases was 67% compared with 40% among control cases.

Oncological treatment of nonagenarians

There is little data in the literature analysing the oncological treatment of nonagenarian patients [118–132]. They are most often single centre studies with small numbers of patients included.

In the domain of radiotherapy (RT), the study of Chargari C et al. [118] is the first large retrospective multicentre study of patients aged 90 years or older receiving RT. Two university hospitals and two private centres participated in the study. Tumour characteristics were examined, as well as treatment specificities and treatment intent. A total of 308 patients receiving 318 RT courses were identified, the mean age was 93.2 years. Treatment was given with curative intent in 44.2% of cases (141 patients) and was given with palliative intent in 55.8% of cases (177 patients). Most frequent primary tumours were skin tumours (30.2%), followed by breast carcinoma (15.6%), tumours of the digestive tract (13.3%), and urological tumours (14.6%). Hypofractionation and split course were used in 87.7% and 7.3% of cases, respectively. Factors associated with a choice of curative treatment were performance status (PS), place of life, previous surgery and tumour stage. The median survival estimated was 22.9 months (95 CI 15.5–42.7 months) and RT could not be completed in 23 patients (7.5% of cases). Regarding toxicities, most were mild to moderate, with no long term toxicity but with an acute grade 5 toxicity for one patient in the palliative RT group. Cancer was cause of death in 8.7% and 46.2% of patients treated with curative and palliative intent. In the study, 79 patients (25.6% of cases) among the palliative treatment group, did not receive any follow-up from their radiation oncologist after completion of RT.

In conclusion, the authors noted that RT was feasible in nonagenarians and some factors like PS, place of life and tumour stage were factors of the therapeutic decision. Age did not seem to be the only factor to exclude patients from a potentially curative radiotherapy, but an accurate assessment of geriatric vulnerabilities seemed to be essential to select the optimal treatment for these patients.

Other studies with more limited populations included were interested in the RT [125, 129, 131, 133]. In Ikeda H et al. [125], 57 nonagenarian patients were included and treated by radical radiotherapy. The rate of completion of treatment was 75% (43/57), if the treatment field was limited to the gross primary tumour volume only and if the cumulative dose was above 80% of the tolerable adult dose. Familial support seemed to be important for the choice of the treatment. In Mitsuhashi N et al. [129], the authors have retrospectively examined the clinical efficacy of RT in 32 patients aged 90 years or older. Oguchi et al. [131], have examined clinical records of 27 patients aged over 90 years and who received RT in the 90's. Both authors founded that the age was not an independent criteria for modifying the strategy of RT and studies have suggested that RT was feasible in patients older than 90 years, with tolerable acute side effects.

Finally, Thompson A et al. [133] confirmed the conclusions of the authors cited previously, with 55 nonagenarians included in the study: RT was well tolerated, with 89% completing planned RT and only 18% requiring interruption. Median survival post-RT was 13.0 months, with 56% of patients alive at 12 months.

The study of Moriceau G et al. [130] has analysed the efficacy and safety of chemotherapy among nonagenarians. However, patients treated with oral chemotherapy were not included in the study. Twelve patients were included in this single centre retrospective study, the mean age at initiation of treatment was 90.5 years. The treatment was considered palliative in all patients except one (basaloid carcinoma of the cervix T2a), the general condition of the patients was generally good, with three of 12 patients who had a performance status (PS) of 0 at the beginning of treatment, seven patients were PS 1 and two patients were PS 2. However, half of them lived in an institution at the time of diagnosis. Ten patients had a solid cancer and two were treated for haematological malignancies. Two patients were treated with concomitant radiochemotherapy. Despite a reduction of dosage in half of the patients, nine acute grade 3–4 toxicities were reported and two patients died of septic shock deemed attributable to chemotherapy. The median duration of treatment was 3.2 months (0–9 months) in the first line. Progression free survival ranged from 18 days to 311 days in the front line. Overall survival ranged from 18 days to more than eleven years. The authors concluded that the nonagenarian patients who would theoretically be able to withstand chemotherapy should receive geriatric assessment in order not to compromise their independence and quality of life.

Regarding the centenarian patients with a cancer, there is some epidemiological data [132, 134], but studies on the management of these patients are scarce. In the study of Chargari C et al. [135], the feasibility and toxicity of radiotherapy among centenarians was analysed. The authors note in this study that radiotherapy can be offered in centenarians with an adapted scheme of irradiation and after a careful assessment of geriatric vulnerabilities.

Conclusion and future directions

In the study of Saltzstein SL et al. [132], the authors showed that cancer was a common disease among nonagenarians and centenarians and will be an increasing healthcare problem. Knowledge of its features is essential to planning, delivering and financing health care. However, the realisation of supportive care for nonagenarian patients remains an essential prerequisite for beginning specific treatment in good conditions.

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Correspondence: *Nicolas Magné, Department of Radiotherapy, Institut de Cancérologie Lucien Neuwirth, 108 bis, avenue Albert Raimond – BP 60008, FR-42271 Saint-Priest en Jarez cedex, France, nicolas.magne[at]icloire.fr*

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